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ORIGINAL ARTICLE

Bringing Generalists Into the Hospital: Outcomes of a Family Medicine Hospitalist Model in Singapore

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PURPOSE: The aim of this study was to assess a newly introduced hospitalist care model in a Singapore hospital. Clinical outcomes of the family medicine hospitalists program were compared with the traditional specialists-based model using the hospital's administrative database.

METHODS: Retrospective cohort study of hospital discharge database for patients cared for by family medicine hospitalists and specialists in 2008. Multivariate analysis models were used to compare the clinical outcomes and resource utilization between patients cared for by family medicine hospitalists and specialist with adjustment for demographics, and comorbidities.

RESULTS: Of 3493 hospitalized patients in 2008 who met the criteria of the study, 601 patients were under the care of family medicine hospitalists. As compared with patients cared for by specialists, patients cared for by family medicine hospitalists had a shorter hospital length of stay (adjusted LOS, geometric mean, GM, 4.4 vs. 5.3 days; $P < 0.001$) and lower hospitalization costs (adjusted cost, GM, \$2250.7 vs. \$2500.0; $P = 0.003$), but a similar in-patient mortality rate (4.2% vs. 5.3%, $P = 0.307$) and 30-day all-cause unscheduled readmission rate (7.5% vs. 8.4%, $P = 0.231$) after adjustment for age, ethnicity, gender, intensive care unit (ICU) admission, numbers of organ failures, and comorbidities.

CONCLUSION: The family medicine hospitalist model was associated with reductions in hospital LOS and cost of care without adversely affecting mortality or 30-day all-cause readmission rate. These findings suggest that the hospitalist care model can be adapted for health systems outside North America and may produce similar beneficial effects in care efficiency and cost savings. ***Journal of Hospital Medicine*** **2011;6:115–121.** *© 2011 Society of Hospital Medicine.*

KEYWORDS: hospital mortality, Hospitalists, ICD-9-AM, length of stay, unscheduled readmission.

The hospitalist care model as described by Drs Robert Wachter and Lee Goldman in 1996 has seen rapid growth in terms of the number of hospitalists and the number of hospitals served by hospitalists' groups in North America.[1–6] Hospitalists were initially defined as physicians who spend a minimum of 25% to 50% of their time caring for inpatients.[7] The Society of Hospital Medicine later identified hospitalists as "physicians whose primary professional focus is the general medical care of hospitalized patients. Their activities include patient care, teaching, research, and leadership related to hospital care".[7,8]

Previous study results have consistently demonstrated that hospitalists may decrease overall cost and length of stay (LOS) for patients without compromising clinical outcomes.[9–12]

Like many countries around the world, tertiary hospitals in the Singapore health system grapple with the challenges of providing highly subspecialized care to patients who at the same time requires general medical care for multiple complex comorbidities. Unlike the United States, the shortage of generalists in Singapore's hospitals is partly historical, due to the fact that its health system was developed based on the British health system. Under this model of care, family doctors or general practitioners (GP) do not have a tradition of attending to their patients after they are admitted to the hospital. Care of patient is handed over to hospital specialist on admission. In the interest of improving patient care amidst increasing fragmentation of care due to subspecialization, Singapore General Hospital (SGH) developed a hospitalist care model that is adapted to the health system of Singapore.[13] The hospital conducted an extensive study of the hospitalist care model which included study visits to the hospitalist programs at the Calgary Health Region in Canada and the University of California, San Francisco, CA, in the United States.[14]

The aim of this study was to assess the clinical outcomes of the adapted hospitalist program which uses family physicians as generalists in the hospital and compare this with

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the traditional model of using specialists to provide general medical care in the Singapore General Hospital. The care outcome indicators we used were hospital LOS, 30 day all-cause readmissions, mortality, and cost of care.

