記述結果

	平均値	中央値	標準偏差	25ﾊﾟｰｾﾝﾀｲﾙ	50ﾊﾟｰｾﾝﾀｲﾙ	75ﾊﾟｰｾﾝﾀｲﾙ	N
チームワーク	74.4	75.0	16.1	62.5	75.0	87.5	5,225
情報共有	73.0	75.0	18.9	62.5	75.0	87.5	5,244
士気・やる気	76.6	75.0	15.6	66.7	75.0	83.3	5,234
プロとしての成長	71.4	75.0	19.0	58.3	75.0	83.3	5,237
資源（人材や機器の充実）	50.8	50.0	19.8	33.3	50.0	66.7	5,222
責任と権限	65.9	75.0	21.0	50.0	75.0	75.0	5,244
改善のシステム	66.6	68.8	18.0	56.3	68.8	75.0	5,218
業務改善	65.5	66.7	16.1	58.3	66.7	75.0	5,238
経営改善	61.5	66.7	17.4	50.0	66.7	75.0	5,233
仕事量と負担	31.6	25.0	17.9	25.0	25.0	50.0	5,270
安全の確保	68.3	75.0	16.7	62.5	75.0	75.0	5,261
計画実施	66.2	66.7	17.7	58.3	66.7	75.0	5,229
改善の成果	59.8	62.5	19.2	50.0	62.5	75.0	5,237
職務定着意欲	56.2	62.5	24.6	37.5	62.5	75.0	5,262

29

職場定着意欲と組織文化の関連

[redacted]

30

質問項目の妥当性の検証

項目(項目数)	相関係数
職場定着意欲(2)	0.678
チームワーク(4)	0.339, 0.469, 0.582
情報共有(2)	0.601
士気・やる気(3)	0.456, 0.527,0.636
プロとしての成長(3)	0.561, 0.568, 0.699
資源(3)	0.454, 0.497, 0.695
責任と権限(2)	0.644
改善のシステム(4)	0.618, 0.627, 0.639, 0.672, 0.727
安全の確保(2)	0.759
仕事量と負担(2)	0.488
業務改善(3)	0.389, 0.398, 0.512, 0.559
経営改善(3)	0.602, 0.619, 0.629
計画実施(3)	0.360, 0.448, 0.514
改善の成果(2)	0.634

Effect of certified training facilities for intensive care specialists on mortality in Japan

Kazuto Yamashita, Hiroshi Ikai, Masaji Nishimura, Kiyohide Fushimi and Yuichi Imanaka

ABSTRACT

Objective: To compare patient outcomes in hospitals certified by the Japanese Society of Intensive Care Medicine (JSICM) as training facilities for intensive care specialists with patient outcomes in hospitals not certified by the JSICM (non-CFs).

Design: A retrospective case–control study using administrative data.

Main outcome measure: Inhospital mortality.

Results: 164 803 intensive care unit admissions were identified between 1 April 2008 and 31 March 2010, of which 159 540 were for adults (≥ 18 years). A total of 50 875 patients in 125 hospitals were admitted to certified facilities (CFs) and 108 665 patients in 309 hospitals were admitted to non-CFs. Inhospital mortality rates were 9.9% and 10.6% in CFs and non-CFs, respectively ($P < 0.001$). After adjusting for age, emergency admission, admission route, use of vasopressors, mechanical ventilation, and renal replacement therapy, the odds ratio for hospital mortality in CF-treated patients was 0.81 (95% confidence interval, 0.78–0.85). The *c* statistic of the model was 0.881.

Conclusions: Patients admitted to the intensive care unit in CFs had better outcomes. To improve patient outcomes, more board-certified intensivists are required in Japan.

Crit Care Resusc 2013; 15: 28–32

The impact of intensive care physicians on patient outcomes is widely debated. Critical care represents a large percentage of health care spending, and improving the quality of care in intensive care units is essential, given that medical needs will increase as the population ages rapidly. However, as of August 2011, Japan had only 878 critical care specialists certified by the Japanese Society of Intensive Care Medicine (JSICM; referred to as "board-certified" intensivists) — only 0.3% of the total number of physicians.[1] This suggests that the majority of patients who need intensive care are treated by non-board-certified physicians. JSICM certifies training facilities for intensive care specialists. According to their rules for certification,[2] an ICU that is a certified facility (CF) has at least one board-certified intensivist. The question of whether more intensivists are needed must be addressed immediately, as intensivist training takes 5 to 10 years after graduation from medical school, and medical demand is estimated to peak in 2025 in Japan; however, it is difficult to answer this question, because few studies have investigated the impact of board-certified intensivists in Japan.

The purpose of our study was to investigate the impact of board-certified intensivists in Japan, using administrative data. The study was approved and registered by the Kyoto University Graduate School and Faculty of Medicine Ethics Committee.

Methods

Data source

Data were obtained from the Diagnosis Procedure Combination (DPC) database, which is the national administrative database of a casemix classification system for acute inpatient care, developed in Japan and used since 2003.[3] The database consists of summarised clinical information and detailed health care claim data. Clinical information comprises key patient information on age, sex, primary diagnosis, comorbidities (as classified by the International Classification of Diseases, 10th revision), complications, surgeries, and the DPC code. The DPC code is a 14-digit code used for reimbursement, where the first two digits represent the 18 major diagnosis categories (MDC) comprising diseases that require the most medical resource expenditure. Health care claim data include detailed medical resources use, indexed in the original Japanese codes,[4] including diagnostic tests, all surgical or interventional procedures, medications, and the specified hospitalisation fees.

Hospital selection

All hospitals in the DPC database with at least one patient admitted to the ICU were included in this study. A list of CFs was obtained from the JSICM website.[5]

Patient selection

From all patients who were discharged between 1 April 2008 and 31 March 2010 we selected patients who were admitted to an ICU at any point during their hospitalisation. To focus on adult intensive care, patients younger than 18 years of age were excluded.

Table 1. Background of patients, by type of intensive care facility in Japan

	CFs (n = 50 875)*	Non-CFs (n = 108 665)*	$P^{\dagger}$
No. of hospitals	125	309	
Age (years)	67.2 (14.0)	68.3 (14.4)	< 0.001
Male	31 950 (62.8%)	64 306 (59.2%)	< 0.001
Emergency admission	24 042 (47.3%)	59 063 (54.4%)	< 0.001
Admission route to ICU			< 0.001
Post scheduled surgery	27 516 (54.1%)	52 716 (48.5%)	
Post emergency surgery	8 540 (16.8%)	18 483 (17.0%)	
Medical indication	14 819 (29.1%)	37 466 (34.5%)	
Major diagnosis category			< 0.001
Nervous system	6 314 (12.41%)	17 055 (15.7%)	
Eye	12 (0.02%)	20 (0.02%)	
Ear, nose, mouth and throat	572 (1.12%)	852 (0.78%)	
Respiratory system	4 461 (8.77%)	10 059 (9.26%)	
Circulatory system	20 601 (40.49%)	33 601 (30.92%)	
Digestive system	9 362 (18.4%)	23 765 (21.87%)	
Musculoskeletal system	1 203 (2.36%)	4 092 (3.77%)	
Skin and subcutaneous tissue	48 (0.09%)	89 (0.08%)	
Breast	58 (0.11%)	442 (0.41%)	
Endocrine and metabolic system	849 (1.67%)	1 789 (1.65%)	
Kidney and urinary system	2 114 (4.16%)	3 843 (3.54%)	
Female reproductive system	597 (1.17%)	1 546 (1.42%)	
Blood and immunological disorders	985 (1.94%)	1 603 (1.48%)	
Congenital disease	220 (0.43%)	262 (0.24%)	
Paediatric disease	25 (0.05%)	82 (0.08%)	
Injuries, burns and poisoning	1 756 (3.45%)	6 261 (5.76%)	
Psychiatry	36 (0.07%)	251 (0.23%)	
Others	1 657 (3.26%)	3045 (2.8%)	
Uncoded	5 (0.01%)	8 (0.01%)	

CFs = hospitals certified as training facilities for intensive care specialists by the Japanese Society of Intensive Care Medicine. ICU = intensive care unit.
* Categorical variables are given as no. of cases (%); continuous variable is given as mean (SD). † χ^2 test for categorical variables; Student *t*-test for continuous variables.

