

Relationship Between Caseload Volume and Outcome for Systemic Lupus Erythematosus Treatment: The Experience of Taiwan

TZU-FENG WANG and HERNG-CHING LIN

ABSTRACT. Objective. To determine if a physician's experience or hospital caseload volume is associated with in-hospital mortality of patients with systemic lupus erythematosus (SLE).

Methods. We used data from Taiwan's National Health Insurance Research Database covering 2002 to 2004. A total of 8536 hospital admissions citing a principal diagnosis of SLE were selected. Hospitals with an average of > 50, 26–50, and < 26 SLE cases per year were categorized as high, medium, and low-caseload-volume hospitals, respectively. Physician caseload volume was defined as low (< 1 SLE case per year), medium (1–3 cases per year), and high-volume (> 3 cases per year). Multivariate logistic regression analyses employing generalized estimated equations were performed to assess the independent association between physician or hospital SLE caseload volume and in-hospital mortality, after adjusting for other factors.

Results. We found that in-hospital mortality declined with increasing physician caseload volume (3.0%, 1.0%, and 0.8% for low, medium, and high-volume physicians, respectively), with the adjusted odds of in-hospital mortality for patients treated by low-volume physicians being 2.681 ($p < 0.05$) times greater than for patients treated by medium-volume physicians, and 3.195 ($p < 0.001$) times greater than for those treated by high-volume physicians. No significant relationship was found between in-hospital mortality and hospital SLE caseload volume ($p = 0.896$).

Conclusion. We concluded that the factor of physicians' experience treating SLE is more crucial in determining in-hospital mortality than a hospital's annual SLE caseload. (First Release Aug 15 2008; *J Rheumatol* 2008;35:1795–800)

Key Indexing Terms:

SYSTEMIC LUPUS ERYTHEMATOSUS VOLUME-OUTCOME IN-HOSPITAL MORTALITY

Many studies have been conducted since the first study on the relationship between caseload volume and outcome reported by Luft and colleagues in 1979¹. Most studies thereafter reported lower mortality among patients undergoing surgical procedures by health providers with higher caseloads who perform such procedures regularly, than among those treated by health providers with less experience^{1–10}. Although studies have been conducted for nonsurgical conditions such as myocardial infarction, acquired immunodeficiency syndrome (AIDS), and community-acquired pneumonia^{11–19}, less consistent inverse volume-outcome relations have been reported for these medical conditions¹⁸. Systemic lupus erythematosus (SLE) is an uncom-

mon but potentially fatal medical condition for which only a few volume-outcome studies have been conducted^{20–23}.

Utilizing the California Hospital Discharge Database from 1991 to 1994, Ward published 2 studies of hospital SLE-volume and patient mortality, reporting that hospital volume was inversely related to patients' in-hospital mortality, especially for those hospitalized for SLE on an emergency basis^{20,21,23}. In addition, in his third SLE study, Ward speculated that it is not the hospital's experience per se, but rather the experience of individual physicians that determines patient outcomes²².

Nevertheless, none of these studies used a nationwide population database to examine the volume-outcome relationship for SLE, and further, no study on volume-outcome relationship for SLE treatment has been conducted outside the USA. Thus, our aim was to investigate the relationship between physician caseload volume, hospital caseload volume, and the in-hospital mortality among patients with SLE, using Taiwan's National Health Insurance Research Database (NHIRD). The National Health Insurance program in Taiwan was initiated in 1995. Unlike other healthcare delivery systems, which tend to limit a patient's choice to certain providers, all citizens are covered and every patient has the choice of access to any healthcare provider. Thus it provides

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a unique opportunity to examine the volume-outcome relationship for SLE treatment based on a nationwide database.

MATERIALS AND METHODS

Database. This study used pooled data for the years 2002, 2003, and 2004 obtained from the NHIRD, which is provided by the Bureau of National Health Insurance, Taiwan Department of Health, and managed by the Taiwan National Health Research Institute. The NHIRD covers all in-patient medical benefit claims for the Taiwanese population of over 23 million. The database includes a registry of contracted medical facilities, a registry of board-certified physicians, a monthly claims summary for in-patient claims, and details of in-patient orders. It also provides principal operation procedures along with one principal diagnosis code, and up to 4 secondary diagnosis codes for each patient, using the International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM).

