根拠に基づく医療（EBM）

- evidence based medicine, EBM
  - カナダのマクマスター大学のサケット教授たちにより提唱された。
  - 自分自身が直面する診療上の問題（治療法の選択など）について文献検索を行い、エビデンスレベル（後述）や研究の質を批判的に吟味する。
  - 診療上の結論を自分の患者に適用して良いかを判断する。
  - 臨床疫学とも呼ばれる。

EBMにおける研究デザインの評価

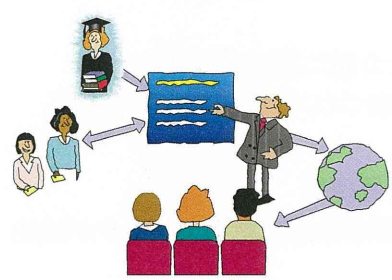
分類	研究デザインの名称
Ⅰa	システマティック・レビュー　／メタ・アナリシス
Ⅰb	無作為化比較試験(randomized controlled trial, RCT)
Ⅱa	非ランダム化比較試験
Ⅱb	分析疫学的研究（コホート研究や症例対照研究）
Ⅲ	記述的研究（症例報告やケースシリーズなど）
Ⅳ	患者データに基づかない専門委員会や権威者個人の意見

RCTが常に最高の研究デザイン？

- ヒトに対して有害と考えられる暴露を強制的に与えることは**倫理**上許されない。
  - RCTの適用は新薬の治療効果などに限定される。
- すでに日常診療に導入されている行為を改めて評価する場合
- 薬物副作用の検討
- 時間や資源の制約

疫学研究の目的

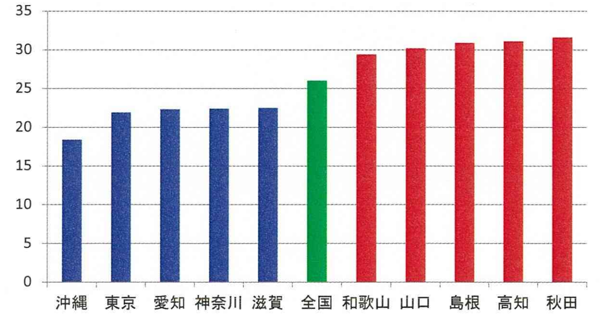
様々な因子の中から**疾患発生確率**を増加（減少）させるものを発見し、本当に疾患と関連があるかを検討（<u>因果推論</u>）し、有効な対策を生み出していくこと



「エビデンス」を鵜呑みにしない

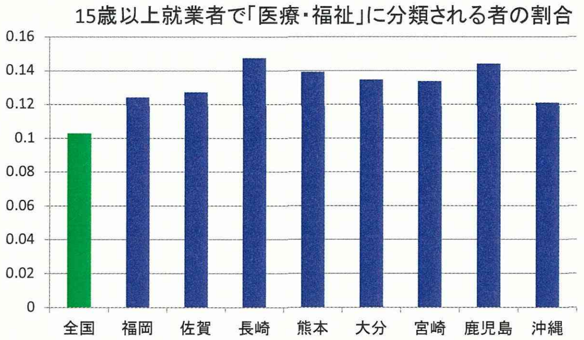
- 海外の有名な学術誌に採択された論文に記載された内容が**「わが町」に適用するか？**
- <u>被用者保険で成立する前提条件</u>が国保にも当てはまるか？
- **人口規模や年齢構成**の異なる自治体の先進事例はどの程度参考になるだろうか？

老年人口割合の地域格差



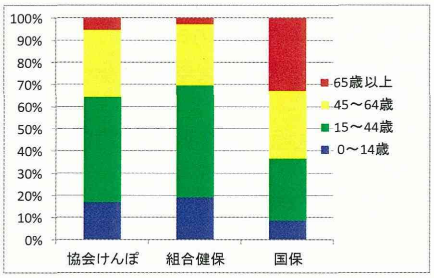
総務省：平成25年10月1日推計人口より

九州は全国より医療・福祉の割合が高い



「国勢調査」: 平成22年10月1日現在

国保は高齢者の割合が高い



注: 協会けんぽ及び組合健保は平成25年10月1日の被保険者と被扶養者の合計、国保は同年9月30日の市町村と組合の合計である。いずれも後期高齢者医療制度の対象者は含まれていない。
資料: 厚生労働省「健康保険・船員保険被保険者実態調査」「国民健康保険実態調査」

わかっているようでわかっていない

- 社会的入院と介護施設入所の関係
  →医療と介護を合算したデータはどこに？
- 医療と介護に関する費用の分布
  →健康づくり事業と医療費適正化
- 年齢と医療費
  →国保と後期高齢者でデータが断絶

まとめ

- **研究者も一人の人間**である。
  →**「お互い様」の心**で思いやりを。
- 学術論文に示された「エビデンス」の限界
  →前提条件などをきちんと把握しましょう。
- 地域格差の拡大
  →優先順位を今一度見直しましょう。

研究成果の刊行に関する一覧表

書籍

著者氏名	論文タイトル名	書籍全体の編集者名	書　籍　名	出版社名	出版地	出版年	ページ
消費生活マスター介護問題研究会著		本澤巳代子監修	『サ高住の探し方』	信山社	東京	2015	全55頁

雑誌

発表者氏名	論文タイトル名	発表誌名	巻号	ページ	出版年
Abe T, Tamiya N, Kitahara T, Tokuda Y	Polypharmacy as a risk factor for hospital admission among ambulance-transported old-old patients	Acute Medicine & Surgery	On line first doi: 10.1002/ams2.153	1-7	2015
Ishizaki T, Shimmei M, Fukuda H, Oh E H, Shimada C, Wakui T, Mori H, Takahashi R	Cumulative number of hospital bed days among older adults in the last year of life: A retrospective cohort study	Geriatrics & Gerontology International	doi: 10.1111/ggi.12777	1-7 (in press)	2016
Nagata I, Abe T, Nakata Y, Tamiya N	Factors related to prolonged on-scene time during ambulance transportation for critical emergency patients in a big city in Japan: a population-based observational study	BMJ Open	6 doi:10.1136/bmjopen-2015-009599	1-6	2016
Takeda F, Noguchi H, Monma T, Tamiya N	How possibly do leisure and social activities impact mental health of middle-aged adults in Japan?: An evidence from a national longitudinal survey.	PLOS ONE	10(10) DOI:10.1371/journal.pone.0139777	1-10	2015
石崎達郎	療養場所移動時におけるケアの質確保の取り組み	老年社会科学	37(3)	347-352	2015
桑名温子　田宮菜奈子　森山葉子　堤春菜　柏木聖代	娘による母親の介護と義理の娘による義母の介護の比較一つくば市におけるアンケート調査結果から	厚生の指標	5月号	(印刷中)	2016

Original Article

Polypharmacy as a risk factor for hospital admission among ambulance-transported old-old patients

Toshikazu Abe,[1,2] Nanako Tamiya,[2] Takako Kitahara,[1] and Yasuharu Tokuda[3]

[1]*Department of Emergency and Critical Care Medicine, Tsukuba Medical Center Hospital, Tsukuba, Japan,* [2]*Department of Health Services Research, Faculty of Medicine, University of Tsukuba, Tsukuba, Japan, and* [3]*Department of Medicine, Japan Community Healthcare Organization, Tokyo, Japan*

Aim: The aim of this study was to analyze the relationship between polypharmacy and hospital admission in ambulance-transported old-old patients.

Methods: A retrospective cohort study was conducted of consecutive old-old patients (aged ≥ 85 years) transported by ambulance to a community teaching hospital between April and December of 2013. Patients with out-of-hospital cardiopulmonary arrest were excluded. Data were collected from the computerized records on the demographics, chief complaints, vital signs, and level of consciousness at arrival, final diagnoses at discharge, and polypharmacy (≥5 medications). The primary outcome was requirement of hospital admission. We also analyzed symptomatic adverse drug events (ADEs).

Results: Of the 3,084 adults (aged ≥ 18 years) transported to the hospital during the study period, 381 (13%) were old-old patients. Of those, 233 (61%) were women, and 261 (69%) were admitted to the hospital. The mean number of their baseline medications was 6.8 ± 3.9, and 250/347 patients (72%) were suffering from polypharmacy. Twenty-seven of the patients (7%) had symptomatic ADEs. Although the ADEs were not related to polypharmacy ($P = 0.437$), logistic regression adjustments for age, sex, and vital signs at arrival showed that patients with polypharmacy were more likely to be admitted to the hospital than were patients without (odds ratio: 2.12 [95% CI, 1.03–4.43]; $P = 0.042$).

Conclusions: Symptomatic ADEs due to polypharmacy were one of the most preventable causative factors leading to hospital admission of old-old patients. Polypharmacy could be a major risk for emergency admission to hospital.

Key words: Adverse drug event, hospital admission, old-old, polypharmacy

INTRODUCTION

THE PROPORTION OF the population that is elderly has been increasing: 1 in 5 people is now elderly. In particular, the proportion of the "old-old", that is, those aged 85 years and older, has been growing rapidly.[1] Thus, the increase in the number of older patients will become the new global issue of medicine. As the frontrunner among nations with aging populations, this issue is particularly urgent for Japan.