Patient outcomes

We evaluated ICU mortality and hospital mortality and compared patients who were treated in CFs with those who were treated in non-CFs.

We evaluated the impact of CFs on mortality using a two-step analysis. First we generated two models using multivariate logistic regression to adjust for casemix. One model (model A) included the variables age, emergency admission, admission source, treatments carried out in the ICU, such as mechanical ventilation, renal replacement therapy, and use of vasopressors. The other model (model B) included primary diagnosis in addition to the variables in model A. The forced-entry method was used in both models. In model B, MDCs constituting more than 1% of the total cases were selected, and the MDC "circulatory system" was used as the reference category. To check the discriminatory ability of the models, *c* statistics were calculated.

After calculating *c* statistics of the models, a binary variable was assigned to indicate the group to which the patient belonged. The *c* statistics of the models were calculated again.

Statistical analyses

Data were compared using the χ^2 test for categorical variables and the unpaired Student *t*-test for continuous variables. Data are expressed as mean (standard deviation [SD]) or number (%). $P < 0.05$ was considered significant. All statistical analyses were performed using SPSS 11.0J (SPSS Inc).

Table 2. Treatments and outcomes of patients, by type of intensive care facility in Japan

	CFs (n = 50 875)*	Non-CFs (n = 108 665)*	P
Vasopressor	24 147 (47.5%)	43 738 (40.3%)	< 0.001
Mechanical ventilation	14 503 (28.5%)	21 786 (20.0%)	< 0.001
Renal replacement therapy	2 420 (4.8%)	3 443 (3.2%)	< 0.001
Blood transfusion	11 688 (23.0%)	17 908 (16.5%)	< 0.001
Tracheostomy	1 843 (3.6%)	2 548 (2.3%)	< 0.001
Length of ICU stay (days)	3.1 (3.4)	3 (3.3)	< 0.001
Length of hospital stay (days)	28.8 (26.4)	27.7 (27.1)	< 0.001
Discharge to other hospitals	6 172 (12.1%)	15 351 (14.1%)	< 0.001
ICU mortality	2 407 (4.7%)	5 744 (5.3%)	< 0.001
Inhospital mortality	5 046 (9.9%)	11 540 (10.6%)	< 0.001

CFs = hospitals certified as training facilities for intensive care specialists by the Japanese Society of Intensive Care Medicine. ICU = intensive care unit.
* Categorical variables are given as no. of cases (%); continuous variables are given as mean (SD).

Results

A total of 164 803 ICU admissions in 434 hospitals were identified, of which 5266 cases (3.2%) were excluded because the patients were under 18 years of age. A total of 159 540 cases were included in our analysis.

A total of 50 875 patients in 125 hospitals were treated in CFs and 108 665 patients in 309 hospitals were treated in non-CFs. The two groups were not substantially different with respect to disease categories; however, a higher proportion of CF patients exhibited diseases and disorders of the circulatory system (P < 0.001) (Table 1).

The proportions of patients who needed special treatments in the ICU were higher in CFs than in non-CFs (Table 2). ICU mortality and inhospital mortality were slightly higher in non-CFs (ICU mortality: 4.7% in CFs, 5.3% in non-CFs; inhospital mortality: 9.9% in CFs, 10.6% in non-CFs).

Results of the logistic regression analysis are presented in Table 3. In the first step, both models exhibited a good discriminatory ability. In the second step, among CF-treated patients the odds ratios for ICU mortality were 0.78 in both models and the odds ratios for hospital mortality were 0.81 and 0.85 in models A and B, respectively.

Discussion

This is the first large-scale study to document the use of ICUs and focus on board-certified intensivists in Japan. According to the Ministry of Health, Labour and Welfare, 806 hospitals were equipped with ICUs in 2008;[6] therefore, these data are from more than half (53.8%) of the ICUs in Japan. Among the patients who needed critical care in our study, admission to hospitals whose ICUs were certified as training facilities for intensive care specialists had a positive effect on patient mortality, after risk adjustment.

Administrative data are easier and less expensive to collect than clinical data and are increasingly used in a variety of specialties. However, whether administrative data are suitable for risk adjustment in critically ill patients is debatable. A comparison between the performance of a model based on clinical data (customised Simplified Acute Physiology Score [SAPS] II) with that of a model based on administrative data (customised hospital standardised mortality ratio) in a Dutch ICU population showed that the clinical data-based model outperformed the administrative data-based model, particularly for high-risk patients.[7] On the other hand, a comparison between several models based on administrative data with three physiology-based scores (Acute Physiology and Chronic Health Evaluation [APACHE] II, SAPS II and SAPS III) concluded that the Charlson comorbidity index[8] combined with other administrative data predicted short- and long-term mortality in ICU patients as effectively as the physiology-based scores.[9]

In Japanese ICUs that are not certified as training facilities, physiological scores are not available for all patients, because there are no critical care specialists or such requirements. In general, physiological scores, such as the Sequential Organ Failure Assessment (SOFA) score[10] and APACHE II,[11] are preferred for clinical decision making, standardising research and comparing the quality of patient care across ICUs. We adjusted for the difference in casemix using ICU treatments because in our view each treatment reflects the severity of illness. The SOFA score comprises six elements: respiratory, renal, hepatic, cardiovascular, haematological and neurological. The predictive power of each element has been reviewed previously.[12] Entry criteria for each treatment vary somewhat between clinicians; some ICU treatments may be used as surrogates of the physiological score. For example, in the SOFA score, the use of mechanical ventila-

Table 3. Multiple logistic regression analysis of inhospital and ICU mortality

	Inhospital mortality, by model				ICU mortality, by model			
	A	A + certified status	B	B + certified status	A	A + certified status	B	B + certified status
Age	1.03*	1.03*	1.03*	1.03*	1.02*	1.02*	1.02*	1.02*
Emergency admission	2.20*	2.17*	2.13*	2.10*	2.09*	2.05*	2.01*	1.97*
Admission route								
Post scheduled surgery	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Post emergency surgery	2.11*	2.12*	2.05*	2.05*	3.93*	3.94*	3.70*	3.71*
Medical indication	6.01*	5.98*	5.18*	5.16*	9.22*	9.17*	9.17*	9.14*
ICU treatment								
Vasopressor	4.39*	4.41*	5.12*	5.13*	4.75*	4.78*	5.19*	5.20*
Mechanical ventilation	3.77*	3.85*	3.60*	3.65*	4.45*	4.55*	4.51*	4.62*
Renal replacement therapy	3.52*	3.57*	3.51*	3.54*	2.12*	2.15*	2.27*	2.30*
Major diagnosis category								
Nervous system			3.04*	3.00*			1.59*	1.56*
Respiratory system			2.46*	2.43*			0.71*	0.70*
Circulatory system			1.00	1.00			1.00	1.00
Digestive system			1.58*	1.57*			0.93	0.91*
Musculoskeletal system			1.28*	1.27*			0.61*	0.60*
Endocrine and metabolic system			1.47*	1.46*			0.78	0.78
Kidney and urinary system			1.32*	1.31*			0.71*	0.70*
Female reproductive system			1.41	1.4			0.53	0.52
Blood and immunological disorders			5.17*	5.19*			1.27*	1.28*
Injuries, burns and poisoning			1.67*	1.65*			1.23*	1.21*
Others			2.68*	2.67*			0.92	0.92
Other diagnosis categories†			1.01	1.02			0.56*	0.56*
Certified ICU, odds ratio (95% CI)		0.81 (0.78–0.85)		0.85 (0.81–0.88)		0.78 (0.74–0.82)		0.78 (0.73–0.82)
c statistic	0.881	0.881	0.892	0.892	0.892	0.881	0.902	0.902