Methods

Setting

SGH is the largest acute tertiary care hospital in Singapore. It has 29 clinical departments many of which are established as national referral centers. It has 1600-beds in Singapore, serving approximately one-fourth of its population of 4.59 million.[15] It is affiliated with the Yong Loo Lin School of Medicine at the National University of Singapore (NUS) and the Duke-NUS Graduate Medical School. Forty-eight percent of the medical staff hold teaching appointments. It is also a major training hospital for residents, accounting for approximately 60% of the total amount of residency training in Singapore.

Intervention

In May 2006, a clinical family medicine department was established in the Singapore General Hospital with the intention of developing a local adaptation of the hospitalist care model.[16] The important distinctive features of the adapted hospitalist model as compared to the model commonly found in North America include:

1. All attending physicians in the hospitalist teams are family physicians by training. The family medicine training program in Singapore resembles a hospital based residency program in the United States. It comprises a minimum of 2 years of structured training based in an acute hospital and 1 year in a primary care setting. The attending physicians in the hospitalist program spend a minimum of 25% of their time providing general medical care for hospitalized patients. The average time spent in inpatient care by the attending physicians was 33%(unpublished internal data). The rest of the time, they are rotated to run hospital-based ambulatory care clinics, preoperative evaluation clinics, health assessment clinics and a home-based intermediate care service. All the attending physicians hold teaching appointments and are involved in the teaching of medical students and residents.
2. Bringing family physicians into the hospital. In Singapore as it is in many health system modeled after the British system, internists work almost exclusively in the hospitals while primary care is almost exclusively provided for by family physicians who are referred to as GP. Primary physicians in Singapore do not have a tradition of managing their patients after admission to the hospital. The pace of specialization of medicine intensified after the mid-1980s when all public hospitals in Singapore were restructured. The number of full-time general internist dwindled dramatically and presently general medical care of patients in most hospitals in Singapore are provided for mainly by specialists.[17] There had been criticism of the hospitalist care model in the United States for introducing care discontinuity between the hospital and the community.[18,19] Unlike the situation in the United States, the use of family physicians as hospitalist in Singapore is seen as a disruption of a different kind of tradition where there is a distinct divide between physicians who care for patients in the community and those who care for patients in the hospital setting.
3. Discharged patients with unresolved issues are followed up by the family medicine hospitalist at the ambulatory care clinics in the hospital. Patients are reviewed until they can be handed off to suitable health care providers in the community, to continue with their long term care outside the hospital. Specialist physicians of the hospital provide a similar system of follow-up of discharged patients although they are more likely to be referred for review by different specialties according to the patients' comorbidities.

Traditionally, patients who are admitted to the Singapore General Hospital come under the care of single system specialists. Many of them are subspecialists who spend a large part of their time running specialist outpatient services and performing procedures and interventions related to their specialty. Approximately 66% of cases admitted from the emergency department to be cared for by the medical departments require specialty care and are admitted directly to the specialist departments. The rest of the patients (34%) are admitted under the category of "internal medicine". The admitting physicians who work in Department of Emergency Medicine make these decisions independently. All physicians from the medical specialty departments go on a roster to provide general medical care for such patients usually with the help of specialist consultations. The reason for this form of "usual care" is again historically related to the fact that the Singapore health system was developed and modeled after the British system.

Patients admitted under the category of "internal medicine" were assigned hospital beds based on availability of beds for this category of admissions by the bed management unit of the hospital. A total of 34 beds out of 232 beds that are available for use under this category of admission are assigned to be cared for by the family medicine hospitalists in this program. The assignment is administrative and these beds are no different from other beds that accept patients admitted under the same admission category. The assignment of patients to the family medicine hospitalist or the specialist is therefore determined by the bed availability at the time of admission.