Old-old adults tend to use health care services because of multimorbidity and polypharmacy (multiple medication use).[2,3] Polypharmacy is associated with an increased likelihood of inappropriate prescription and adverse drug events (ADEs).[4]

Corresponding: Toshikazu Abe, MD, MPH, Department of Emergency and Critical Care Medicine, Tsukuba Medical Center Hospital, 1-3-1, Amakumo, Tsukuba, 305-0005, Japan. E-mail: abetoshi1@md.tsukuba.ac.jp.
Received 19 Mar, 2015; accepted 3 Jul, 2015; online publication 27 Aug, 2015

The aging of the population affects the clinical setting of emergency medicine because the emergency department (ED) sits at a unique crossroads in the sequence of geriatric care, overlapping with the outpatient, inpatient, prehospital, home, and extended care settings. In Japan, the hospital admission rates of elderly patients have also been increasing. Emergency department admission of old-old adults challenges emergency physicians, and polypharmacy is one of the possible risk factors for such admissions. Therefore, the aim of this study was to analyze the relationship between polypharmacy and hospital admissions of ambulance-transported old-old patients.

METHODS

Ethics statement

THE STUDY PROTOCOL was reviewed and approved by the ethics committee of Mito Kyodo General Hospital, University of Tsukuba.

Study design, setting, and participants

This was a retrospective cohort study. We reviewed the medical records of consecutive old-old patients (aged ≥ 85 years) transported to the ED of a community teaching hospital (Mito Kyodo General Hospital, Japan) by ambulance. The period studied was from April to December 2013. Patients with out-of-hospital cardiopulmonary arrest at arrival were excluded from the study.

Data collection

Data on demographics, chief complaints, vital signs, and level of consciousness at arrival, final diagnoses at discharge, and medication numbers and lists were collected from the computerized records. Prescription medications were counted according to classes: calcium channel blockers (CCBs), beta-blockers, angiotensin receptor blockers (ARBs), furosemide, digitalis, antithrombotic agents, anticoagulants, antidiabetics, statins, drugs for osteoporosis including calcium and vitamin D, proton pump inhibitors (PPIs), H2 blockers, analgesics, nonopioids, benzodiazepines, antidementia drugs, drugs for dysuria, and drugs for constipation. Polypharmacy was defined as concurrent use of ≥ 5 baseline medications prescribed at outpatient clinics, according to the most common definition used in international polypharmacy studies.[5–7] The primary outcome was requirement of hospital admission. The secondary outcome was symptomatic adverse drug events (ADEs), which were judged and recorded by the patients' primary doctors including emergency physicians and hospitalists.

Statistical analysis

The baseline and clinical characteristics were compared using a *t*-test for the continuous variables and a χ^2 test for the categorical variables, where appropriate. To compare patients with polypharmacy with those without polypharmacy, multivariate logistic regression models were constructed; odds ratios with 95% confidence intervals (CIs) and probability values were estimated. Dependent variables were a requirement of hospital admission for the primary analysis and symptomatic ADEs for the secondary analysis. The exposure was polypharmacy. To adjust for patient acuity, we chose age, sex, and initial vital signs including mean blood pressure (MBP), respiration rate (RR), and heart rate (HR). They were selected on clinical meaning without a statistical selection. The relationship between the vital signs and the severity of the patient's condition should present as a U curve on an ICU severity scoring system such as the Acute Physiology and Chronic Health Evaluation II (APACHE II).[8] We divided MBP, RR, and HR into three categories according to the interquartile range since we controlled for patients' acuity with precision in the multivariate logistic regression models. We also investigated the characteristics of the ADEs and prescription medication classes to obtain more details regarding old-old patients The two-sided significance level for all tests was $P < 0.05$. All analyses were performed using STATA version 13.1 software (StataCorp, College Station, TX, USA) and JMP version 9.0.2 (SAS Institute, Cary, NC, USA).

RESULTS

OF THE 3,084 adults (aged ≥ 18 years) who were transported to the hospital by ambulance, 381 (13%) were aged ≥ 85 years; of these, 233 (61%) were women. Data on the number of medications were missing for 34 patients; therefore, 347 patients were used for the analysis. The mean number of their baseline medications was 6.8 ± 3.9 (Min-Max, 0–22); 250 (72%) were suffering from polypharmacy; and 331 (95%) were taking at least one medication. In total, 261 of the ambulance-transported old-old patients (69%) were admitted to the hospital, and 27 of those (7%) had symptomatic ADEs.

The baseline characteristics of the two groups of patients (with polypharmacy and without polypharmacy) were similar for age, sex, initial vital signs, ADEs, and requirement of hospital admission (Table 1).

Table 2 shows the multivariate logistic regression model for hospital admission among the ambulance-transported old-old patients. Patients with polypharmacy were more likely to be admitted to hospital than were patients without polypharmacy. Increased heart rate was also a risk for admission. Table 3 displays the multivariate logistic regression model for ADEs in the ambulance-transported old-old patients. The proportions of the ADEs did not differ significantly between the two groups. None of the vital signs was related to ADEs.

Table 4 shows the clinical characteristics of the ADEs among the old-old patients. Almost all the ADEs were causative factors for admission. Benzodiazepines were one of the main causative medications of ADEs in this population. Table 5 shows the most common prescription medication classes in the old-old patients. Of the 347 patients with data on medications, 140 (40.3%) were taking calcium channel blockers (CCBs); 123 (35.4%), proton pump inhibitors (PPIs); 109 (31.4%), drugs for constipation; 106 (30.5%), angiotensin receptor blockers (ARBs); 96 (27.7%), benzodiazepines; 83 (23.9%), antithrombotic agents; 61 (17.6%), statins; and 47 (13.5%), antidiabetic agents. Anticoagulants and digitalis were prescribed in a small number of the patients (5.8% and 3.5%, respectively).

Table 1. Characteristics of oldest old transported by Emergency Medical Service (EMS)

		Polypharmacy (n = 250)	No polypharmacy (n = 97)	
	units	Counts (%) or Mean ± SD	Counts (%) or Mean ± SD	*P*-value*
Age	years	90 ± 4	90 ± 4	0.952
Sex (female)		156 (62%)	58 (60%)	0.654
Systolic blood pressure	mmHg	146 ± 30	146 ± 30	0.948
Diastolic blood pressure	mmHg	77 ± 19	78 ± 18	0.708
Respiratory rate	/min	20 ± 5	22 ± 6	0.172
Heart rate	/min	84 ± 21	89 ± 27	0.117
Glasgow Coma Scale		14 ± 2	14 ± 3	0.443
Adverse drug events		19 (8%)	8 (8%)	0.840
Hospital admission		189 (76%)	65 (67%)	0.105

Missing data are systolic blood pressure, n = 45; diastolic blood pressure, n = 48; respiratory rate, n = 107, heart rate, n = 51; Glasgow Coma Scale, n = 81.
**t*-test for continuous variables, χ^2 test for discrete variables.

Table 2. Multivariate logistic regression model for hospital admission in old-old patients transported to hospital by ambulance (n = 226)

		Odds Ratio	95% Confidence Interval		*P*-value
Age, years		1.04	0.95	1.13	0.381
Sex		1.49	0.77	2.88	0.236
Respiratory rate (/min)	Q1 (9–17)	0.91	0.44	1.92	0.801
	reference (18–23)				
	Q3 (24–54)	2.26	0.99	5.52	0.055
Heart rate (/min)	Q1 (30–71)	0.90	0.44	1.90	0.785
	reference (72–97)				
	Q3 (98–199)	8.71	2.80	38.74	<0.001
Mean blood pressure (mmHg)	Q1 (53–87)	0.83	0.37	1.87	0.648
	reference (88–112)				
	Q3 (113–171)	1.36	0.61	3.17	0.464
Polypharmacy		2.12	1.03	4.43	0.042

Q1 = 25% interquartile, Q3 = 75% interquartile.

DISCUSSION

WE HAVE HERE shown that polypharmacy is one of the major risks for hospital admission through the emergency department among old-old adults. To the best of our knowledge, only a few reports about polypharmacy have focused on old-old patients. In our population, the mean number of baseline medications (6.8 ± 3.9) met the definition of polypharmacy (≥ 5 medications). Tsoi *et al.* reported the clinical characteristics of old-old patients in Canada and showed that these patients received a mean number of 6.8 medications per day. They suggested that multimorbidity and polypharmacy were highly prevalent in old-old adults.[9] Hohl *et al.* also showed that young-old patients (aged 65 years and older) who visited the emergency department received an average of 4.2 ± 3.1 medications per day (range, 0–17), with 90.8% receiving at least one medication.[7] As expected, in our study, the number of medications being taken by old-old

Table 3. Multivariate logistic regression model for adverse drug events in old-old patients transported to hospital by ambulance (n = 226)

		Odds Ratio	95% Confidence Interval		*P*-value
Age, years		1.05	0.91	1.22	0.538
Sex		1.11	0.42	3.16	0.830
Respiratory rate (/min)	Q1 (9–17)	1.37	0.42	4.49	0.595
	reference (18–23)				
	Q3 (24–54)	1.24	0.36	4.17	0.725
Heart rate (/min)	Q1 (30–71)	2.03	0.65	6.27	0.218
	reference (72–97)				
	Q3 (98–199)	0.85	0.21	2.98	0.800
Mean blood pressure (mmHg)	Q1 (53–87)	2.35	0.76	7.38	0.136
	reference (88–112)				
	Q3 (113–171)	1.57	0.43	5.28	0.478
Polypharmacy		0.67	0.25	1.92	0.437

Q1 = 25% interquartile, Q3 = 75% interquartile.

patients was greater than that being taken by young-old patients. Our target population (aged ≥ 85 years) comprised 13% of all ambulance transports, and their admission rate was also very high (70%), similar to the findings of a previous report.[10] These high percentages of ambulance transportation and admission rates of old-old patients highlight the trend towards a rapidly growing aging population in Japan.