ICU = intensive care unit. * $P < 0.05$. † Includes seven major diagnosis categories (eye; ear, nose, mouth and throat; skin and subcutaneous tissue; breast; congenital disease; paediatric disease; psychiatry), each of which consisted of less than 1% of total cases.

tion is about equivalent to a respiratory score of > 2, the use of renal replacement therapy is equivalent to a renal score of ≥ 3, and the use of vasopressors is equivalent to a cardiovascular score of ≥ 2. The *c* statistics for our models were high. Therefore, the use of ICU treatments as risk-adjustment variables is one option for countries where physiological scores are unavailable for evaluating the quality of care in a critical care setting.

Suitable physician staffing in ICUs is widely debated. High-intensity ICU physician staffing has been shown to be associated with reduced hospital mortality.[13] However, it has also been reported that patients managed by critical care physicians had higher hospital mortality than those who were not.[14]

In our study, overall mortality was relatively low compared with that of other countries. An investigation of international variation in critical care services across North America and Western Europe found an inverse correlation between ICU beds per capita and hospital mortality.[15] In the United States, less than one-third of patients admitted to the ICU are from an operating room or related sources.[16] By contrast, in our study, about half of the patients in both groups were admitted to the ICU after a scheduled operation. Admission route has already been shown to be a risk factor for inhospital mortality,[17,18] so casemix may explain the fact that overall mortality among ICU patients is relatively low in Japan considering the number of ICU beds. However, this fact raises a new question: where are the other patients who suffer from severe diseases and need to be treated in the ICU?

The reason why better outcomes were achieved in CFs is unclear from this study, but possible explanations include implementation of best clinical practices, such as evidence-based treatments for acute lung injury and sepsis; prevention of ICU complications;[19] the educational role of ICU staff;[20] and quick responses to emergency situations.

Limitations

This study has several limitations. First, we did not consider the intensity of care provided by each physician, which may influence the result. The 24-hour availability of a consultant-level intensivist is considered ideal,[21] but in Japan physicians were not present in 21% of ICUs.[22] These variations in the intensity of care may decrease the effect. We used mortality as the outcome, but mortality alone is not sufficient to measure the quality of ICUs.[23] Activities of daily living after hospital discharge, the care process and costs should be evaluated in the future.

Second, the administrative data included information on a calendar-day basis rather than an hourly basis. We were therefore unable to distinguish between death in the ICU and death in the ward immediately after ICU discharge. But these deaths appear to indicate poor quality of care, given that a significant rate of readmission to the ICU within 48 hours is considered to indicate suboptimal clinical care.[21] Therefore, inclusion of these deaths in ICU mortality is not germane to our discussion.

Conclusion

In Japan, models that use administrative data to adjust for the casemix of ICU patients provide good discriminatory ability, and we have shown that ICUs that are certified as training facilities for intensive care specialists have a positive effect on mortality in Japan.

Competing interests

None declared.

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References

1 Japanese Board of Medical Specialties. http://www.japan-senmon-i.jp/data/index.html [Japanese] (accessed Dec 2012).
2 Japanese Society of Intensive Care Medicine. Regulations of the intensive care board certificate system, chapter 8. Tokyo: JSICM. http://www.jsicm.org/en/rules/rule11.html (accessed Dec 2012).
3 Fushimi K, Hashimoto H, Imanaka Y, et al. Functional mapping of hospitals by diagnosis-dominant case-mix analysis. *BMC Health Serv Res* 2007; 7: 50.
4 Kubo T, Fujino Y, Murata A, et al. Prevalence of type 2 diabetes among acute inpatients and its impact on length of hospital stay in Japan. *Intern Med* 2011; 50: 405-11.
5 Japanese Society of Intensive Care Medicine. http://www.jsicm.org/senmon/index.html [Japanese]. Tokyo: JSICM (accessed Dec 2012).
6 Ministry of Health, Labour and Welfare (Japan). [Survey of medical institutions] [Japanese]. 2008. Page 16. www.mhlw.go.jp/toukei/saikin/hw/iryosd/08/dl/03.pdf (accessed Jan 2013).
7 Brinkman S, Abu-Hanna A, van der Veen A, et al. A comparison of the performance of a model based on administrative data and a model based on clinical data: effect of severity of illness on standardized mortality ratios of intensive care units. *Crit Care Med* 2012; 40: 373-8.
8 Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis* 1987; 40: 373-83.
9 Christensen S, Johansen MB, Christiansen CF, et al. Comparison of Charlson comorbidity index with SAPS and APACHE scores for prediction of mortality following intensive care. *Clin Epidemiol* 2011; 3: 203-11.
10 Vincent JL, de Mendonça A, Cantraine F, et al. Use of the SOFA score to assess the incidence of organ dysfunction/failure in intensive care units: results of a multicenter, prospective study. Working group on "sepsis-related problems" of the European Society of Intensive Care Medicine. *Crit Care Med* 1998; 26: 1793-800.
11 Knaus WA, Draper EA, Wagner DP, Zimmerman JE. APACHE II: a severity of disease classification system. *Crit Care Med* 1985; 13: 818-29.
12 Minne L, Abu-Hanna A, de Jonge E. Evaluation of SOFA-based models for predicting mortality in the ICU: a systematic review. *Crit Care* 2008; 12: R161.
13 Pronovost PJ, Angus DC, Dorman T, et al. Physician staffing patterns and clinical outcomes in critically ill patients: a systematic review. *JAMA* 2002; 288: 2151-62.
14 Levy MM, Rapoport J, Lemeshow S, et al. Association between critical care physician management and patient mortality in the intensive care unit. *Ann Intern Med* 2008; 148: 801-9.
15 Wunsch H, Angus DC, Harrison DA, et al. Variation in critical care services across North America and Western Europe. *Crit Care Med* 2008; 36: 2787-93.
16 Lilly CM, Zuckerman IH, Badawi O, Riker RR. Benchmark data from more than 240,000 adults that reflect the current practice of critical care in the United States. *Chest* 2011; 140: 1232-42.
17 Azoulay E, Adrie C, De Lassence A, et al. Determinants of postintensive care unit mortality: a prospective multicenter study. *Crit Care Med* 2003; 31: 428-32.
18 Iapichino G, Morabito A, Mistraletti G, et al. Determinants of post-intensive care mortality in high-level treated critically ill patients. *Intensive Care Med* 2003; 29: 1751-6.
19 Kim MM, Barnato AE, Angus DC, et al. The effect of multidisciplinary care teams on intensive care unit mortality. *Arch Intern Med* 2010; 170: 369-76.
20 Kim JH, Hong SK, Kim KC, et al. Influence of full-time intensivist and the nurse-to-patient ratio on the implementation of severe sepsis bundles in Korean intensive care units. *J Crit Care*.2012; 27: 414.e11-21.
21 Rhodes A, Moreno RP, Azoulay E, et al. Prospectively defined indicators to improve the safety and quality of care for critically ill patients: a report from the Task Force on Safety and Quality of the European Society of Intensive Care Medicine (ESICM). *Intensive Care Med* 2012; 38: 598-605.
22 Imanaka Y, Hayashida K, Murakami G, et al. Physician staffing and patient outcome in Japanese ICUs [Japanese]. *J Jpn Soc Intensive Care Med* 2010; 17: 227-32.
23 Eddleston JM, White P, Guthrie E. Survival, morbidity, and quality of life after discharge from intensive care. *Crit Care Med* 2000; 28: 2293-9. ❑