Data Source

Data of all hospitalized patients aged 18 years and above who were admitted into the Singapore General Hospital from January 1, 2008 to December 31, 2008 were collected from the hospital data warehouse at the Information

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Technology Department, SingHealth Group, Singapore. The collected data included demographic information such as ethnic group, gender, age, marital status, admission date, discharge date, intensive care unit (ICU) admission, disease codes under ICD-9-AM (International Statistical Classification of Diseases and Related Health Problems, 9th Revision, Australian Modification), and ICD-9-AM procedure codes. Data of patients who were readmitted to the hospital within 30-days after the first discharge were also extracted. Available cost of care data including investigation, medication, treatment, and facility charges were also extracted based on hospital service codes. The protocol was approved by the Ethics Committee of the Singapore General Hospital with exemption from the requirement for informed consent.

Case Definition

Patients cared for by hospitalists were inpatients who were under the care of attending physicians from the Department of Family Medicine and Continuing Care using the adapted hospitalist care model. Patients cared for by nonhospitalists who were inpatients and who were cared for by all other attending specialist physicians from the other medical departments go on a roster to provide general medical care under the usual care model.

Surgical and medical conditions were determined based on the presence of ICD-9-AM diagnostic codes and procedure codes.[20]

Chronic comorbid conditions were identified by ICD-9-AM codes and were then studied using the Charlson Index.[21–23] The Charlson score was then classified into 4 previously defined grades known as the Charlson Comorbidity Index (CCI): 0 points (none), 1 to 2 points (low), 3 to 4 points (moderate), and $\geq$5 points (high).[21–23]

Organ failure was defined by a combination of ICD-9-AM diagnosis and procedure codes, as outlined previously.[24,25]

Statistical Analysis

Categorical variables were reported as percentages, continuous variables were reported as mean and standard deviation (SD). Hospital LOS and hospitalization cost of care were reported using geometric mean (GM) and 95% confidence interval (CI) because of their skewed distribution.

Hospital mortality rate was defined as the ratio of inpatient deaths to the total number of inpatients. Age was categorized into quintiles (18-54, 55-64, 65-74, 75-84, and >84 years) to capture the nonlinear effect of age on hospital service quality and resource utilization. Parameters were compared between patients cared for by hospitalists and nonhospitalists by chi-square test for hospital mortality and readmission rate and by Mann-Whitney U test for LOS and hospital cost. All hospital costs were converted to the year 2008 US dollars for presentation based on the Annual Average Rates of Exchange, Singapore (2008).[26] Logistic regression was used to assess the association of hospital mortality and 30-day all-cause unscheduled readmission after adjusting for gender, ethnic group, ICU admission, CCI groups, number of organ failures, and the interaction among age groups, CCI groups, and numbers of organ failures. Analysis of hospital LOS and hospitalization costs were restricted to cases with values within 3 SD of the mean because of the extremely skewed nature of these data. Generalized linear model was used to assess log-transformed LOS and cost with hospitalists care and adjusted for the above-mentioned factors. The Hosmer–Lemeshow chi-square goodness-of-fit tests were used to exclude variables and identify clinically plausible interaction terms. Using the estimates from the regression models, we presented differences in adjusted LOS, hospitalization costs, hospital mortality, and 30-day all-cause unscheduled readmission between hospitalists and nonhospitalists. All P values were 2 sided. The level of statistical significance was considered to be the conventional alpha = 0.05. The data analysis was performed with SPSS 17.0 software (SPSS, Chicago, IL).

Results

A total of 3493 patients met the inclusion/exclusion criteria, in which 601 patients were under the care of hospitalists. The demographic and clinical characteristics of all patients are shown in Table 1. There were no differences in age (67.0 $\pm$ 20.4 vs. 66.1 $\pm$ 19.8 years, P= 0.311) and ethnic group (P= 0.253) between patients cared for by hospitalists and nonhospitalists. Patients cared for by hospitalists were less likely to be admitted to ICU (0.5% vs. 2.5%, P= 0.002) than patients cared for by nonhospitalists. There were similar CCI grades between patients cared for by hospitalists and nonhospitalists (P= 0.872). Patients cared for by hospitalists had similar numbers of organ failures as compared to patients cared for by nonhospitalists.