Although we showed that polypharmacy was significantly related to requirement of hospital admission after controlling for patient acuity levels using their vital signs at arrival, our results did not prove a causal relationship between polypharmacy and ADEs. To the best of our knowledge, no reports have been published comparing the ADEs of old-old patients with polypharmacy with those of old-old patients without polypharmacy. Evidence suggests that the risk of prescribing error, high-risk prescribing, and ADEs are increased as the number of drugs prescribed rises.[11] A previous report also showed that polypharmacy was related to inappropriate medication use.[12] Another report suggested that a higher number of medications was associated with higher rates of ADEs.[7] However, we could not explain which comes first, the chicken or the egg: whether it is polypharmacy or multimorbidity that leads to hospital admission.

Hohl *et al.* reported that 11% of the patients aged older than 65 years who visited the ED had ADEs.[7] This percentage was higher than that of the patients with ADEs found in our study. A likely explanation is that these patients included not only those with symptomatic ADEs but also those taking inappropriate medications. We might have detected such a relationship if we had used the Beers criteria.[13] In our study, almost all ADEs were causative factors for admission because we confirmed only symptomatic ADEs noted by the patients' primary physicians. Therefore, we might have missed potential ADEs. Since Hohl *et al.*'s study reported only descriptive statistics, further research is needed to compare patients with and without polypharmacy.

Our results on baseline medications were similar to those of previous reports. Oral anticoagulants or antiplatelet agents, antidiabetic agents, and agents with a narrow therapeutic index were frequently implicated medicines.[7] The National Electronic Injury Surveillance System-Cooperative Adverse Drug Event Surveillance project showed that three medication classes (oral anticoagulant or antiplatelet agents, antidiabetic agents, or agents with a narrow therapeutic index) caused 48% of all ED visits for ADEs in older patients.[14] However, in our study, benzodiazepines were the most implicated drug. The proportion of benzodiazepines was much greater than those of previous studies, despite benzodiazepines being considered one of the common inappropriate medications prescribed to older adults.[12]

We showed the most common prescription medication classes in old-old adults. Major implicated drugs such as anticoagulants or antiplatelet agents, antidiabetic agents, and agents with a narrow therapeutic index were relatively less prescribed than expected. Physicians might hold back on prescribing drugs associated with worse adherence, such as oral anticoagulants or agents with a narrow therapeutic index. On the other hand, drugs that are easy to prescribe, such as drugs for constipation and benzodiazepines, were frequent. The relationship between benzodiazepines and ADEs in older adults has been documented.[7]

Table 4. Characteristics of adverse drug events in the old-old patients of this study

Age, years	Sex	Implicated Medications	Adverse drug event	No. of medications	Final diagnosis at discharge	Disposition
85	F	Theophylline	Tachycardia	5	Pneumonia	Ad
86	M	Aspirin, Clopidogrel	Blood-stained sputum	9	Lung Cancer	Ad
86	F	Furosemide, Losartan + Hydrochlorothiazide	Vertigo, Vomit, Altered mental state	13	Cerebral infarction	Ad
86	F	Carvedilol	Altered mental state, Bradycardia	8	Bradycardia	Ad
86	F	Glycerin enema	Constipation	4	Rectal perforation	Ad
87	F	Donepezil, Carvedilol, Benzodiazepines	Syncope	10	Syncope	Ad
87	M	Pregabalin, Limaprost alfadex	Syncope	4	Syncope	Home
87	F	Benidipine	Orthostatic hypotension	6	Orthostatic hypotension	Ad
87	M	Digoxin, Benzodiazepines	Delirium	10	Delirium	Ad
87	M	Mexiletine	Anuresis	12	Anuresis	Ad
88	M	Aspirin	Thalamic hemorrhage	2	Thalamic hemorrhage	Ad
88	M	Influenza vaccination	Anaphylactic shock	12	Anaphylactic shock	Ad
89	F	Digoxin	Bradycardia (Af)	3	Digitalis intoxication	Ad
89	F	Spironolactone	Hyponatremia	10	Hyponatremia	Ad
89	M	Aspirin	Chronic subdural hematoma	9	Chronic subdural hematoma	Ad
90	F	Benzodiazepines	Altered mental state	7	Hyperkalemia	Ad
90	F	Benzodiazepines	Aspiration	8	Aspiration pneumonia	Ad
90	F	Benzodiazepines	Aspiration	9	Aspiration pneumonia	Ad
91	F	Benzodiazepines	Altered mental state	3	Altered mental state	Ad
92	M	Digoxin	Bradycardia (Af)	7	Digitalis intoxication	Ad
92	M	Naftopidil	Fall	4	Hypovolemia	Home
92	M	Tramadol	Nausea Dizziness	6	Nausea Dizziness	Home
93	M	Aspirin	Subcortical hemorrhage	3	Subcortical hemorrhage	Ad
94	M	Lansoprazole	Diarrhea	10	Collagenous colitis	Ad
94	F	Benzodiazepines	Aspiration	5	Aspiration pneumonia	Ad
94	F	Benzodiazepines	Fall	6	Hip fracture	Ad
95	F	Benzodiazepines	Altered mental state	4	Somnolentia	Home

Ad, admission.

Table 5. The most common prescription medication classes in the old-old patients of this study (*n* = 347)

Medication class	*n*	%
CCBs	140	40.3%
PPIs	123	35.4%
Drugs for constipation	109	31.4%
ARBs	106	30.5%
Benzodiazepines	96	27.7%
Antithrombotic agents	83	23.9%
Analgesics, nonopioids	70	20.2%
Statins	61	17.6%
Furosemide	53	15.3%
Drugs for dysuria	50	14.4%
Antidiabetics	47	13.5%
Drugs for osteoporosis including Ca and Vit D	44	12.7%
Beta-blockers	41	11.8%
H2 blockers	38	11.0%
Antidementia drugs	35	10.1%
Anticoagulants	20	5.8%
Digitalis	12	3.5%

ARBs, angiotensin receptor blockers; CCBs, calcium channel blockers; PPIs, proton pump inhibitors.

If medication-related problems were ranked as a disease, ADEs would be the fifth leading cause of death in the United States.[13] A heightened awareness of this issue and systematic screening for use of the above medications should lead to better detection of ADEs in the ED. The ADEs caused by those drugs might be preventable.

This study suffers from several limitations. The admission criteria determined by the primary physician were important factors because the primary outcome was requirement of hospital admission. Also, a patient's circumstances might influence the admission criteria. For example, the primary physician might be more likely to admit a patient to hospital before the weekend, or a patient living at a health-care facility might be more likely to be admitted to hospital than a patient living at home. We did not control for these potential confounders. However, the primary outcome, requirement of hospital admission, is still important in clinical practice as a medical service. Soft outcomes, such as admission, are actually more useful than hard outcomes, such as death, in this study setting. Moreover, polypharmacy itself could be a surrogate maker of composite such as nutrition, the level of activities of daily living, dementia comorbidity, and residence. We did not have data on who prescribed the medications. Polypharmacy might have been caused by prescription by multiple clinics. Communicating with the patient's primary physician is probably also crucial. Further studies are needed to analyze such a possible causal relationship.

In conclusion, old-old patients admitted to hospital after being transported to the hospital by ambulance were likely to be taking a number of baseline prescription medications. Some of them had symptomatic adverse drug events, which was one of the most preventable causative factors leading to hospital admission. Polypharmacy could be one of the red flags for hospital admission through the ED.

CONFLICT OF INTEREST

NONE.

FUNDING

A GRANT-IN-AID FOR SCIENTIFIC Research from the Japanese Ministry of Health, Labour and Welfare (H24-Chikyukibo-ippan-001) on Challenges of global ageing without borders. This study is also funded by the Ministry of Health, Labour and Welfare (H27-seisaku-senryaku-012).

ACKNOWLEDGMENT

WE THANK MS Flaminia Miyamasu for English-language revision.