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Physician adherence to asthma treatment guidelines in Japan: focus on inhaled corticosteroids

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administrative data, asthma management, compliance, database research, insurance claim review, quality measurement

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Abstract

Objectives Asthma treatment guidelines recommend inhaled corticosteroids (ICS) as the first-line therapy. However, ICS are prescribed to lower percentages of asthmatic patients in Japan than in other developed countries. The aim of this study was to reveal factors affecting the prescription of ICS for asthmatic adults.
Methods Using insurance claims data in Kyoto Prefecture, Japan, we performed a cross-sectional study. We assessed whether outpatients aged 15 years or older who were diagnosed with asthma had received ICS or not, and conducted logistic regression analyses to identify patients' and facilities' factors associated with ICS use.
Results We analysed 13 428 asthmatic adults, of which 51% were prescribed ICS. Patients receiving asthma care at facilities with respiratory or allergy specialists were more likely to receive ICS than facilities without specialists (adjusted odds ratio 2.70; 95% confidence interval 2.46–2.97). Those aged 75 years or older were less likely to receive ICS than those aged 15 to 64 (adjusted odds ratio 0.71; 95% confidence interval 0.64–0.78). An examination of the interaction between the presence or absence of specialists and facility training status suggested that whether asthmatic adults received ICS depended on the former factor rather than the latter.
Conclusion The presence of specialists in facilities and the age of patients were strong factors affecting ICS prescription. Increases in ICS therapy for the elderly and ICS prescription by non-specialists would lead to an overall increase in patients receiving ICS and consequently achieving the goal of asthma control.

Introduction

Clinical practice guidelines are defined as 'systematically developed statements to assist practitioner and patient decisions about appropriate health care for specific clinical circumstances' [1]. Adherence to guidelines has been shown to improve the quality of health care by promoting standardized processes of diagnosis and treatment [2]. Asthma is recognized as a global public health problem, afflicting an estimated 300 million patients worldwide [3]. In Japan, asthma prevalence for adults has been reliably estimated to be 4.2% [4], and guidelines have been established for its treatment [5].

Adherence to asthma guidelines contributes to better control of asthma and decreases in asthma-related hospitalizations and fatal cases [6,7]. National guidelines in Japan are based on international guidelines as provided by the Global Initiative for Asthma [3], and modified to take into account local cultural and health care system requirements. Table 1 shows the treatment steps of long-term asthma management as recommended in the Asthma Prevention and Management Guidelines 2009 [5], the current version of the Japanese guidelines. Both international and national guidelines have recommended the use of inhaled corticosteroids (ICS) as the first-line treatment of asthma irrespective of asthma severity. ICS are typically administered via a metered-dose inhaler or a dry powder inhaler.

Asthma Insights and Reality in Japan in 2000 reported that 12% of adults with asthma had been prescribed ICS [8], whereas Asthma Insights and Reality in Europe in 1999 showed this proportion to be 22% [9]. As a consequence of poor adherence to asthma guidelines in Japan, there is a general failure to achieve well-controlled asthma [8].

Previous studies conducted outside Japan have reported physician prescription behaviours in samples of asthmatic patients within specific age ranges [10,11]. Little is known, however, about the risk of non-use of ICS for the elderly with asthma compared to younger adults in multicentre surveys. Insurance claims data in

Table 1 Long-term asthma management as recommended in the Asthma Prevention and Management Guidelines 2009, Japan*

Step 1†	Step 2†	Step 3†	Step 4†‡
Low-dose ICS	Low- or medium-dose ICS	Medium- or high-dose ICS	High-dose ICS
Or any one of the following alone if ICS cannot be used:	And any one of the following if needed:	And any one or a combination of the following:	And a combination of the following:
Leukotriene modifier	Long-acting beta2-agonist	Long-acting beta2-agonist	Long-acting beta2-agonist
Sustained release theophylline	Leukotriene modifier	Leukotriene modifier	Leukotriene modifier
	Sustained release theophylline	Sustained release theophylline	Sustained release theophylline

*If asthma is not controlled, treatment should be stepped up. If control is maintained for 3 to 6 months, treatment can be stepped down.
†If needed, anti-allergic drugs other than leukotriene modifier can be added in each step. Anti-allergic drugs indicate chemical mediator release inhibitor, H1-antihistamine, thromboxane A2 inhibitor and Th2 cytokine inhibitor.
‡If asthma is not well controlled by the above therapy, addition of anti-IgE treatment and/or oral corticosteroids can be considered.
ICS, inhaled corticosteroids.

Japan include detailed prescription data, which allows for the evaluation of physicians' adherence to asthma treatment guidelines in multiple health care facilities. The aim of our study was to conduct an analysis of claims data in order to reveal the factors affecting ICS prescription in asthmatic adults of all ages in Japan.

Methods

We utilized a cross-sectional analysis of insurance claims data. The data source was comprised of claims information that had been electronically submitted to National Health Insurance and Long Life Medical Care System from February 2009 to November 2009 by health care facilities in Kyoto Prefecture, located in western Japan. National Health Insurance covers the unemployed population (e.g. farmers, the self-employed, the retired, part-time workers, and their families), while the Long Life Medical Care System covers participants aged 75 or older, as well as those aged between 65 and 74 with disabilities. The number of total participants from Kyoto Prefecture in both systems was 953 000 people. Our database did not include patients' personal information, and patients could not be identified from the data that we utilized. This study was approved by the Ethics Committee of Kyoto University Graduate School of Medicine (E1023).

Study population

We retrospectively identified all outpatients aged 15 years or older who were diagnosed with asthma. Asthma was identified according to International Classification of Diseases, 10th Revision (ICD-10) codes (see Appendix S1). To ensure a conclusive diagnosis of asthma, patients were required to have had at least two insurance claims for treatment of asthma at one health care facility. Patients were excluded: if they were given a diagnosis of chronic obstructive pulmonary disease (COPD) (ICD-10 codes shown in Appendix S1) in order to avoid confusion with asthma in diagnostic and therapeutic procedures; if they were diagnosed as having rheumatic disease (ICD-10 codes shown in Appendix S1) [12], with which patients are more likely to receive systemic corticosteroids; or if they had not received any anti-asthmatic medication.

We identified allergic rhinitis [13] and gastro-oesophageal reflux disease [14] as co-morbid conditions frequently occurring in combination with asthma (ICD-10 codes shown in Appendix S1). We also determined the presence of the following co-morbidities cited from Charlson co-morbidity index [15] to adjust for pre-existing conditions among patients: myocardial infarction, congestive heart failure, peripheral vascular disease, cerebral vascular disease, dementia, chronic pulmonary disease (excluding asthma and COPD), peptic ulcer, mild to severe liver disease, diabetes without chronic complication, diabetes with chronic complication, hemiplegia or paraplegia, renal disease, malignancy (including lymphoma and leukaemia, and excluding malignant neoplasm of skin) and metastatic solid tumour. These were identified according to ICD-10 coding algorithms for Charlson co-morbidities (see Appendix S1) [12].