Unadjusted Clinical Outcomes and Resource Utilization

The in-hospital mortality rates in patients cared for by hospitalists were similar (4.0% vs. 5.3%, P= 0.187) compared to patients cared for by nonhospitalists (Table 2). Also, there were no statistically significant differences in the 30-day all-cause unscheduled readmission rates between patients cared for by hospitalists and nonhospitalists (7.5% vs. 7.3%, p= 0.854). As for resource utilization, patients cared for by hospitalists had significantly shorter hospital LOS (GM, 4.6 vs. 5.7 days, $P < 0.001$) and lower cost (GM, $2301.0 vs. $2656.6, P= 0.001) compared with that in patients cared for by nonhospitalists (Table 2).

Adjusted (Multivariate) Results of Hospital Clinical Outcomes and Resource Utilization

Multivariate analysis was used with adjustment for age groups, ethnic group, gender, ICU admission, numbers of organ failures, and CCI grades. Patients cared for by hospitalists, as compared with patients cared for by nonhospitalists, had a statistically significant shorter hospital LOS by 0.9 days (GM, 4.4 vs. 5.3 days, $P < 0.001$) and lower cost by

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$250 (GM, $2250.7 vs. $2500.0, $P = 0.003$), but similar in-hospital mortality and 30-day all-cause readmission rates (both $P > 0.05$; Table 2). The goodness of fit of the regression model used for hospital LOS was assessed with the Hosmer-Lemeshow test ($\chi^2 = 546.1$, degree of freedom (df) = 3406, $P = 0.160$).

As for the detailed secondary cost, patients cared for by hospitalists had significantly lower treatment costs by $66 (GM, $462.9 vs. $528.1 $P < 0.001$) and facility costs by $127 (GM, $827.1 vs. $953.7 $P < 0.001$) compared with patients cared for by nonhospitalists after adjustment for age groups, ethnic group, gender, ICU admission, presence of organ failures, and CCI grades. The investigation and medication costs were comparable between the 2 groups (all $P > 0.05$) even after similar adjustments (Table 3).

TABLE 1. The Demographic, Clinical Characteristics of Patients Cared by Hospitalist and Non-Hospitalist Services

	Non Hospitalist, n = 2892	Hospitalist, n = 601	P*
Age, year	66.1 ± 19.8	67.0 ± 20.4	0.311
Male sex, %	49.2	44.4	0.033
Ethnicity, %			0.253
Chinese	79.2	76.9	
Malay	7.8	7.7	
Indian	9.8	12.5	
Others	3.3	3.0	
ICU admission, %	2.5	0.5	0.002
Charlson Comorbidity Index, %			0.872
None	43.5	42.3	
Low	35.5	36.6	
Moderate	14.0	14.6	
High	7.0	6.5	
Organ failure No, %			0.192
0	73.7	75.9	
1	21.6	20.5	
2	3.7	3.5	
≥3	1.0	0.2	

* *P* value was calculated using chi-square test except p value for age was calculated using 2 sample *t*-test.

Discussion

We found that patients cared for by hospitalists had shorter hospital LOS (reduced by 0.9 days), and reduced cost (reduced by $250), compared with that of patients cared for by nonhospitalists. This occurred without any compromise of the clinical outcomes as measured by hospital mortality and 30-day all-cause unscheduled readmission. The mortality rates were 4.0%(hospitalist) and 5.3%(nonhospitalist). The difference was not statistically significant ($P = 0.187$). The differences in hospital LOS and cost still existed even after adjustment for age, gender, ethnic group, ICU admission, CCI, and the numbers of organ failure.