REFERENCES

1 Christensen K, Doblhammer G, Rau R, Vaupel JW. Ageing populations: the challenges ahead. Lancet 2009; 374: 1196–208.
2 Nie JX, Wang L, Tracy CS, Moineddin R, Upshur RE. Health care service utilization among the elderly: findings from the Study to Understand the Chronic Condition Experience of the Elderly and the Disabled (SUCCEED project). J. Eval. Clin. Pract. 2008; 14: 1044–9.
3 Vegda K, Nie JX, Wang L, Tracy CS, Moineddin R, Upshur RE. Trends in health services utilization, medication use, and health conditions among older adults: a 2-year retrospective chart review in a primary care practice. BMC Health Serv. Res. 2009; 9: 217.
4 Goulding MR. Inappropriate medication prescribing for elderly ambulatory care patients. Arch. Intern. Med. 2004; 164: 305–12.
5 Masoodi AN. Polypharmacy: to error is human, to correct divine. BJMP 2008; 1: 6–9.
6 Hamza S, Abdelwadoud M, Kandil I, Mortagy A. Polypharmacy and inappropriate medication use among elderly persons in an Egyptian rural area. Middle East J. Age Ageing 2012; 9: 13–9.
7 Hohl CM, Dankoff J, Colacone A, Afilalo M. Polypharmacy, adverse drug-related events, and potential adverse drug interac-

tions in elderly patients presenting to an emergency department. Ann. Emerg. Med. 2001; 38: 666–71.
8 Knaus WA, Draper EA, Wagner DP, Zimmerman JE. APACHE II: a severity of disease classification system. Crit. Care Med. 1985; 13: 818–29.
9 Tsoi CS, Chow JY, Choi KS *et al.* Medical characteristics of the oldest old: retrospective chart review of patients aged 85+ in an academic primary care centre. BMC Res. Notes 2014; 7: 340.
10 Vilpert S, Ruedin HJ, Trueb L, Monod-Zorzi S, Yersin B, Bula C. Emergency department use by oldest-old patients from 2005 to 2010 in a Swiss university hospital. BMC Health Serv. Res. 2013; 13: 344.
11 Wise J. Polypharmacy: a necessary evil. BMJ 2013; 347: f7033.
12 Fialova D, Topinkova E, Gambassi G *et al.* Potentially inappropriate medication use among elderly home care patients in Europe. JAMA 2005; 293: 1348–58.
13 Fick DM, Cooper JW, Wade WE, Waller JL, Maclean JR, Beers MH. Updating the Beers criteria for potentially inappropriate medication use in older adults: results of a US consensus panel of experts. Arch. Intern. Med. 2003; 163: 2716–24.
14 Budnitz DS, Shehab N, Kegler SR, Richards CL. Medication use leading to emergency department visits for adverse drug events in older adults. Ann. Intern. Med. 2007; 147: 755–65.

SPi	Journal Code	Article ID	Dispatch: 16.03.16	CE:
	G G I	1 2 7 7 7	No. of Pages: 7	ME:

ORIGINAL ARTICLE

Cumulative number of hospital bed days among older adults in the last year of life: A retrospective cohort study

Tatsuro Ishizaki,[1] Masaya Shimmei,[1] Haruhisa Fukuda,[2] Eun-Hwan Oh,[3] Chiho Shimada,[1] Tomoko Wakui,[1] Hiroko Mori[1] and Ryutaro Takahashi[1]

[1]*Human Care Research Team, Tokyo Metropolitan Institute of Gerontology, Itabashi, Tokyo,* [2]*Department of Health Care Administration and Management, Graduate School of Medical Sciences, Kyushu University, Fukuoka, Fukuoka, Japan, and* [3]*Department of Health Management, Hyupsung University, Hwaseong, Gyeonggi Korea*

Aim: To determine whether age, proximity to death and long-term care insurance certification are related to receiving hospital inpatient care; the number of hospital bed days (HBD) among older Japanese adults in the last year of life; and to estimate the total number of HBD.

Methods: Using health insurance claims and death certificate data, the present retrospective cohort study examined the HBD of city residents aged ≥65 years who died between September 2006 and October 2009 in Soma City, Japan. Using a two-part model, factors associated with receiving hospital inpatient care and the total number of HBD in each quarter in the last year of life were examined.

Results: The total number of HBD in the last year of life varied widely; 13% had no admission, and 27% stayed ≥90 days. Younger age, approaching death and having long-term care insurance certification were significantly associated with being more likely to receive hospital inpatient care during each quarterly period in the last year of life. In contrast, having long-term care insurance certification and the last 3-month period before death, compared with the first 3-month period, were significantly associated with a fewer number of HBD.

Conclusions: The present study showed that older age was associated with being less likely to receive hospital inpatient care. The findings regarding the risk of inpatient care and total number of HBD in the last year of life help to understand resource use among older dying adults, and to develop evidence-based healthcare policies within aging societies. **Geriatr Gerontol Int 2016; ••: ••–••.**

Keywords: aged, death, health resources, hospitalization, time factors.

Introduction

The Japanese Ministry of Health, Labor and Welfare forecasts that there will be 1.6 million decedents in 2030 in Japan.[1] The number of persons aged ≥75 years at the time of death doubled from 445 000 in 1990 to 896 000 in 2012.[2] Approximately 80% of the elderly decedents in 2012 died at hospital and 13% at home.[2] The Ministry is concerned that similar proportions of the place of death and average length of hospital stay in 2030, owing to excessive use of hospital inpatient care at the end of life, will create challenges for >400 000 decedents to die in the hospital; furthermore, hospitals will have no capacity to cope with the demand.[1] Therefore, the Ministry restructured the current medical and long-term care (LTC) system for older people, and promoted home care, to avoid hospital bed unavailability and reduce hospitalization for older dying patients by increasing the number of older patients who die at home or in LTC facilities.

There are two issues with the Ministry's projected hospital bed shortage. First, because their interpretation of the place of death (80% in hospitals) in Japan is based on death certificates, the place of death shows only where physicians confirmed the death,[3] not necessarily the place of residence before death, as found in the USA.[4] Second, many studies from Western countries have explored healthcare expenditure within a certain period before death and the association between age, proximity to death and healthcare expenditure.[5–10] However, a few studies from outside Japan have examined the total number of hospital bed days (HBD) and associated factors before death.[4,11,12] The few published studies involving older Japanese individuals have included small sample sizes (109–154 deceased persons).[13–15] In a related study of resource use during a

Accepted 16 February 2016.

Correspondence: •• Tatsuro Ishizaki MD PhD MPH, Human Care Research Team, Tokyo Metropolitan Institute of Gerontology, 35-2 Sakae-cho, Itabashi-ku, Tokyo 173-0015, Japan. Email: tatsuro.ishizaki@gmail.com

doi: 10.1111/ggi.12777

1-year period among 550 non-surviving patients hospitalized in a Japanese hospital, the median number of cumulative HBD was very similar in the 65–74 years, 75–84 years and ≥85 years age groups.[16]

To date, there have been no reports regarding the association of age, proximity to death and disability with the total number of HBD at the end of life in Japan. It is not only valuable to identify healthcare expenditure during the end-of-life period, but also important to understand hospital bed use before death in aged countries. Because population aging incurs greater LTC requirements because of disability, with greater healthcare expenditure, it is relevant to examine whether older persons with disability stayed a greater number of HBD before death compared with those without disability.[17] Furthermore, it is suggestive for researchers and policy makers, both in Japan and abroad, to examine how strong the association of age, proximity to death and disability with hospital resource use in the last year of life in Japan is, because hospital resource use in the end of life might vary across countries because of variation in healthcare policy.

The present study aimed to determine whether age, proximity to death and LTC insurance certification were related to receiving hospital inpatient care; the number of HBD among older Japanese adults in the last year of life; and to estimate the total number of HBD.

Methods

Study location

Soma City in Fukushima prefecture in the northeastern area of Honshu, one of the main islands of Japan, had a population of approximately 38,000 in 2010, and 26% were aged ≥65 years. Approximately 90% of the residents were engaged in secondary or tertiary industries. Available healthcare resources included a total of 347 hospital beds in two hospitals in the city.

Data sources

We collected three sets of insurance claims data from the city: (i) a national health insurance plan for citizens; (ii) a health insurance plan for older people; and (iii) a public LTC insurance plan. The data of these claims were developed on a monthly basis for reimbursement purposes, and were extracted, anonymized and added an individual-level unique identification code by the city. Then the utilization datasets were linked with a register of the city's residents, including sex, birthdate, date of move-in and date of move-out or death, using the assigned identification aforementioned code. Finally, this intermediate dataset was merged with death certificates obtained from Japan's Ministry of Health, Labor and Welfare comprising sex, birthdate, date of death, place of death and main cause of death, matching the birthdate, date of move-out or death and sex (the linkage rate was 100%).

Participants

City residents aged ≥65 years who died of an illness between September 2006 and October 2009, and received medical care during the last year of life between October 2005 and October 2009 were included as members of the cohort in the present study. Residents who died of external causes, such as injuries, burns, poisoning, transport accidents, falls, intentional self harm or assault, were excluded.

According to the death certificate data, 1019 residents aged ≥65 years died during the specified period. Of these residents, 888 were matched with data from either the national health insurance plan or the health insurance plan for older people. To avoid underestimation of medical resource use as a result of migration, we included only decedents who lived in the city for ≥12 months before death ($n = 882$).

Definitions

The demographic variables in the linked data included sex, age 1 year before death, location of death (home, hospital and LTC facility or other), the main cause of death, LTC insurance certification showing a disability (absent or present[18]),and total number of HBD. The main cause of death in the death certificate data was coded based on the International Statistical Classification of Diseases and Related Health Problems, 10th Revision and categorized into five groups: malignant neoplasm (C00-C97); cardiovascular diseases (I01-I02, I05-I09, I20-I25, I27, I30-I52); pneumonia, including aspiration pneumonia (J12-J18, J69); cerebrovascular diseases (I60-I69); and other. In Japan's public LTC insurance system, an insured person's eligibility for insurance benefits is assessed in terms of his/her physical and cognitive function. In the present study, when a person aged ≥65 years was certified as eligible by the local government, he/she was categorized as having a LTC insurance certification.[18] When an individual was not eligible or did not require LTC services, he/she was categorized as not having a LTC insurance certification.