Study sample. The study sample was identified from the database by a principal admission diagnosis of SLE (ICD-9-CM code 710.0) between January 2002 and December 2004 ($n = 9741$). The reason for including only patients with a principal diagnosis of SLE was to assure that all selected admissions are SLE-related. To limit our study sample to the adult population, all patients below 18 years of age ($n = 984$) were excluded. In addition, we excluded patients who were transferred to or from another hospital ($n = 87$) or who were discharged against medical advice ($n = 234$). Ultimately, our study sample comprised 8536 hospitalizations and represented 4314 patients, treated by 857 physicians at 145 hospitals.

Physician and hospital SLE caseload volume groups. Since unique physician and hospital identifiers are available for each medical claim submitted to the Bureau of National Health Insurance, this enabled us to identify particular physicians and hospitals treating SLE cases during our 3-year study period. Indeed, many SLE patients may have more than one physician (including resident physician), but only one physician (the attending physician) is responsible for the coordination or integration of the patient's care. This is a uniform rule across all hospitals in Taiwan. The national database in our study allowed us to identify only the attending physician for each patient. To facilitate comparing our findings to those from the US, we have used the same volume thresholds as those adopted by US studies²⁰⁻²³. The sample of 8536 patients was divided into 3 physician caseload volume groups: < 1 case per year (referred to as low volume), 1-3 cases per year (medium volume), and > 3 cases per year (high volume), while the 3 hospital caseload volume groups were ≤ 25 cases per year (low volume), 26-50 cases per year (medium volume), and > 50 cases per year (high volume).

Key variables of interest. The key independent variable of interest was hospital and physician caseload volume. The key dependent variable was in-hospital mortality. However, since the majority of citizens in Taiwan prefer to die at home, it is not uncommon for hospitals in Taiwan to discharge patients before death at the family's request. Therefore, we define in-hospital mortality as "the death of a patient at any time after admission, if the patient does not leave hospital or dies within 7 days of discharge," in order to better reflect the real situation in Taiwanese communities. In this study, the NHIRD was linked to the "cause of death" data file by patient's national identification number with the assistance of the Department of Health in Taiwan. Since the registration of all deaths is mandatory, the data are considered to be very accurate and comprehensive. This linkage allowed us to identify all deaths occurring within 7 days of discharge. The primary treatment outcome was dichotomous, irrespective of whether SLE treatment resulted in in-hospital mortality or not.

The variables adjusted for in the regression model included characteristics of the physician, hospital, and patients. Physician characteristics included the physician's sex and age (as a surrogate for practice experience). Hospital characteristics included hospital ownership, hospital level, and geographic location. Hospital ownership was recorded as one of 3

types: public hospital, private not-for-profit (NFP), or private for-profit (FP). The hospital level indicates whether each hospital is a medical center (minimum of 500 beds), a regional hospital (minimum 250 beds), or a district hospital (minimum 20 beds). Hospital level can therefore be used as a proxy for both hospital size and clinical service capabilities. Hospital teaching status was not included within the regressions, since all medical centers and regional hospitals in Taiwan are teaching hospitals.

Patient characteristics comprised age, sex, monthly income, and Charlson Comorbidity Index (CCI) score. The monthly income data in New Taiwan dollars were obtained from the registry for beneficiaries of the NHIRD. Monthly income was categorized as 0, NT\$1 to \$15,840, NT\$15,841 to \$25,000, and \geq NT\$25,001. The reason for selecting NT\$15,840 (average exchange rate in 2004: US\$1 = NT\$33) as a cutoff point is that this value is stipulated by government as the minimum wage for a full-time employee in Taiwan. Since no illness severity index is currently available in Taiwan, we used the CCI score, which was identified and calculated according to diagnosis codes, with the total score being ≤ 1 , 2, 3, and ≥ 4 .

Statistical analysis. The SAS statistical package (SAS for Windows, V. 8.2) was used to perform statistical analysis. Global chi-square analyses were conducted in order to examine the relationship between hospital and physician caseload volume groups and unadjusted in-hospital deaths. Thereafter, a multivariate logistic regression analysis employing a generalized estimation equation was also carried out to assess the independent association between physician SLE case volume and in-hospital mortality after adjusting for patient and hospital characteristics and clustering on physician and patient (some patients had more than one hospitalization during the study period). A 2-sided p value ≤ 0.05 was considered statistically significant.