Facility characteristics were derived from the prefectural health care facilities information system. Facility type was classified into the following four categories according to facility size and training status: physician's office, non-training hospital, cooperative type of clinical resident training hospital, and management type of clinical resident training hospital. Cooperative type of training hospitals conduct training for a portion of courses for medical residents belonging to management type of hospitals, while management type of training hospitals, including university hospitals, provide all or a large part of medical training courses for clinical residents. The distinction between these two types of hospitals is designated by the Ministry of Health, Labour and Welfare. Specialists were identified as board certified members of Japanese Respiratory Society and Japanese Society of Allergology. Whether facilities are located in the prefectural capital city or not was employed as facility location status.

Variables for analysis

We created dependent and independent valuables to perform bivariable analysis and multiple logistic regression analysis. The dependent variable used in the analysis was the utilization of ICS in each patient, and categorized as follows: 0 (ICS not utilized) and 1 (ICS utilized).

The independent variables were patient- and facility-level characteristics available in the database. Patients' sex was scored 0 (men) or 1 (women). Patients' age was collapsed into three categories (15 to 64 years, 65 to 74 years, and 75 years or older) because of the quadratic relationship with the dependent variable in the models tested. Patients who were 15 to 64 years old served as the reference group. Variables related to co-morbidity were dichotomized as 0 (no co-morbid condition) or 1 (co-morbid condition) for each co-morbidity. The variables for the characteristics of the facility were as follows: presence (scored 1) versus absence (scored 0) of respiratory or allergy specialists; facility type which was collapsed into the aforementioned four categories; and facility location which was dichotomized as 0 (within the prefectural capital city) or 1 (outside of the prefectural capital city).

Development of the statistical model

Initially, we performed bivariable analyses using chi-squared testing to determine the relationship between each independent variable and dependent variable. We then constructed multivariable logistic regression models to assess the effect of presence or absence of specialists, facility type and patients' age on the decisions of physicians with regard to prescription of ICS. We also controlled for other variables that could be potential confounding factors (i.e. sex, co-morbidity and facility location). We hypothesized an interaction between the presence or absence of specialists and the facility type. Other statistical methods were considered (e.g. fitting a multivariable model including all possible interactions between specialists, facility type, age and each co-morbidity), but consequently ruled out because of the difficulties in interpreting such complex logistic regression models [16].

In the first model, we utilized all the independent variables as described above. The second model was similar to the first, but with an inclusion of the interaction between the presence or absence of specialists and each of the facility types. The second model enabled us to assess facility characteristics with eight categories, which represented all possible combinations of specialists (presence vs. absence) and facility type (physician's office, non-training hospital, cooperative type of training hospital, and management type of training hospital).

Both models were adjusted for sex, age, each co-morbidity, presence or absence of specialists, facility type and facility location. We calculated adjusted odds ratios (ORs) with 95% confidence intervals (CIs). $P < 0.05$ was considered statistically significant. All *P*-values were two-tailed. Statistical analyses were performed using SPSS software, version 18.0.0 (SPSS Inc., Chicago, IL, USA).

Results

Patient description and bivariable analysis

We identified 43 724 adult patients with asthma; of these patients, 30 105 had at least two insurance claims for asthma treatment submitted by one health care facility in the study period, and 21 524 were not diagnosed with COPD or rheumatic disease. Within this sample, 8096 were treated without anti-asthmatic medication. This left a study population of 13 428 patients enrolled from 588 facilities.

Approximately half of the population ($n = 6876$, 51%) received ICS for asthma care. Table 2 provides patient- and facility-level characteristics of patients who did or did not receive ICS. There were more women than men (61% vs. 39%), and patients aged 15 to 64 years, 65 to 74 years, and 75 years or older accounted for about one-third of the study population, respectively. More than half of the patients aged 15 to 64 years and 65 to 74 years received ICS, whereas less than half of those aged 75 years or older did not ($P < 0.001$). The most common co-morbidity was allergic rhinitis ($n = 5031$, 38%).

In facility-level characteristics, facilities with respiratory or allergy specialists provided asthma care for 5155 patients (38% of the study population). Two-thirds of these patients ($n = 3432$) received ICS. In contrast, 42% of patients ($n = 3444$) who were treated at facilities without specialists received ICS ($P < 0.001$). Forty-five per cent of the study population ($n = 5974$) were treated at physicians' offices, with the remaining treated at hospitals. The proportion of ICS use in each facility type ran from 45% (non-training hospital) through 63% (management type of training hospital) ($P < 0.001$). Sixty-one per cent of the patients ($n = 8196$) received regular outpatient treatment at facilities located in the prefectural capital city. We found significant association between facility location and ICS use in the bivariable analysis ($P < 0.001$).

In the results of the bivariable analyses, as shown in Table 2, sex and chronic pulmonary disease (excluding asthma and COPD) were not significantly associated with ICS use.

Multivariable analysis

Table 3 shows the results of the first model, without taking into account the interaction between the presence or absence of specialists and the facility training status. After adjustment for all the variables listed in Table 2, one of the factors associated with a high possibility of ICS use was presence of specialists (adjusted OR 2.70; 95% CI 2.46–2.97) when compared with their absence. The odds of prescribing ICS were greater when the facility type was physician's office (adjusted OR 1.19; 95% CI 1.07–1.33), cooperative type of training hospital (adjusted OR 1.22; 95% CI 1.06–1.41) or management type of training hospital (adjusted OR 1.44; 95% CI 1.28–1.62), when compared with non-training hospital.

Patients aged 75 years or older had significantly decreased odds of receiving ICS (adjusted OR 0.71; 95% CI 0.64–0.78) compared with a reference group aged 15 to 64 years. In contrast, the odds of receiving ICS for patients aged 65 to 74 years did not differ from those aged 15 to 64 years. We found significant inverse associations between the following co-morbidities and ICS use: allergic rhinitis, congestive heart failure, peripheral vascular disease, cerebral vascular disease, dementia, peptic ulcer, mild to severe liver disease, diabetes without chronic complication, malignancy (including lymphoma and leukaemia, and excluding malignant neoplasm of skin) and metastatic solid tumour. We found that sex, co-morbidities other than those mentioned above, and facility location were not significantly associated with ICS use after adjustment for the effects of the other variables.

Table 4 shows the results of the second model. We examined the interaction between the presence or absence of specialists and the facility training status. After adjustment for sex, age, each co-morbidity and facility location, the 'absence of specialists + physician's office' category was the only category that was significantly less likely to prescribe ICS (adjusted OR 0.79; 95% CI 0.69–0.90) than the 'absence of specialists + non-training hospital' category, which served as the reference group. Facilities with specialists had significantly increased odds of ICS prescription regardless of facility type than the 'absence of specialists + non-training hospital' category. For example, the