The number of HBD either during the last year before death or during each 3-month period in the last year before death was calculated by summing the number of HBD in each month. Because claims data are billed on a monthly basis, the death date affects the volume of resources used in the last month before death. When a hospitalized person dies on the first day of the month, there is 1 bed day in the last month of life. However, if a hospitalized person dies on the last day of the month, there are 28–30 HBD in the last month of life. Thus, to dilute the effect of the death date on the length of hospital stay in the last month of life, we calculated HBD for every 3-month period in the last year of life (time [T]1 = 10–12, T2 = 7–9, T3 = 4–6, and T4 = 1–3 months before death).

Data analysis

Frequency tables for discrete variables, and mean and standard deviation or median and interquartile range for continuous variables were calculated to describe participant characteristics. For comparison with previous studies, the categories for the total number of HBD in the last year of life were no admission, and 1–13, 14–27, 28–89, 90–179 and ≥180 days.[19,20]

When we calculated summary statistics for the total number of HBD, we excluded participants with 0 days. When calculating tables for the total number of HBD, we stratified by sex, age group (65–74 years, 75–84 years and ≥85 years) and LTC insurance certification status (absent or present) in each quarterly period.

We used a two-part model to estimate the probability of hospital inpatient care and total number of HBD during each quarter in the last year of life. Because there might be many zero values in the number of HBD at the individual level during the first, second and third quarters of the last year of life, a two-part model is useful.[21] In a two-part model, the first equation estimates the probability that an individual has any use, and the second equation estimates the level of use for those identified as users in the first equation. The expected level of use for a person is then calculated by multiplying these two estimates together.[21] In the present study, each participant had four data points for the four-quarter period. Specifically, this involved both hospital inpatient care (absent or present) and the total number of HBD during each quarterly period (if hospitalized). In the first part of the model, the dependent variable was hospital inpatient care during each 3-month period in the last year of life. When the number of HBD during each quarterly period of a participant was ≥1 day, we regarded this as receiving hospital inpatient care during the period. In the second part of the model, the dependent variable was the total number of HBD during each quarterly period for hospitalized participants. Independent variables in both models were sex, age (for a 1-year increase), time before death (T1, T2, T3, T4) and LTC insurance certification status (absent or present). In the first part of the model, a generalized linear model for data with a binomial distribution with a log-link function was used. The effect size in the first model is shown as odds ratios (OR), indicating the likelihood of hospital inpatient care among participants with a specific condition, relative to those with a referent condition. In the second part of the model, we used a generalized linear model for data with a gamma distribution with a log-link function. The effect size in the second model is shown as risk ratios (RR), indicating the likelihood of the number of HBD among participants with a specific condition, relative to those with a referent condition. Finally, to estimate the predicted number of HBD during each quarterly period, we multiplied the predicted probability of undergoing hospital inpatient care by the predicted number of HBD (given that hospitalization occurred) for each sex, age group and quarterly period. A two-tailed P-value <0.05 was considered statistically significant. All analyses were carried out using SPSS v20.0 (IBM, Armonk, NY, USA). The study was approved by the institutional review board of the Tokyo Metropolitan Institute of Gerontology.

Results

Table 1 shows the basic participant characteristics. On average, women were 4.2 years older than men. The proportions of decedents with no hospital admission and

Table 1 Characteristics of decedent participants

	Total (n = 882)	Men (n = 466)	Women (n = 416)
Age (years)	82.8 (8.2)	80.8 (8.0)	85.0 (7.9)
Age group (years)			
65–74	17.5	23.2	11.1
75–84	38.1	41.8	33.9
≥85	44.4	35.0	55.0
LTC insurance certification status			
Absent	69.2	75.1	62.5
Present	30.8	24.9	37.5
Place of death			
Hospital	83.9	86.3	80.4
Home	11.3	10.7	12.6
LTC facility or other	4.8	2.4	7.0
Main cause of death			
Malignant neoplasms	27.9	31.8	23.6
Cardiovascular diseases	17.0	14.4	20.0
Pneumonia	15.4	15.0	15.0
Cerebrovascular diseases	14.3	12.7	16.1
Other	25.4	26.2	24.5

Values are reported as % or mean (standard deviation). LTC, long-term care hospital stay ≥90 days were 11% and 29% for men, respectively, and 15% and 25% for women, respectively (Table 2). The total number of HBD in the last year of life varied widely; 13% had no admission, and 27% stayed ≥90 days. Among 768 decedents who received hospital inpatient care at least once during the last year of life, the median (interquartile range) number of hospital stays for men and women were 55 (22, 108) and 50 (17, 106), respectively (Table 3). Table 3 also shows the number of HBD during each quarterly period by sex, age group and LTC insurance certification. The median HBD for each age group was 27–40 days, except T1 to T4 among men aged 65–74 years and T1 among women aged 75–84 years. The 75th percentiles of the total number of HBD in T1, T2, and T3 among men and women without LTC insurance certification were ≥90 days. The median HBD in each quarterly period (20–29 days) was stable for both sexes with LTC insurance certification.

Table 4 shows the two-part model results. The first part of the model showed that approaching death (T2, OR 1.50, $P < 0.001$; T3, OR 2.42, $P < 0.001$; T4, OR 16.32, $P < 0.001$) was significantly associated with receiving inpatient care. Older age was significantly associated with less risk of receiving hospital inpatient care (OR for a 1-year increase 0.97, $P < 0.001$). In the second part of the model, having LTC insurance certification (RR 0.61, $P < 0.001$) and T4 compared with T1 (RR 0.87, $P = 0.007$) were significantly associated with fewer HBD. The predicted number of HBD increased as death approached in any age group for both sexes (Fig. 1). Participants with LTC insurance certification were more likely to have fewer total HBD during each quarterly period than those without certification.

Discussion

In the present study, the total number of HBD in the last year of life among participants who died in the hospital varied widely. Younger age, approaching death and having LTC insurance certification were significantly associated with being more likely to receive hospital inpatient care during each quarterly period in the last year of life. In contrast, having LTC insurance certification and the last 3-month period before death, compared with the first 3-month period, were significantly associated with a lower number of HBD.

Older age was significantly associated with a lower risk of receiving hospital inpatient care, but was not significantly associated with the number of HBD in each 3-month period in the last year of life. Previous studies from the UK[19] and Australia[20] showed that older adults aged ≥85 years were less likely to be hospitalized, and more likely to have a greater number of total HBD in the last year of life than younger patients. Another study from Sweden confirmed, using multiple logistic regression analysis, that approaching death was associated with being more likely to receive hospital inpatient care, and increasing age was associated with longer hospital stays.[22] Despite different healthcare systems, the findings were similar to the present study in that older dying individuals were less likely to receive hospital inpatient care. Physicians in the USA believe that hospital inpatient care for frail older patients is not always superior to outpatient care because of the higher risk of iatrogenic disorders, such as delirium, falls, functional decline, cognitive decline and medication error.[23] We speculate that physicians in Japan might also be reluctant to hospitalize very old frail patients.

Table 2 Hospital bed days in the last year of life by sex, age group and place of death

		Not admitted	1–13 days	14–27 days	28–89 days	90–179 days	≥180 days
Total ($n = 882$)		114 (12.9%)	139 (15.8%)	99 (11.2%)	293 (33.2%)	138 (15.6%)	99 (11.2%)
Sex and age group (years)							
Men	**65–74 ($n = 108$)**	11 (10.2%)	13 (12%)	9 (8.3%)	30 (27.8%)	23 (21.3%)	22 (20.4%)
	75–84 ($n = 195$)	18 (9.2%)	36 (18.5%)	23 (11.8%)	69 (35.4%)	29 (14.9%)	20 (10.3%)
	≥85 ($n = 163$)	23 (14.1%)	21 (12.9%)	22 (13.5%)	57 (35%)	23 (14.1%)	17 (10.4%)
	Total ($n = 466$)	52 (11.2%)	70 (15%)	54 (11.6%)	156 (33.5%)	75 (16.1%)	59 (12.7%)
Women	**65–74 ($n = 46$)**	2 (4.3%)	4 (8.7%)	6 (13%)	18 (39.1%)	9 (19.6%)	7 (15.2%)
	75–84 ($n = 141$)	20 (14.2%)	31 (22%)	12 (8.5%)	41 (29.1%)	21 (14.9%)	16 (11.3%)
	≥85 ($n = 229$)	40 (17.5%)	34 (14.8%)	27 (11.8%)	78 (34.1%)	33 (14.4%)	17 (7.4%)
	Total ($n = 416$)	62 (14.9%)	69 (16.6%)	45 (10.8%)	137 (32.9%)	63 (15.1%)	40 (9.6%)
Place of death							
Hospital ($n = 740$)		39 (5.3%)	126 (17%)	84 (11.4%)	260 (35.1%)	132 (17.8%)	99 (13.4%)
Home ($n = 100$)		54 (54.0%)	10 (10.0%)	7 (7.0%)	24 (24.0%)	5 (5.0%)	0 (0.0%)
LTC facility or other ($n = 42$)		21 (50.0%)	3 (7.1%)	8 (19.0%)	9 (21.4%)	1 (2.4%)	0 (0.0%)

LTC = long-term care

Table 3 Hospital bed days in the last year of life by sex, age group and long-term care insurance certification