Our findings are consistent with previous reports of reduced hospital LOS and hospitalization costs in patients cared for by hospitalists in the United States.[27–30]

Several explanations have been proposed for the favorable results. First, hospitalists' accessibility and holistic approach to the multiple problems of individual patients provide a more coordinated response to the patient's changing needs during the hospital stay. Second, studies had suggested that better coordination of care by hospitalist results in a lower use of resources and fewer specialist consultations.[31] Reduced patients hospital LOS and cost may lead to an overall reduction in total revenue to the hospital, resulting in an advantage to the patients and a disadvantage to the hospital. However, this reduction in total revenue may

TABLE 2. The Length of Stay, Total Hospitalization Cost and Outcomes of Care of Patients Cared by Hospitalist and Non-Hospitalist Services

	Non hospitalist, n = 2892	Hospitalist, n = 601	Difference	P
Length of stay, day†				
Un-adjusted mean (95% CI)	5.7 (5.4, 5.9)	4.6 (4.2, 5.0)	1.1	<0.001
Adjusted mean (95% CI)	5.3 (5.3, 5.4)	4.4 (4.3, 4.5)	0.9	<0.001
Total hospitalization cost, $†				
Un-adjusted mean (95% CI)	2656.6 (2569.8, 2746.4)	2301.0 (2125.2, 2460.1)	335.6	0.001
Adjusted mean (95% CI)	2500.6 (2471.5, 2530.1)	2250.7 (2195.9, 2306.8)	250	0.003
Unscheduled readmission, %*				
Un-adjusted	7.5	7.3	0.2	0.854
Adjusted	8.4	7.5	0.9	0.761
Hospital mortality, %*				
Un-adjusted	5.3	4.0	1.3	0.187
Adjusted	5.3	4.2	1.1	0.307

Abbreviations: CI, confidence interval; SD, standard deviation.

* *P* value was calculated using chi-square test. Adjusted hospital mortality and unscheduled readmission was calculated with logistic regression model. Models were adjusted for the patients' age group, sex, race, ICU admission, Charlson comorbidity index and numbers of organ failure. CI, confidence interval.

† Geometric mean (95% CI); *P* value for un-adjusted mean length of stay and hospitalization cost was calculated using Mann-Whitney U test; *P* value for adjusted mean length of stay and cost was calculated using linear regression model with log transformation of length of stay and hospitalization cost. Length of stay and cost data were truncated at above mean plus 3 SD values before regression analysis.

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TABLE 3. The Unadjusted Geometric Mean Investigation, Medication, Treatment and Facility Cost Per Admission by Hospitalist and Non-Hospitalist Services

	Non hospitalist, n = 2892	Hospitalist, n = 601	Difference	*P*
Investigation Cost, $				
Un-adjusted mean (95% CI)	828.3 (802.2, 855.3)	772.3 (722.2, 825.8)	24.7	0.196
Adjusted mean (95% CI)	776.5 (767.8, 785.2)	759.0 (741.4, 776.9)	17.5	0.673
Medication Cost, $				
Un-adjusted mean (95% CI)	62.8 (58.7, 67.2)	68.2 (59.6, 78.2)	−9.0	0.409
Adjusted mean (95% CI)	50.5 (49.1, 52.0)	56.9 (53.5, 60.6)	−6.4	0.184
Treatment Cost, $				
Un-adjusted mean (95% CI)	561.2 (542.3, 580.7)	472.4 (442.1, 504.8)	93.4	<0.001
Adjusted mean (95% CI)	528.1 (522.1, 534.3)	461.9 (450.8, 473.3)	66.2	<0.001
Facility Cost, $				
Un-adjusted mean (95% CI)	1015.9 (978.8, 1054.4)	847.6 (787.8, 912.0)	178.5	<0.001
Adjusted mean (95% CI)	953.7 (942.2, 965.4)	827.1 (806.0, 848.9)	126.6	<0.001
Total hospitalization cost, $				
Un-adjusted mean (95% CI)	2656.6 (2569.8, 2746.4)	2301.0 (2125.2, 2460.1)	335.6	0.001
Adjusted mean (95% CI)	2500.6 (2471.5, 2530.1)	2250.7 (2195.9, 2306.8)	250	0.003

NOTE: Geometric mean (95% confidence interval); *P* value for unadjusted mean was calculated using Mann-Whitney U test; *P* value for adjusted mean was calculated using linear regression model with log transformation of cost. Cost data were truncated at above mean plus 3 SD values before regression analysis. Models were adjusted for the patients' age group, sex, race, ICU admission, Charlson comorbidity index and numbers of organ failure. CI, confidence interval.