RESULTS

The study sample comprised 8536 hospitalizations and represented 4314 patients. Among 4314 patients, 479 (11.1%) were male and the mean age was 37.5 (± 14.5) years. The mean number of hospitalizations per patient was 1.98 (± 2.04) during the study period.

Table 1 describes the distribution of the sampled patients by in-hospital mortality. Of the total of 8536 hospitalizations during the 3-year study period, 87 (1.0%) were discharged upon death. The majority (89.1%) were female, and a majority (70.0%) were unemployed (no monthly income) or employed part-time (monthly income NT\$1 to \$15,840). Table 1 also shows the distribution of the sampled hospitalizations according to hospital and physician caseload volume group. The overwhelming majority of the sampled hospitalizations were in the high-volume hospital (89.0%) as well as high-volume physician (82.7%) groups.

The chi-square analyses showed that in-hospital mortality was significantly related to patient's age ($p < 0.001$), CCI score ($p < 0.001$), and physician caseload volume ($p < 0.001$). The in-hospital mortality decreased with increasing physician caseload volume; patients treated by low, medium, and high-volume physicians had 3.0%, 1.0%, and 0.8% in-hospital mortality rates, respectively. However, no significant relationship was observed between in-hospital mortality and hospital caseload volume groups ($p = 0.896$).

Physician SLE caseload volume groups are summarized in Table 2, which shows that 857 physicians admitted and treated SLE patients between 2002 and 2004, with a mean 3.7 admissions per year. The distribution of sample admis-

Table 1. Details of sampled hospitalizations for treatment of SLE associated with in-hospital mortality in Taiwan, 2002-2004.

Variable	All (n = 8536)		In-hospital Mortality				P value
	No.	Column %	No. (n = 8449)	Row %	No. (n = 87)	%	
Age of patients, mean (SD) yrs	35.6	13.8	35.5	13.7	41.6	17.0	< 0.001
Patient gender							0.389
Male	931	10.9	924	99.3	7	0.7	
Female	7,605	89.1	7,525	99.0	80	1.0	
Charlson Comorbidity Index score							< 0.001
1 or less	6,804	79.7	6,748	99.2	56	0.8	
2	810	9.5	800	98.8	10	1.2	
3	723	8.5	709	98.1	14	1.9	
4 or more	199	2.3	192	96.5	7	3.5	
Monthly income (New Taiwan dollars)							0.359
0	1,345	15.8	1,326	98.6	19	1.4	
NT\$1–15,840	4,626	54.2	4,583	99.1	43	0.9	
NT\$15,841–25,000	1,631	19.1	1,613	98.9	18	1.1	
≥ NT\$25,001	934	10.9	927	99.3	7	0.7	
Hospital case volume							0.896
Low	499	5.9	493	98.8	6	1.2	
Medium	439	5.1	435	99.1	4	0.9	
High	7,598	89.0	7,521	99.0	77	1.0	
Physician case volume							< 0.001
Low	708	8.3	687	97.0	21	3.0	
Medium	768	9.0	760	99.0	8	1.0	
High	7,060	82.7	7,002	99.2	58	0.8	

Table 2. Physician and hospitalization details in Taiwan, by physician SLE caseload volume groups, 2002–2004.

Variable	Physician SLE Case Volume Group					
	Low (< 1 per yr)		Medium (1-3 per yr)		High (> 3 per yr)	
	No.	%	No.	%	No.	%
Physician characteristics						
Total no. of physicians	580	67.7	159	18.6	118	13.8
Physician age, yrs						
≤ 40	296	51.0	72	45.3	40	33.9
41-50	206	35.5	63	39.6	61	51.7
> 50	78	13.5	24	15.1	17	14.4
Physician sex						
Male	563	97.1	150	94.3	115	97.5
Female	17	2.9	9	5.7	3	2.5
Hospital details**						
Total no. hospitalizations	708	8.3	768	9.0	7,060	82.7
Age of patients, mean (SD)	40.5	15.7	37.9	14.9	34.9	13.3
Patient sex						
Male	94	13.3	94	12.2	743	10.5
Female	614	86.7	674	87.8	6,317	89.5
Charlson Comorbidity Index score						
1 or less	478	67.5	507	66.0	5,819	82.4
2	103	14.5	68	8.9	639	9.1
3	94	13.3	167	21.7	462	6.5
4 or more	33	4.7	26	3.4	140	2.0
Monthly income						
0	103	14.6	101	13.2	1,141	16.2
NT\$1–15,840	383	54.1	415	54.0	3,828	54.2
NT\$15,841–25,000	156	22.0	177	23.1	1,298	18.4
≥ NT\$25,001	66	9.3	75	9.8	793	11.2

*Total no. of physicians = 857; total patient sample = 8536.