	Men ($n=466$)		Women ($n=416$)					
	Not receiving hospital care	Hospital care	Not receiving hospital care		Hospital care			
	n (%)	*n* (%)	Mean	Median (IQR)	*n* (%)	*n* (%)	Mean	Median (IQR)
During a 12-month period in the last year of life								
Total	52 (11.2)	414 (88.8)	86.2	55 (22–108)	62 (14.9)	354 (85.1)	77.7	50 (17–106)
Age group (years)								
65–74	11 (10.2)	97 (89.8)	113.3	74 (30–170)	2 (4.3)	44 (95.7)	95.3	58 (35–152)
75–84	18 (9.2)	177 (90.8)	75.4	46 (18–94)	20 (14.2)	121 (85.8)	78.9	51 (11–121)
≥85	23 (14.1)	140 (85.9)	72.7	46 (20–94)	40 (17.5)	189 (82.5)	72.7	46 (20–94)
LTC insurance certification								
Absent	34 (11.3)	268 (88.7)	89.8	57 (19–108)	23 (11.3)	180 (88.7)	82.4	46 (16–114)
Present	18 (11.0)	146 (89.0)	79.8	53 (26–109)	39 (18.3)	174 (81.7)	72.8	54 (23–99)
During each 3-month period in the last year of life								
Total								
T1	351 (75.3)	115 (24.7)	45.1	36 (14–89)	333 (80.0)	83 (20.0)	46.7	38 (16–91)
T2	308 (66.1)	158 (33.9)	40.5	32 (11–66)	307 (73.8)	109 (26.2)	42.6	33 (17–73)
T3	258 (55.4)	208 (44.6)	45.4	39 (14–89)	261 (62.7)	155 (37.3)	42.9	31 (16–70)
T4	76 (16.3)	390 (83.7)	38.9	35 (13–66)	80 (19.2)	336 (80.8)	37.8	33 (14–64)
Age group (years)								
65–74 T1	75 (69.4)	33 (30.6)	51.7	49 (16–91)	33 (71.7)	13 (41.3)	50.8	35 (18–92)
T2	63 (56.8)	45 (43.2)	44.3	38 (16–79)	27 (58.7)	19 (47.8)	45.4	37 (17–79)
T3	51 (47.2)	57 (52.8)	52.8	53 (18–91)	24 (52.2)	22 (91.3)	44.1	34 (10–76)
T4	17 (15.7)	91 (84.3)	47.0	55 (17–71)	4 (8.7)	42 (18.4)	40.5	40 (16–62)
75–84 T1	141 (72.3)	54 (27.7)	40.6	30 (14–65)	115 (81.6)	26 (29.8)	50.1	47 (20–81)
T2	136 (69.7)	59 (30.3)	40.4	31 (12–64)	99 (70.2)	42 (41.1)	42.2	33 (16–70)
T3	111 (56.9)	84 (43.1)	39.9	27 (11–66)	83 (58.9)	58 (80.1)	43.3	34 (15–73)
T4	28 (14.4)	167 (85.6)	33.4	28 (9–59)	28 (19.9)	113 (19.2)	36.6	33 (11–61)
≥85 T1	135 (82.8)	28 (17.2)	45.9	33 (11–91)	185 (80.8)	44 (19.2)	43.5	31 (13–92)
T2	109 (66.9)	54 (33.1)	37.6	28 (10–67)	181 (79.0)	48 (21.0)	41.8	31 (22–71)
T3	96 (58.9)	67 (41.1)	46.0	33 (13–91)	154 (67.2)	75 (32.8)	42.1	31 (17–68)
T4	31 (19.0)	132 (81.0)	40.2	37 (13–68)	48 (21.0)	181 (79.0)	38.0	32 (14–66)
LTC insurance certification								
Absent T1	265 (75.7)	85 (24.3)	49.6	45 (16–91)	212 (81.5)	48 (18.5)	58.8	69 (26–92)
T2	229 (66.8)	114 (33.2)	43.8	33 (12–90)	197 (79.4)	51 (20.6)	50.8	39 (26–91)
T3	190 (57.4)	141 (42.6)	52.0	52 (17–92)	140 (63.6)	80 (36.4)	54.6	56 (19–91)
T4	40 (13.5)	256 (86.5)	45.0	49 (15–71)	22 (11.6)	167 (88.4)	46.7	50 (17–72)
Present T1	86 (74.1)	30 (25.9)	32.1	27 (13–51)	121 (77.6)	35 (22.4)	30.1	23 (9–48)
T2	79 (64.2)	44 (35.8)	32.1	28 (10–54)	110 (65.5)	58 (34.5)	35.3	29 (13–56)
T3	68 (50.4)	67 (49.6)	31.5	23 (11–49)	121 (61.7)	75 (38.3)	30.4	23 (13–42)
T4	36 (21.2)	134 (78.8)	27.1	25 (8–40)	58 (25.6)	169 (74.4)	29.1	26 (10–45)

Time (T)1 = 10–12 months before death, T2 = 7–9 months before death, T3 = 4–6 months before death, T4 = 1–3 months before death. LTC = long-term care.

The risk of receiving hospital inpatient care non-linearly increased as time of death approached. However, significantly fewer total HBD were present during the last 3-month period of life than during the 10–12-month period before death. Based on the two-part model, the estimated number of HBD during each 3-month period increased as death approached in all age groups for both sexes (Fig. 1). Thus, the impact of approaching death on the risk of receiving hospital inpatient care was relatively greater than on the number of HBD. Similar to the results regarding age and use of hospital inpatient care of previous studies carried out in Western countries, the expected number of HBD increased as death approached.[24] Additionally, our finding that the risk of receiving hospital

Table 4 Factors associated with receiving hospital care and the number of hospital bed days during each 3-month period in the last year of life (results from the two-part model)

	First model†				Second model‡			
	Receiving hospital inpatient care during each quarterly period (analyzable data: $n = 3528$)				No. hospital bed days during each quarterly period (analyzable data: $n = 1554$)			
	Odds ratio	95% confidence interval		*P*-value	Risk ratio	95% confidence interval		*P*-value
Sex								
Men	1.000				1.000			
Women	0.808	0.651	1.002	0.052	1.057	0.966	1.157	0.227
Age								
For a 1-year increase	0.974	0.961	0.988	<0.001	1.002	0.996	1.008	0.509
LTC insurance certification								
Absent	1.000				1.000			
Present	1.166	0.955	1.423	0.133	0.614	0.565	0.667	<0.001
Proximity to death								
10–12 months before death (T1)	1.000				1.000			
7–9 months before death (T2)	1.503	1.286	1.756	<0.001	0.948	0.853	1.054	0.317
4–6 months before death (T3)	2.421	2.024	2.897	<0.001	0.995	0.894	1.107	0.926
1–3 months before death (T4)	16.323	13.091	20.352	<0.001	0.874	0.792	0.963	0.007

†First model: generalized linear model for data distributed under a binomial distribution with a log-link function. ‡Second model: generalized linear model for data distributed under a gamma distribution with a log-link function. LTC, long-term care; T, time

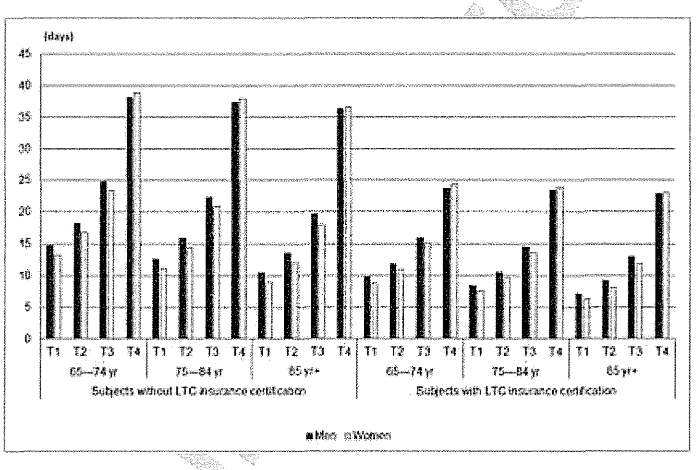


Figure 1 Predicted values of the total number of hospital bed days per 3-month period in the last year of life by sex, age and long-term care (LTC) insurance certification status. T1, 10–12 months before death; T2, 7–9 months before death; T3, 4–6 months before death; T4, 1–3 months before death.

inpatient care during the last 3-month period in the last year of life was higher than that of home care was consistent with that of a Swedish study.[22]

LTC insurance certification was not significantly associated with receiving hospital inpatient care, but was significantly associated with 39% fewer HBD during each quarter in the last year of life, compared with not having LTC insurance certification. Contrary to the initial expectation that older patients with some disability would have a higher risk of both receiving hospital inpatient care and using greater resources than those without disabilities, participants with LTC insurance certification in the present study were more likely to have fewer total HBD during each quarterly period than those without certification.[17,25] We must recognize that participants without LTC insurance certification are not necessarily without disabilities. Thus, the present study results do not necessarily show that older adults with disabilities were more likely to spend less time in the hospital than those without disabilities. Because older adults with some disability, but without certification, were likely in very poor health, it might have been difficult to discharge them from the hospital and to use services covered by LTC insurance at either their homes or LTC facilities, which resulted in more HBD.