Table 2 Characteristics of study population

	All patients (n = 13 428)	No ICS therapy (n = 6552)	ICS therapy (n = 6876)	P-value*
Patient-level characteristics				
Sex				
Men	5278 (39.3)	2561 (39.1)	2717 (39.5)	0.61
Women	8150 (60.7)	3991 (60.9)	4159 (60.5)	
Age (years)				
15–64	4812 (35.8)	2032 (31.0)	2780 (40.4)	
65–74	3989 (29.7)	1814 (27.7)	2175 (31.6)	<0.001
≥75	4627 (34.5)	2706 (41.3)	1921 (27.9)	
Co-morbidity†				
Allergic rhinitis	5031 (37.5)	2510 (38.3)	2521 (36.7)	0.049
Gastro-oesophageal reflux disease	2999 (22.3)	1612 (24.6)	1387 (20.2)	<0.001
Myocardial infarction	295 (2.2)	175 (2.7)	120 (1.7)	<0.001
Congestive heart failure	2118 (15.8)	1290 (19.7)	828 (12.0)	<0.001
Peripheral vascular disease	1338 (10.0)	789 (12.0)	549 (8.0)	<0.001
Cerebral vascular disease	2113 (15.7)	1277 (19.5)	836 (12.2)	<0.001
Dementia	346 (2.6)	247 (3.8)	99 (1.4)	<0.001
Chronic pulmonary disease‡	171 (1.3)	88 (1.3)	83 (1.2)	0.48
Peptic ulcer	3727 (27.8)	2026 (30.9)	1701 (24.7)	<0.001
Mild to severe liver disease	2095 (15.6)	1180 (18.0)	915 (13.3)	<0.001
Diabetes without chronic complication	2903 (21.6)	1648 (25.2)	1255 (18.3)	<0.001
Diabetes with chronic complication	619 (4.6)	341 (5.2)	278 (4.0)	0.001
Hemiplegia or paraplegia	82 (0.6)	51 (0.8)	31 (0.5)	0.02
Renal disease	367 (2.7)	217 (3.3)	150 (2.2)	<0.001
Malignancy§	1227 (9.1)	693 (10.6)	534 (7.8)	<0.001
Metastatic solid tumour	162 (1.2)	107 (1.6)	55 (0.8)	<0.001
Facility-level characteristics				
Presence or absence of specialists¶				
Absence	8273 (61.6)	4829 (73.7)	3444 (50.1)	<0.001
Presence	5155 (38.4)	1723 (26.3)	3432 (49.9)	
Facility type				
Physician's office	5974 (44.5)	3228 (49.3)	2746 (39.9)	
Non-training hospital	2228 (16.6)	1215 (18.5)	1013 (14.7)	<0.001
Cooperative type of clinical resident training hospital	1392 (10.4)	688 (10.5)	704 (10.2)	
Management type of clinical resident training hospital	3834 (28.6)	1421 (21.7)	2413 (35.1)	
Location				
Within the prefectural capital city	8196 (61.0)	3787 (57.8)	4409 (64.1)	<0.001
Outside of the prefectural capital city	5232 (39.0)	2765 (42.2)	2467 (35.9)	

Data are given as number (column percentage) of patients.
*Data are given for the comparison between no ICS therapy and ICS therapy groups.
†Not mutually exclusive.
‡Asthma and chronic obstructive pulmonary disease are excluded.
§Lymphoma and leukaemia are included. Malignant neoplasm of skin is excluded.
¶Specialists indicate respiratory or allergy specialists.
ICS, inhaled corticosteroids.

odds of ICS use were increased in the 'presence of specialists + physician's office' category (adjusted OR 6.89; 95% CI 5.39–8.81). We did not find a significant difference among training status of hospitals without specialists. For example, the odds of prescribing ICS in the 'absence of specialists + management type of training hospital' category did not differ from those in the 'absence of specialists + non-training hospital' category in the second model. Each of the other independent variables (i.e. sex, age, each co-morbidity and facility location) yielded ORs similar to those in the first model that did not include the interaction between the presence or absence of specialists and the facility training status (data not shown).

Discussion

We identified patients' and facilities' factors affecting ICS prescription for 13 428 patients with asthma from 588 health care facilities in Japan. Our findings are based on an analysis of a patient sample covering a wide age range.

Table 3 ORs for ICS prescription in the model without taking into account any interaction

	OR (95% CI)	*P*-value
Patient-level variable		
Sex		
Men	Reference	
Women	1.00 (0.92–1.07)	0.92
Age (years)		
15–64	Reference	
65–74	1.02 (0.93–1.12)	0.68
≥75	0.71 (0.64–0.78)	<0.001
Co-morbidity*		
Allergic rhinitis	0.88 (0.81–0.94)	0.001
Gastro-oesophageal reflux disease	0.96 (0.88–1.06)	0.44
Myocardial infarction	0.91 (0.70–1.18)	0.47
Congestive heart failure	0.75 (0.67–0.84)	<0.001
Peripheral vascular disease	0.81 (0.71–0.92)	0.001
Cerebral vascular disease	0.79 (0.71–0.88)	<0.001
Dementia	0.59 (0.46–0.76)	<0.001
Chronic pulmonary disease†	0.85 (0.61–1.17)	0.32
Peptic ulcer	0.86 (0.79–0.94)	0.001
Mild to severe liver disease	0.85 (0.77–0.94)	0.002
Diabetes without chronic complication	0.80 (0.73–0.89)	<0.001
Diabetes with chronic complication	1.01 (0.83–1.22)	0.93
Hemiplegia or paraplegia	0.77 (0.47–1.24)	0.28
Renal disease	0.91 (0.72–1.15)	0.44
Malignancy‡	0.77 (0.67–0.88)	<0.001
Metastatic solid tumour	0.51 (0.36–0.73)	<0.001
Facility-level variable		
Specialists§		
Absence	Reference	
Presence	2.70 (2.46–2.97)	<0.001
Facility type		
Physician's office	1.19 (1.07–1.33)	0.002
Non-training hospital	Reference	
Cooperative type of clinical resident training hospital	1.22 (1.06–1.41)	0.005
Management type of clinical resident training hospital	1.44 (1.28–1.62)	<0.001
Location		
Within the prefectural capital city	Reference	
Outside of the prefectural capital city	0.96 (0.89–1.04)	0.33

Data are provided as adjusted ORs (95% CI) for all the patient- and facility-level variables.

*Data are provided as ORs when compared with absence of each co-morbidity.

†Asthma and chronic obstructive pulmonary disease are excluded.

‡Lymphoma and leukaemia are included. Malignant neoplasm of skin is excluded.

§Specialists indicate respiratory or allergy specialists.

ICS, inhaled corticosteroids; OR, odds ratio; CI, confidence interval.

The presence of respiratory or allergy specialists in health care facilities was a strong factor affecting the likelihood of ICS use. This finding is consistent with that of a previous study [10]. In facilities without specialists, there may be several potential factors that contribute to suboptimal ICS use, including lack of guideline understanding [17] and underestimation of asthma severity [18]. There are many systematic approach methods to enhance guideline compliances: for instance, an instructive process has been shown to improve general practitioners' prescription behaviour for asthmatic patients in Japan [19]. However, further efforts are required to disseminate guidelines to non-specialists, because 62% of asthmatic adults are treated at health care facilities without specialists.

We also found that patients aged 75 or older were less likely to receive ICS than those aged 15 to 64. In Japan, age-adjusted asthma mortality rates have decreased in recent years [20]. This trend is considered to be associated with increasing ICS use [21]. However, two-thirds of all fatal asthma cases in Japan involved patients that were 75 years or older [22]. Thus, one of the causes of the observed high asthma mortality among the elderly might be the low prescription rate of ICS among patients aged 75 or older. Sin *et al.* [23] have demonstrated that ICS therapy reduces mortality and hospitalization among asthmatic elderly patients. Increasing ICS prescription for the elderly may therefore result in the reduction in asthma mortality in Japan.

Strengths and limitations

Our study possesses several advantages when compared to those in the existing literature. Because of the comprehensiveness of our data source, we were able to include study patients of all adult ages, rather than be limited to patients of a certain age range. As stated in the introduction, previous studies have focused on physician behaviour prescribing for asthmatic patients within specific age ranges [10,11]. To the best of our knowledge, the present study is the first claims data research that has revealed the increased risk of not prescribing ICS for the elderly when compared to younger adults.

Furthermore, in this study we have examined facility training statuses and their interactions with the presence or absence of specialists on ICS prescription. The training status was shown to affect the prescription or non-prescription of ICS in the model that did not include these interactions as independent variables. The model that included these interactions, however, suggested that whether asthmatic patients received ICS or not depended on the presence or absence of specialists rather than the training statuses of hospitals.