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sions, by physician caseload volume, sex, specialty, and age are shown in Table 2. The physicians in the high-volume group were more likely to be older ($p < 0.001$).

Table 2 also presents the details of the sampled hospitalizations by physician SLE volume group. The chi-square analyses show that there were significant relationships in the distributions of hospitalizations among physician volume groups in terms of patient's age ($p < 0.001$), sex ($p = 0.038$), CCI score ($p < 0.001$), and monthly income ($p = 0.004$). Those patients treated by high-volume physicians were more likely to be female, with a CCI score ≤ 1 , and with a monthly income \geq NT\$25,001.

Table 3 provides the adjusted odds ratio estimates of the likelihood of in-hospital mortality, by physician SLE caseload volume. The adjusted odds ratio of in-hospital mortality declined with increasing physician caseload volume, with the odds of in-hospital mortality for patients treated by low-volume physicians being 2.681 (reciprocal of 0.373) times the odds for patients of medium-volume physicians, and

3.195 (reciprocal of 0.313) times the odds for patients of high-volume physicians. As expected, the odds of in-hospital mortality increased with patient age and the CCI score. We also performed sensitivity analyses and found that the model is very stable under various cutoff points of the physician SLE caseload volume.

DISCUSSION

To our knowledge, this is the first SLE volume-outcome relationship study undertaken outside the United States. Compared to the 3.0% observed mortality for SLE patients treated by physicians in the low SLE caseload volume group, we found that patients treated by medium or high SLE caseload physicians had much lower in-hospital mortality rates (1.0% and 0.8%, respectively). After adjusting for patient and hospital characteristics, the SLE patients treated by physicians in the medium caseload volume group were 0.373 times less likely to die in hospitals than patients treated by low-volume physicians. The inverse volume-outcome relationship was even more apparent when outcomes for high SLE caseload volume physicians were compared to those for low volume physicians; patients were on average 0.313 times less likely to die if they were treated by physicians with high SLE caseloads than those treated by physicians with low caseloads. This result concurs with the study conducted by Ward in 2005, which reported a 59% lower mortality risk among patients attended by physicians with the highest SLE caseload volume compared to those treated by the lowest caseload physicians²².

Nevertheless, when we analyzed the relationship between hospital SLE-volume and in-hospital mortality of SLE patients, we failed to find any significant relationship between them. This finding does not support studies conducted by Ward^{21,23} that reported patients admitted to high-volume hospitals on an emergency basis for SLE were 95% less likely to die, compared to those admitted to hospitals with less SLE experience²¹. However, in a later study, Ward reported that in-hospital mortality might be influenced by the type of insurance the SLE patients had. Patients with private medical insurance had comparable in-hospital mortality whether they were treated in highly experienced or less experienced hospitals. For patients with public insurance (Medicare) or no medical insurance, lower risk of in-hospital mortality was observed only at highly experienced hospitals²⁰. In contrast with the different health insurance systems employed in the United States, > 98% of citizens in Taiwan are insured by National Health Insurance. This single-payer system may explain why no significant relationship between hospital SLE volume and in-hospital mortality of SLE patients was observed in our study.

Two hypotheses have been proposed to explain the volume-outcome relationship^{1,11,24,25}. The first, "practice makes perfect," is based upon the idea that providers with a larger volume of patients develop better experience and skill

Table 3. Adjusted odds ratio for in-hospital death by physician SLE caseload volume group and the characteristics of the hospital and patient.

Variable	In-hospital Death Adjusted OR (95% CI)
Physician SLE caseload volume	
Low	1.000
Medium	0.373 (0.162-0.855)*
High	0.313 (0.187-0.561)**
Hospital characteristics	
Hospital level	
Medical center	1.037 (0.283-3.767)
Regional hospital	0.523 (0.130-2.108)
District hospital	1.000
Hospital ownership	
Public	3.317 (0.363-29.852)
Private not-for-profit	2.523 (0.331-22.911)
Private for-profit	1.000
Hospital geographic location	
Northern	0.153 (0.068-0.378)**
Central	0.621 (0.351-1.078)
Southern	2.791 (1.222-6.365)
Eastern	
Patient characteristics	
Patient sex	
Male	0.672 (0.304-1.473)
Female	1.000
Charlson Comorbidity Index score	
1 or less	1.000
2	1.183 (0.594-2.365)
3	2.059 (1.145-3.765)*
4 or more	2.740 (1.212-6.354)*
Patient age	
Monthly income	1.132 (1.014-1.033)*
0	1.000
NT\$1-15,840	0.611 (0.363-1.106)
NT\$15,841-25,000	0.732 (0.365-1.374)
\geq NT\$25,001	0.544 (0.223-1.244)