Abbreviations: CI, confidence interval; ICU, intensive care unit; SD, standard deviation.

have been partially offset by an increase in the number of patients receiving hospital care services.[32] Third, fewer patients in the hospitalists group had an ICU stay and this could be another reason for an increased chance of earlier discharge from the hospital.[33] The reduced LOS still existed even after adjustment for ICU admission and other factors. The total number of patients with ICU admissions was small in both groups and did not make a difference to the outcome measures used in our study. The use of ICU is significantly higher by the nonhospitalist group. It is unlikely that the difference was due to severity of illness on admission because the admitting physicians at the emergency department do not specify whether patients are to be managed by hospitalists or nonhospitalists. Assignment of the patient to the 2 groups was based only on the availability of bed at the time of admission. There is a possibility that the difference had occurred by chance due to the small number of patients requiring ICU admission. Discussion of end of life care issues and palliation as an option is known to result in lowered utilization of ICU.[34] There is a possibility that hospitalists are more likely to engage the patient and family in end of life care discussions although this would require further studies to confirm. Finally, hospitalists might be more effective in navigating the complex environment of the hospital and might develop greater clinical expertise as a result of repeated experience in caring for patients in a similar setting.[35] All these favorable factors were present in our adapted hospitalist care model.

While some studies of hospitalist care have shown reduced LOS without reduction of cost, our results showed significant reduction in the cost of care ($250, $P = 0.001$) for patient who are managed under the hospitalist program. The differences lie mainly in the cost of treatment and facilities. There were no significant differences in the cost of investigations and drugs.

There were several limitations in our study. Although hospital discharge data had numerous advantages including reliability and extensive use in various analyses in health services and health policy research,[36] the dataset was administrative in nature and was not created specifically for our study. The hospital discharge data was also at risk of coding errors and omissions of important diagnoses and complications, which may affect the disease complexity estimates.[37] In our study this was partly mitigated by the quality control processes instituted by the hospital and government agencies that use this data for planning and health care financing purposes. As all the data came from a single hospital, there was less risk of coding discrepancies and nonuniformity in calculating hospitalization costs. Our study was retrospective and observational in nature. Nevertheless we did use a number of statistical methods and analyses to minimize the risk of bias. Underlying differences in the patient populations of the 2 comparison groups led us to rely heavily on multivariate analysis and adjustment to minimize confounding factors. Nevertheless it is still possible that factors not included in administrative data might still exist as unmeasured confounders.[28] In the period of study, we did not identify significant changes in the process of care for the patients apart from the introduction of the adapted hospitalist care model. This study was done in a single hospital. The hospital is an acute tertiary hospital. It is also a teaching hospital with affiliation to 2 medical schools (Duke-NUS Graduate Medical School and Yong Loo Lin School of Medicine). The results might not be

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generalizable to other hospitals with different characteristics. Finally, this study was limited to information concerning in-hospital deaths, and we did not have data that would have allowed us to detect differences in deaths that occurred after discharge. Similarly, we could only assess readmissions within our hospital. We do not know how frequently patients were admitted to other hospitals, a potential problem in all research of this type reported to date.[30]

In conclusion, our study showed that the hospitalist care model can be adapted to work in health systems outside North America with favorable outcomes. Our adapted hospitalist care model using family physicians as generalists in the hospital was associated with improvements in areas of LOS and cost reductions. There were no difference in mortality and readmissions. In health systems where hospital and primary care providers are historically divided, the deployment of family physicians as hospitalist may have the additional benefit of bridging the gap and support care continuity across the entire spectrum of care settings for patients.

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