Our study has several limitations. First, health insurance claims are essentially financial documents and not medical records. Information about individual patient details such as asthma severity, control status, smoking habits and patient adherence is scant. ICS should in theory be prescribed for all asthmatic patients because its use is recommended in the guidelines irrespective of these patients' factors. Moreover, the diagnostic accuracy in claims data may be questioned. Previous studies, however, have validated the accuracy of asthma diagnosis in claims data [24]. In fact, there have been numerous influential asthma studies using claims data [25]. As such, we believe our findings to be based on reliable information about diagnosis and prescription.

Second, the database includes prescription information on a facility basis rather than a physician basis. In Japan, some asthmatic patients are treated by non-specialists in hospitals despite the presence of specialists. Also, patients treated at physicians'

Table 4 ORs for ICS prescription in the model examining interaction*

	OR (95% CI)	*P*-value	OR (95% CI)	*P*-value
	Absence of specialists†		Presence of specialists†	
Physician's office	0.79 (0.69–0.90)	<0.001	6.89 (5.39–8.81)	<0.001
Non-training hospital	Reference		1.33 (1.12–1.58)	0.001
Cooperative type of clinical resident training hospital	0.93 (0.78–1.12)	0.47	2.28 (1.85–2.81)	<0.001
Management type of clinical resident training hospital	1.20 (1.00–1.44)	0.051	2.72 (2.36–3.13)	<0.001

Data are provided as adjusted ORs (95% CI) for all the patient-level variables and facility location.
*Interaction between the presence or absence of specialists and the facility type.
†Specialists indicate respiratory or allergy specialists.
ICS, inhaled corticosteroids; OR, odds ratio; CI, confidence interval.

offices with specialists are more likely to receive specialist care than those treated at hospitals with specialists, because most offices are managed by solo-practitioners. Access to physician-level prescription data may allow us to observe a stronger association between specialists and ICS use.

Conclusions

We have revealed several factors that influence ICS prescription in various health care facilities. We found that increases in ICS therapy for the elderly and ICS prescription by non-specialists would lead to an overall increase in patients receiving ICS. Consequently, this could contribute to a decrease in asthma mortality rates among the elderly and an increase in the number of patients achieving the goal of asthma control.

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References

1. Institute of Medicine Committee to Advise the Public Health Service on Clinical Practice Guidelines (1990) Clinical Practice Guidelines: Directions for a New Program. p. 38. Washington, D.C.: National Academy Press.
2. Audet, A. M., Greenfield, S. & Field, M. (1990) Medical practice guidelines: current activities and future directions. *Annals of Internal Medicine*, 113 (9), 709–714.
3. The Global Initiative for Asthma (GINA) (revised 2010) GINA report, global strategy for asthma management and prevention. Available at: http://www.ginasthma.com/Guidelineitem.asp??l1=2&l2=1&intId=60 (last accessed 19 May 2011).
4. Fukutomi, Y., Nakamura, H., Kobayashi, F., *et al.* (2010) Nationwide cross-sectional population-based study on the prevalences of asthma and asthma symptoms among Japanese adults. *International Archives of Allergy and Immunology*, 153 (3), 280–287.
5. The Japanese Society of Allergology (2009) Asthma Prevention and Management Guidelines 2009, Japan. pp. 108–109. Tokyo: Kyowa Kikaku (in Japanese).
6. Suissa, S., Ernst, P., Benayoun, S., Baltzan, M. & Cai, B. (2000) Low-dose inhaled corticosteroids and the prevention of death from asthma. *New England Journal of Medicine*, 343 (5), 332–336.
7. Suissa, S., Ernst, P. & Kezouh, A. (2002) Regular use of inhaled corticosteroids and the long term prevention of hospitalisation for asthma. *Thorax*, 57 (10), 880–884.
8. Adachi, M., Ohta, K., Morikawa, A., Nishima, S., Tokunaga, S. & Disantostefano, R. (2008) Changes in asthma insights and reality in Japan (AIRJ) in 2005 since 2000. *Arerugi*, 57 (2), 107–120. (in Japanese with English summary).
9. Rabe, K., Vermeire, P., Soriano, J. & Maier, W. (2000) Clinical management of asthma in 1999: the Asthma Insights and Reality in Europe (AIRE) study. *European Respiratory Journal*, 16 (5), 802–807.
10. Sin, D. & Tu, J. (2001) Underuse of inhaled steroid therapy in elderly patients with asthma. *Chest*, 119 (3), 720–725.
11. Breton, M., Lelorier, J., Forget, A. & Blais, L. (2007) Use of combination therapy in asthma: are they prescribed according to guidelines. *Respiratory Medicine*, 101 (9), 1916–1923.
12. Quan, H., Sundararajan, V., Halfon, P., Fong, A., Burnand, B., Luthi, J., Saunders, L., Beck, C., Feasby, T. & Ghali, W. (2005) Coding algorithms for defining comorbidities in ICD-9-CM and ICD-10 administrative data. *Medical Care*, 43 (11), 1130–1139.
13. Bousquet, J., Van Cauwenberge, P., Khaltaev, N. & Aria Workshop Group, WHO (2001) Allergic rhinitis and its impact on asthma. *Journal of Allergy and Clinical Immunology*, 108 (Suppl. 5), S147–S334.
14. Harding, S. (2003) Acid reflux and asthma. *Current Opinion in Pulmonary Medicine*, 9 (1), 42–45.
15. Charlson, M., Pompei, P., Ales, K. & MacKenzie, C. (1987) A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *Journal of Chronic Diseases*, 40 (5), 373–383.
16. Chen, J. (2003) Communicating complex information: the interpretation of statistical interaction in multiple logistic regression analysis. *American Journal of Public Health*, 93 (9), 1376–1377. author reply 7.

17. Crim, C. (2000) Clinical practice guidelines vs actual clinical practice : the asthma paradigm. *Chest*, 118 (Suppl. 2), S62–S64.
18. Wolfenden, L., Diette, G., Krishnan, J., Skinner, E., Steinwachs, D. & Wu, A. (2003) Lower physician estimate of underlying asthma severity leads to undertreatment. *Archives of Internal Medicine*, 163 (2), 231–236.
19. Nishio, C., Hajiro, T., Nagao, T., Ito, M., Sakaguchi, C. & Nakano, Y. (2008) Specialists play a vital role in general practitioners' prescription behavior: a qualitative study of asthma care in Japan. *Journal of Asthma*, 45 (4), 339–342.
20. Ito, Y., Tamakoshi, A., Wakai, K., Takagi, K., Yamaki, K. & Ohno, Y. (2002) Trends in asthma mortality in Japan. *Journal of Asthma*, 39 (7), 633–639.
21. Suissa, S. & Ernst, P. (2003) Use of anti-inflammatory therapy and asthma mortality in Japan. *European Respiratory Journal*, 21 (1), 101–104.
22. Tamura, G. (2005) Recent trends and future issues of asthma mortality in Japan. *Allergology International*, 54 (2), 223–227.
23. Sin, D. & Tu, J. (2001) Inhaled corticosteroid therapy reduces the risk of rehospitalization and all-cause mortality in elderly asthmatics. *European Respiratory Journal*, 17 (3), 380–385.
24. Krueger, K. P., Armstrong, E. P. & Langley, P. C. (2001) The accuracy of asthma and respiratory disease diagnostic codes in a managed care medical claims database. *Disease Management*, 4 (4), 155–161.
25. Thomas, M., Cleland, J. & Price, D. (2003) Database studies in asthma pharmacoeconomics: uses, limitations and quality markers. *Expert Opinion on Pharmacotherapy*, 4 (3), 351–358.