* $p < 0.05$; ** $p < 0.001$.

in operations or treatment procedures. In addition, although a considerable number of studies have reported a significant relationship between high-volume hospitals or surgeons and better outcomes¹⁻¹⁰, this inverse relationship is more pronounced and consistent for low-frequency, high-risk operations, such as pancreatectomy and esophagectomy^{2,5,18}. Further, during the early volume-outcome studies for AIDS treatments, researchers found that when a disease was relatively new, complex, and uncommon, the importance of physicians' prior experience with similar patients was magnified^{26,27}. Similarly to AIDS, SLE is a relatively infrequent medical condition, normally presents a broad spectrum of clinical and immunological manifestations, and often follows an unpredictable course, all of which magnify the importance of experience with similar patients for a physician. Ward similarly suggested that greater experience at diagnosing and managing manifestations of SLE among physicians with higher caseload volume, or better skill in treating general medical problems in such patients, is likely a more important factor in determining patient outcomes²². However, we must be cautious about explaining the inverse-volume relationship by this hypothesis alone; although it is difficult to argue with the principle that "practice makes perfect," a cross-sectional study like ours cannot demonstrate whether the volume-outcome relationship can be explained by such a hypothesis. Nevertheless, if this hypothesis does partly explain the inverse volume-outcome relationship observed here, including the significantly improved survival rate even for SLE patients treated by medium caseload volume physicians, it means that low-volume physicians obtaining poor outcomes can improve their clinical performance substantially by increasing their patient volume.

A second explanation for the inverse volume-outcome relationship is "self-referral"¹¹, that is, physicians who achieve better outcomes get more referrals from patients or physicians. This hypothesis is more likely to account for outcomes among patients admitted on an elective basis than for those admitted with urgent or emergency problems²¹, particularly in a nation like Taiwan, where no formal referral system exists and healthcare consumers have the freedom to choose their provider. Further, physicians graduating from different medical schools with different training might prefer different treatment procedures, with the result that they may be practicing a variety of skills or procedures for SLE treatment, which might well lead to different patient outcomes. Finally, reports of those different outcomes then spread by "word of mouth," with the result that physicians with good reputations or superior outcomes attract a greater number of patients.

The strengths of this study include its large nationwide population-based sample, the availability of data on patients with a wide range of demographic characteristics, adjustment for comorbidities and other potential confounding fac-

tors, and simultaneous evaluation of both physician and hospital caseload volume.

Two caveats to this study should be noted. First, the lack of detailed clinical information and information about severity of SLE is a major limitation. We cannot identify whether an admission is elective or unscheduled within the administrative dataset used for this study. We acknowledge that although SLE patients are admitted only when their conditions are severe enough in Taiwan, the entry criteria may vary among hospitals or physicians. However, prior studies found that low-risk patients were more likely to be treated by low-volume providers^{28,29}.

Second, lacking information about physicians' subspecialties was another potential confounding factor. However, a study conducted by Ward in 2005 concluded that disease-specific experience among high-caseload attending physicians rather than specialty appeared to be responsible for the lower mortality rate observed²². Although attending physicians treating SLE patients in Taiwan are coded as internists in the NHIRD, the majority of those physicians are in fact nephrologists and rheumatologists.

After evaluating 8536 admissions for patients with SLE in the NHIRD from 2002 to 2004, we found a significant inverse relationship between physicians' SLE caseloads and patient mortality; nevertheless, no significant relationship was observed between hospital caseload volume and patient mortality. Our study shows that the lower in-hospital mortality for SLE patients of physicians who more frequently attend such patients was not achieved through longer in-hospital stays or increased medical expenditures. Before any policy can be derived from this relationship, we must identify what clinical procedures or techniques high SLE caseload volume physicians are using, as this information could benefit lower-volume physicians who are currently obtaining poorer outcomes.

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