The present study had certain limitations. First, we could not identify cumulative HBD during a 365-day period before the death date, because insurers generated the claims data on a monthly basis rather than retrospective from the date of death. The impact of date of death on resource use during the last 3 months of life was not negligible, because the date of death varied from the first to last day of the month (difference of ~30 days). Therefore, we used cumulative HBD during each 3-month period in the last year of life. Second, employee health insurance plan claims data were not used, because they were not available at the local government level. Finally, the cumulative number of HBD in the last year of life might not generalize to all of Japan, because hospital inpatient care use might vary substantially by region within prefectures.[26] However, the results could be extrapolated to a city in Japan with similar healthcare resource use and sociodemographic status.

In conclusion, the findings regarding the risk of hospital inpatient care and total number of HBD in the last year of life help to understand resource use among older dying adults. Analysis of linked claims and death certificate data provides insightful information, and could facilitate evidence-based healthcare policies in an aging society.

Acknowledgments

The authors would like to express their sincere appreciation to the municipal officers in Soma City. This work was supported by Japan Society for Promotion for Science Grants-in-Aid for Scientific Research (Grant Number 24590834) and the Ministry of Health, Labour and Welfare (H27-seisaku-senryaku-012).

TI was responsible for study concept and design. TI, MS and RT contributed to acquisition of participants and data. TI, MS, HF, EHO, CS, TM, HM and RT carried out analysis and interpretation of data. TI and MS were responsible for preparation of the manuscript.

Disclosure statement

The authors declare no conflict of interest.

References

1 Ministry of Health, Labour and Welfare. Vital Statistics 2012. Tokyo: Ministry of Health, Labour and Welfare, 2013 [in Japanese].
2 Ministry of Health, Labour and Welfare. The Official Record of the 198th general meeting of Central Social Insurance Medical Council (held on October 5, 2011). 2011. [in Japanese]
3 Ministry of Health, Labour and Welfare. Manual to Fill in a Death Certificate 2009. Tokyo: Ministry of Health, Labour and Welfare, 2009. [in Japanese]
4 Teno JM, Gozalo PL, Bynum JP *et al.* Change in end-of-life care for Medicare beneficiaries: site of death, place of care, and health care transitions in 2000, 2005, and 2009. *JAMA* 2013; **309**: 470–477.
5 Zweifel P, Felder S, Meiers M. Ageing of population and health care expenditure: a red herring? *Health Econ* 1999; **8**: 485–496.
6 Seshamani M, Gray A. Ageing and health-care expenditure: the red herring argument revisited. *Health Econ* 2004; **13**: 303–314.
7 Seshamani M, Gray AM. A longitudinal study of the effects of age and time to death on hospital costs. *J Health Econ* 2004; **23**: 217–235.
8 Polder JJ, Barendregt JJ, van Oers H. Health care costs in the last year of life--the Dutch experience. *Soc Sci Med* 2006; **63**: 1720–1731.
9 Felder S, Werblow A, Zweifel P. Do red herrings swim in circles? Controlling for the endogeneity of time to death. *J Health Econ* 2010; **29**: 205–212.
10 Hashimoto H, Horiguchi H, Matsuda S. Micro data analysis of medical and long-term care utilization among the elderly in Japan. *Int J Environ Res Public Health* 2010; **7**: 3022–3037.
11 Dixon T, Shaw M, Frankel S, Ebrahim S. Hospital admissions, age, and death: retrospective cohort study. *BMJ* 2004; **328**: 1288.
12 Forma L, Rissanen P, Noro A, Raitanen J, Jylha M. Health and social service use among old people in the last 2 years of life. *Eur J Ageing* 2007; **4**: 145–154.
13 Awatani T. Health and long-term care expenditures in the last year of life. *Q Soc Secur Res* 2004; **40**: 236–243[in Japanese].
14 Tanihara S. Determinant of the medical expenses of the elderly during thea last seven month period of life. *J Okayama Med Assoc* 1996; **108**: 267–274 [in Japanese].
15 Takemura S, Hashimoto M, Gunji A. Medical services utilization of the elderly during the last six monts of life. *Nihon Koshu Eisei Zasshi* 1996; **43**: 409–417 [in Japanese].
16 Ishizaki T, Imanaka Y, Oh EH, Sekimoto M, Hayashida K, Kobuse H. Association between patient age and hospitalization resource use in a teaching hospital in Japan. *Health Policy* 2008; **87**: 20–30.
17 Chan L, Beaver S, Maclehose RF, Jha A, Maciejewski M, Doctor JN. Disability and health care costs in the Medicare population. *Arch Phys Med Rrehab* 2002; **83**: 1196–1201.
18 Tsutsui T, Muramatsu N. Care-needs certification in the long-term care insurance system of Japan. *J Am Geriatr Soc* 2005; **53**: 522–527.
19 Henderson J, Goldacre MJ, Griffith M. Hospital care for the elderly in the final year of life: a population based study. *BMJ* 1990; **301**: 17–19.
20 Brameld KJ, Holman CD, Bass AJ, Codde JP, Rouse IL. Hospitalisation of the elderly during the last year of life: an application of record linkage in Western Australia 1985-1994. *J Epidemiol Community Health* 1998; **52**: 740–744.
21 Diehr P, Yanez D, Ash A, Hornbrook M, Lin DY. Methods for analyzing health care utilization and costs. *Annu Rev Public Health* 1999; **20**: 125–144.
22 Larsson K. Care utilization in the last year of life in relation to age and time to death: results from a Swedish urban population of the oldest old. *Eur J Ageing* 2008; **5**: 349–357.
23 Kane RLOJ, Abrass IB, Resnick B. Essentials of Clinical Geriatrics, 6th edn. New York: McGraw-Hill, 2009.
24 Himsworth RL, Goldacre MJ. Does time spent in hospital in the final 15 years of life increase with age at death? A population based study. *BMJ* 1999; **319**: 1338–1339.
25 Tsuji I, Kuwahara A, Nishino Y, Ohkubo T, Sasaki A, Hisamichi S. Medical cost for disability: a longitudinal observation of national health insurance beneficiaries in Japan. *J Am Geriatr Soc* 1999; **47**: 470–476.
26 Forma L, Jylha M, Aaltonen M, Raitanen J, Rissanen P. Municipal variation in health and social service use in the last 2 years of life among old people. *Scand J Public Health* 2011; **39**: 361–370.

BMJ Open

Factors related to prolonged on-scene time during ambulance transportation for critical emergency patients in a big city in Japan: a population-based observational study

Isao Nagata,[1,2,3] Toshikazu Abe,[4,5] Yoshinori Nakata,[3] Nanako Tamiya[5]

To cite: Nagata I, Abe T, Nakata Y, *et al*. Factors related to prolonged on-scene time during ambulance transportation for critical emergency patients in a big city in Japan: a population-based observational study. *BMJ Open* 2016;**6**:e009599. doi:10.1136/bmjopen-2015-009599

▶ Prepublication history for this paper is available online. To view these files please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2015-009599).

Received 5 August 2015
Revised 21 November 2015
Accepted 24 November 2015

CrossMark

For numbered affiliations see end of article.

Correspondence to
Dr Toshikazu Abe;
abetoshi111@gmail.com

ABSTRACT

Objectives: We aimed to investigate the factors related to prolonged on-scene times, which were defined as being over 30 min, during ambulance transportation for critical emergency patients in the context of a large Japanese city.
Design: A population-based observational study.
Setting: Kawasaki City, Japan's eighth largest city.
Participants: The participants in this study were all critical patients (age ≥15 years) who were transported by ambulance between April 2010 and March 2013 (N=11 585).
Outcome measures: On-scene time during ambulance transportation for critical emergency patients.
Results: The median on-scene time for all patients was 17 min (IQR 13–23). There was a strong correlation between on-scene time and the number of phone calls to hospitals from emergency medical service (EMS) personnel ($p<0.001$). In multivariable logistic regression, the number of phone calls to hospitals from EMS personnel, intoxication, minor disease and geographical area were associated with on-scene times over 30 min. Age, gender, day of the week and time of the day were not associated with on-scene times over 30 min.
Conclusions: To make on-scene time shorter, it is vital to redesign our emergency system and important to develop a system that accommodates critical patients with intoxication and minor disease, and furthermore to reduce the number of phone calls to hospitals from EMS personnel.

Strengths and limitations of this study

- Our study population consisted of 11 585 critical patients (age ≥15 years) who were transported by ambulance for 3 years in Japan's eighth largest city.
- This study is the first to focus on factors related to prolonged on-scene time during ambulance transportation for critical emergency patients in a big city.
- Our findings may not be generalisable to rural districts because our study was conducted in a big city.

INTRODUCTION

Total prehospital time consists of response time (the time from ambulance call receipt to arrival of the ambulance at the scene), on-scene time (the time from arrival of the ambulance at the scene to departure), and transport time (the time from departure of the ambulance at the scene to arrival at the hospital). Recently, the Japanese government reported that the average total prehospital time has gradually increased by about 10 min over a decade—from 28.8 min in 2002 up to 38.7 min in 2012.[1]

The prolongation of total prehospital time is a social problem in Japan. It negatively affects the outcomes for critical patients and inhibits the effective utilisation of ambulances.[2–4] Kosaka and Yoshioka[2] reported that hospital mortality for patients with acute cardiac failure was associated with the duration between on-scene time and transport time. Kelly *et al*[3] also showed that patients with ST-elevation myocardial infarction who did not receive thrombolytic therapy within 90 min of calling for medical assistance had an increased risk of death. Therefore, it is very important to reduce the total prehospital time as much as possible. Of the total prehospital time, on-scene time is particularly prolonged because of the expansion of the range of emergency treatments performed by the emergency life-saving technician (ELST) and also by the time taken for hospital selection.[5] Even in big cities where there are a lot of hospitals, the same problems occur.