Supporting information

Additional Supporting Information may be found in the online version of this article:

Appendix S1 ICD-10 codes for the diseases analysed in our study.

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Importance of ambulance utilization for administration of tissue plasminogen activator for acute ischemic stroke

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Introduction

The administration of intravenous tissue plasminogen activator (t-PA) is an effective treatment for acute ischemic stroke if provided promptly. Since its application was approved in October 2005 in Japan, the number of use increases, however, overall use remains small.

Because the use of t-PA use is dependent on the elapsed time after stroke onset, emergency medical service infrastructure is an important factors to be considered in an analysis. Although several previous studies have addressed such a factor influencing t-PA administration, these studies have generally been conducted using relatively small sample sizes.

In this study, we analyze factors associated with t-PA administration using a large-scale administrative database, considering case-mixes adjusting patients stroke severities.

METHODS

In a cross-sectional retrospective analysis, we analyze acute ischemic stroke patients admitted between July 2010 and March 2011 using administrative claims data submitted by hospitals throughout Japan participating in the Quality Indicator/Improvement Project (QIP). We used a logistic regression model to analyze the factors influencing t-PA administration. These candidate factors included patient gender, age, severity of stroke symptoms, and arrival by ambulance. Stroke symptoms at admission included consciousness levels determined using the Japan Coma Scale, and physical impairment levels determined utilizing the modified Rankin Scale scoring system.

RESULTS

We analyzed 11,337 acute ischemic stroke patients from 113 hospitals. We observed 641 (5.7%) of these patients received t-PA treatment. Gender had no association with t-PA administration. Patients aged 75 years or more were found to be associated with decreased t-PA administration. Severe stroke, except for the most severe cases, and ambulance utilization were associated with increased t-PA administration. The regression model had a good level of discrimination with a c-statistic of 0.799.

CONCLUSION

Using a large-scale cross-sectional retrospective analysis of Japanese hospitals, administration of t-PA was found to be significantly associated with age and severity of stroke symptoms. Adjusted by patients' characteristics, administration of t-PA was found to be associated with ambulance use.

Importance of ambulance utilization for administration of tissue plasminogen activator for acute ischemic stroke

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Stroke and t-PA

- Tissue plasminogen activator (t-PA) is a thrombolytic agent
- One of the effective treatments for acute ischemic stroke
  - Approved in 1987 in the US as for AMI
  - additional approval for stroke in 1996
  - Approved in Europe in 2002
  - Approved in Japan in 2005
- Applicable only within a few hours (3h in Japan, ~4.5 in Europe)*
- Opportunities for t-PA administration are restricted
- Utilization remains unsurprisingly low

- Previous studies analyzing the factors affecting t-PA administration were mainly at the hospital or local regional level
- From the social and political perspective, national-level multi-hospital analyses are required to identify these factors in order to improve utilization

**Shinohara Y 2011; Adams Jr. HP 2007; The European Stroke Organization 2008*

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Diagnosis Procedure Combination/Per-Diem Payment System (DPC/PDPS)

- Reimbursement system introduced in Japan in 2003 for acute care hospitals nationwide
- DPC data: uniformly-formatted administrative claims data
  - ➢ Multi-hospital analyses
- From July 2010, additional information
  - – Includes neurological deficits and date of stroke onset in stroke patients
- Analysis of large-scale data while taking into account critical differences in patient case-mix has become possible

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Objective

- To identify factors associated with t-PA administration using a large-scale multi-hospital database
  - – To analyze the effect of ambulance utilization, while adjusting for case-mix, including stroke severity

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Methods

- Cross-sectional retrospective analysis
- Quality Indicator/Improvement Project (QIP) database
  - Administrative claims data is routinely submitted by >300 voluntary participant hospitals throughout Japan
- Acute ischemic stroke patients admitted to QIP hospitals between July 2010 and March 2011
  - Principal diagnosis of stroke detected by ICD-10 code of "I63$", and stroke onset date = date of admission
- Data from only hospitals that had discharged one or more patients with t-PA administration
  - Japanese guidelines recommend their use in hospitals meeting a certain criteria, e.g., with CT or MRI scanners installed, or have Stroke Care Units
- Sample: **11,337 acute ischemic stroke patients** from **113 hospitals**

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Statistical Analysis

- Multivariable logistic regression analysis to identify independent factors associated with t-PA administration
- Candidate factors included patient gender, age, severity of stroke symptoms, and arrival by ambulance
  - Severity of stroke symptoms were analyzed as categories based on the combination of consciousness levels (Japan Coma Scale) and physical Impairment levels (modified Rankin Scale) at admission
- Two-tailed P-values of less than 0.05 indicated statistical significance
- Analysis conducted using SPSS Ver.19.0.0.2

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Results: Characteristics and t-PA Use of Acute Ischemic Stroke Patients

Variables		t-PA use	%	Total
Gender				
Male		376	5.7%	6,624
Female		265	5.6%	4,713
Age (years)				
<65		137	6.0%	2,270
65-74		157	5.5%	2,841
75-84		243	6.2%	3,939
>85		104	4.5%	2,287
Consciousness level and physical impairment level at admission				
Consciousness	Physical impairment			
Grade 0 (Alert)				
	Mild	19	0.7%	2,540
	Moderate	53	2.3%	2,283
	Severe	33	9.9%	335
Grade I (Awake)				
	Mild	18	2.0%	915
	Moderate	132	5.9%	2,234
	Severe	146	11.5%	1,274
Grade II (Arousable)		182	15.8%	1,153
Grade III (Unarousable)		58	9.6%	603
Arrival by ambulance				
No		76	1.5%	5,124
Yes		565	9.1%	6,213
Total	(113 hospitals)	641	5.7%	11,337

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Results: Multivariable Logistic Regression Analysis of t-PA Utilization

Independent variables		OR	(95%CI)
Gender			
Male		Reference	
Female		0.936	(0.78-1.12)
Age (years)			
<65		Reference	
65-74		0.721*	(0.56-0.93)
75-84		0.609***	(0.48-0.77)
>85		0.308***	(0.23-0.41)
Consciousness level and physical impairment level at admission:			
Consciousness	Physical impairment		
Grade 0 (Alert)			
	Mild	Reference	
	Moderate	2.73***	(1.61-4.64)
	Severe	11.78***	(6.55-21.21)
Grade I (Awake)			
	Mild	2.30*	(1.19-4.41)
	Moderate	7.20***	(4.40-11.78)
	Severe	13.90***	(8.46-22.82)
Grade II (Arousable)		19.03***	(11.63-31.14)
Grade III (Unarousable)		10.99***	(6.39-18.90)
Arrival by ambulance		3.85***	(2.99-4.95)

C-statistic: 0.799

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Discussion 1

- Association of increased age and decreased t-PA use were consistent with guidelines*
  - Advising limited indication to older patients
- Effects of the severity of stroke symptoms were also consistent with guidelines**
  - Do not recommend t-PA treatment for patients with minor neurological symptoms, and call caution for patients with major neurological symptoms

**The European Stroke Organization 2008, Ringleb PA 2008*
***Shinohara Y Dis 2011, Adams Jr. HP 2007*

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Discussion 2

- Previous studies have shown inconsistent effects of aging and gender on t-PA use*
- Aging has also been found to be associated with delays in seeking medical help and time to hospital arrival**
- Shorter times to treatment has been found to be associated with higher severity of stroke symptoms**

** De Silva DA 2009, Nagaraja N 2012, Allen NB 2009, Turtzo LC 2008, Singer OC 2012*
*** Chang KC 2004, Gargano JW 2011, Lichtman JH 2009, Hong ES 2011*

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