There have been few studies for prolonged on-scene time during ambulance transportation for critical emergency patients in a big city. Therefore, in this study, we aimed to investigate the factors related specifically to the prolongation of on-scene time during ambulance transportation for critical emergency patients within the context of a large Japanese city.

METHODS

Study design, setting and selection of participants

The study was a population-based observational study conducted in Kawasaki City, the eighth largest city in Japan, with a population of 1.43 million (as of 2013) and a land area of 142.7 km^2.[6] We retrospectively screened every patient who was transported by ambulance in Kawasaki City from 1 April 2010 to 31 March 2013 (N=164 122). Only the patients who the physicians in charge at emergency departments (EDs) classified as critical were included in this study. Critical patients were defined according to the national criteria as those who are expected to be hospitalised for more than 3 weeks or are confirmed dead by the physicians in charge at EDs.[1] We excluded patients who were aged under 15 years and cases of hospital transfer.

The study protocol was reviewed and approved by the Ethics Committee of Teikyo University. The Ethics Committee waived the need for informed consent due to the anonymity of the data collected for routine operations and the retrospective nature of this study.

The Japanese and Kawasaki city's emergency medical service system

The Japanese emergency medical service (EMS) system is operated by a municipality, and its response consists of a single tiered ambulance system that is dispatched for all patients who need ambulance transportation. Each ambulance has at least three EMS personnel, and there is at least one ELST in almost every ambulance. ELSTs are licensed to insert an intravenous line and to place advanced airway management devices for only patients with cardiopulmonary arrest (CPA) under online medical control direction. In addition, specially trained ELSTs are permitted to insert tracheal tubes and to administer intravenous epinephrine for only patients with CPA. Since April 2014, specially trained ELSTs have been permitted to insert an intravenous line and administer intravenous lactated Ringer's solution and to measure the blood glucose and administer intravenous glucose if the patient's blood glucose is low for life-threatening patients. Ambulance service is free of charge.

The Kawasaki Fire Department is responsible for ambulance service in Kawasaki City and had 26 ambulances in 2012. Each ambulance has three EMS personnel, and 99.7% of ambulances had at least one ELST in 2012. Emergency transportations are provided for patients whose symptoms can worsen immediately or who are critically ill, and all patients except those who refuse to travel to hospitals or are already dead are transported to hospitals. Kawasaki city has the checking system for emergency transportation by medical control council. There were three tertiary care emergency centres and 24 acute care hospitals in Kawasaki City in 2012. EMS personnel record initial medical data for all patients whom they transport to hospital on recording papers, and the physicians in charge at EDs check their severities. Finally, the Kawasaki Fire Department keeps them.

Data collection

The data were obtained with the permission of the Kawasaki Fire Department. The data included the following information: age and gender of the patient, the day of the week, the time of the ambulance call, the fire station from which the ambulance was dispatched, the number of phone calls to hospitals from EMS personnel, the disease name as diagnosed at the EDs, response time, on-scene time, and transport time.

Statistical analysis

Prolonged on-scene time was defined as over 30 min because over 30 min is usually used as the prolonged on-scene time in Japanese government reports. To analyse characteristics of patient demographics and backgrounds in relation to on-scene time, normally or near normally distributed continuous variables were presented as means and SD and were compared using the Student t test. Non-normally distributed continuous data were presented as medians and IQRs and were compared using the Wilcoxon rank sum test or Kruskal-Wallis test. Age was divided into three groups: 15–64 years, 65–84 years and over 85 years. Day of the week was divided into 2 groups: weekday and weekend. Time of ambulance call was divided into three groups: night shift (midnight to 08:00), day shift (08:00–16:00), and evening shift (16:00 to midnight). The fire stations from which the ambulances were dispatched were divided into three geographical areas: north, middle and south. The diseases, as diagnosed at the EDs, were divided into 12 groups: CPA, trauma, burn injury, intoxication, other external causes, central neurological diseases, respiratory diseases, cardiovascular diseases, gastrointestinal diseases, renal and urogenital diseases, other internal causes and minor diseases. Other external causes included: heat stroke, hypothermia, hanging, asphyxia, drowning and foreign body. Other internal causes included: disturbance of consciousness and shock of unknown origin, haematological diseases, immunological diseases, endocrine metabolic diseases and neuromuscular diseases. Minor diseases included: eye diseases, skin diseases, nose and throat diseases, obstetrical and gynaecological diseases, psychiatric disorders, breast diseases and orthopaedic diseases except for trauma. Multivariable logistic regression analysis was conducted to investigate the factors related to on-scene time

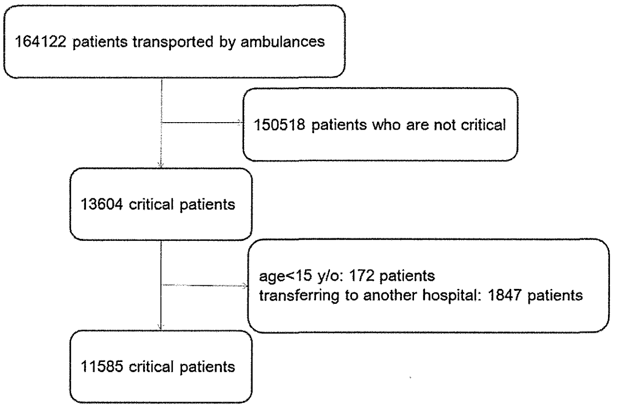


Figure 1 Study profile with selection of participants.

over 30 min. Age, gender and disease as diagnosed at the ED were included in the multivariable logistic regression analysis, and the following variables were applied to multivariable logistic regression analysis using a stepwise selection, if the univariate p value was <0.2: the day of the week, the time of the ambulance call (time of the day), the fire station from which the ambulance was dispatched (geographical area), and the number of phone calls to hospitals from EMS personnel. Data were presented as ORs with 95% CIs. All p-values were two sided, and p<0.05 was considered statistically significant. All analyses were performed using SAS V.9.3 (SAS Institute Inc, North Carolina, USA).

RESULTS

Of 164 122 patients transported by ambulances during the study period, the critical patients numbered 13 604. Among them, 11 585 patients were included in our analysis (figure 1).

Table 1 shows the distribution of response time, on-scene time and transport time. Median on-scene time was 17 min (Q1=25 centile, Q3=75 centile, IQR 13–23).

The demographics and backgrounds of study patients are shown in table 2. On-scene time of age, gender, time of day, geographical area and disease, as diagnosed at the ED, were statistically significant among groups in each category. With regard to the diseases, on-scene times for CPA, trauma, burn injury, intoxication, central neurological diseases, respiratory diseases, cardiovascular diseases, gastrointestinal diseases, other internal causes and minor diseases were statistically significant compared with the other diseases. On-scene times for CPA and cardiovascular diseases were relatively shorter than for the other diseases. On-scene times for trauma, burn injury, intoxication, central neurological diseases, respiratory diseases, gastrointestinal diseases, other internal causes and minor diseases were relatively longer than for the other diseases. Day of the week was not statistically significantly different in each category.

Table 1 The distribution of response time, on-scene time and transport time

	25 centile	Median	75 centile
Response time (min)	6	7	9
On-scene time (min)	13	17	23
Transport time (min)	5	7	11

Figure 2 shows the relationship between on-scene time and the number of phone calls to hospitals from EMS personnel. The more phone calls that were made, the longer was the on-scene time—hence, a strong correlation between the two (Pearson correlation coefficient: 0.57, p<0.001).

The results of the multivariable logistic regression for on-scene time over 30 min are shown in table 3. The number of phone calls to hospitals from EMS personnel, intoxication, minor disease and geographical area were the main factors associated with on-scene times over 30 min. The number of phone calls to hospitals from EMS personnel had a higher OR per phone call (phone calls to hospitals: OR 2.57, p<0.001). Intoxication and minor diseases had higher ORs than the other diseases (intoxication: OR 1.82, p=0.011, minor disease: OR 1.65, p=0.023). As for geographical area, the north and middle areas had higher ORs than the south (the north: OR 3.20, p<0.001, the middle: OR 2.20, p=0.03). Age, gender, day of week, and time of the day had no relationship with on-scene times over 30 min.

DISCUSSION

Key findings

In this study, we found that with regard to ambulance transportation for critical emergency patients in a big city in Japan, the number of phone calls to hospitals from EMS personnel, intoxication, minor disease and geographical area were factors related to prolonged on-scene times over 30 min.

Relationship to previous studies

Our results are in accordance with a number of observational studies in Japan that have reported that on-scene time increased with the number of phone calls to hospitals from EMS personnel regardless of the severity of illness.[7–9] Kitamura *et al*[9] reported that the more phone calls to hospitals from EMS personnel that were made, the longer was the on-scene time for patients with acute myocardial infraction. One prospective population-based cohort study reported that, in Japan, on-scene time is particularly prolonged for suspected drug overdose patients because of the time to obtain acceptance from hospitals to care for them.[10] A population-based observational study, again from Japan, showed that on-scene time of psychiatric emergency services was statistically longer than that of other emergency services.[11] In our study, intoxication was related to prolonged on-scene time over 30 min, and three quarters of those intoxicated patients were suffering from drug overdose and