Impact of a DRG-based Hospital Financing System on Quality and Outcomes of Care in Italy

Daniel Z. Louis, Elaine J. Yuen, Mario Braga, Americo Cicchetti, Carol Rabinowitz, Christine Laine, and Joseph S. Gonnella

Objective. To examine potential changes in quality of care associated with a recent financing system implementation in Italy: in 1995, hospital financing reform implemented in Italy included the introduction of a DRG-based hospital financing system with the goals of controlling the growth of hospital costs and making hospitals more accountable for their productivity.

Data Sources. Hospital discharge abstract data from 1993 through 1996 for all hospitals ($N = 32$) in the Friuli-Venezia-Giulia region of Italy. Regional population data were used to calculate rates.

Study Design. Changes between 1993 and 1996 in hospital admissions, length of stay, mortality rates, severity of illness, and readmission rates were studied for nine common medical and surgical conditions: appendicitis, diabetes mellitus, colorectal cancer, cholecystitis, bronchitis/chronic obstructive pulmonary disease (COPD), bacterial pneumonia, coronary artery disease, cerebrovascular disease, and hip fracture.

Principal Findings. The total number of ordinary hospital admissions decreased from 244,581 to 204,054 between 1993 and 1996, a population-based decrease of 17.3 percent ($p < .001$). The mean length of stay decreased from 9.1 days to 8.8 days, resulting in a 21.1 percent decrease in hospital bed days ($p < .001$). Day hospital use increased sevenfold from 16,871 encounters in 1993 to 108,517 encounters in 1996. The largest decrease in hospital admissions among study conditions was a 41 percent decrease for diabetes (from 2.25 per 1,000 in 1993 to 1.31 in 1996, $p < .001$). For eight of the nine conditions, severity of illness increased. Differences between severity-adjusted expected and observed in-hospital mortality rates were small.

Conclusions. Observed trends showed a decrease in ordinary hospital admissions, an increase in day hospital admissions, and a greater severity of illness among hospitalized patients. There was little or no change in mortality and readmission rates. Administrative data can be used to track changes in patterns of care and to identify potential quality problems deserving further review.

Key Words. Italy, hospital financing, diagnosis-related groups (DRGs), quality of care, Disease Staging

The Italian *Servizio Sanitario Nazionale* (*SSN*) provides universal coverage for all 57 million citizens. The *SSN,* established in 1979, was modeled after the health care system in the United Kingdom (Del Favero and Barro 1996; Bevan, France, and Taroni 1992). The system is primarily government funded, with a large majority of public hospitals—approximately 84 percent of hospital beds—public, although private hospitals also receive most of their funds through the *SSN.* Primary care physician reimbursement is capitated and specialty physicians are salaried.

In 1995, a series of health care reforms were implemented in Italy (Taroni 1996). A major component of the reforms included changes in hospital financing, moving from a global budgeting approach to DRG-based per case financing of hospitals with the goals of controlling the growth of hospital costs and making hospitals more accountable for their productivity. The 1995 reforms also included explicit incentives for the increased use of "day hospital" (outpatient) care to reduce a perceived overuse of "ordinary" hospital (acute inpatient) care. In addition, changes were made in the senior administrative and medical management structure of public hospitals to allow for a more direct relationship between hospital performance and senior managers' incentives.

While there are similarities between the DRG system in Italy and the prospective payment system in the United States, there are also important differences (Langiano 1997). Because the *SSN* is essentially a single payer, all patients are included in the new financing scheme. By contrast to the system in the United States, payment for hospital-based physician services is included in the DRG rate in Italy. A standard hospital discharge abstract (*Scheda di Dimissione Ospedaliera,* or *SDO*) is now required for all hospital discharges (Nonis, Corvino, and Fortino 1997). However, because there was little historical need for patient or insurance company billing, the information systems in place at most Italian hospitals did not include the detailed patient-level data typically available in the United States.

This project was supported by a collaborative agreement between the *Agenzia per i Servizi Sanitari Regionale* (Agency for Regional Health Services), Rome, Italy, and Jefferson Medical College in Philadelphia.

Address correspondence to Daniel Z. Louis, M.S., Managing Director, Center for Research in Medical Education and Health Care, Jefferson Medical College, 1025 Walnut Street (Rm. 119), Philadelphia, PA 19107. Elaine J. Yuen, M.B.A., Carol Rabinowitz, Christine Laine, M.D., M.P.H., and Joseph S. Gonnella, M.D. are also with the Center for Research in Medical Education and Health Care, Jefferson Medical College. Mario Braga, M.D. and Americo Cicchetti are with the *Agenzia per i Servizi Sanitari Regionale,* Rome, Italy. This article, submitted to *Health Services Research* on August 3, 1998, was reviewed and accepted for publication on October 2, 1998.

Despite these differences, concerns similar to those raised by the PPS in the United States are being raised in Italy (Rogers et al. 1990; Kahn et al. 1990). Will the cost-cutting incentives inherent in the new system go beyond eliminating unnecessary or marginally beneficial care and affect needed care also? Will reductions in length of stay or in the use of specific services lead to worse patient outcomes such as increased severity of illness at discharge, increased readmissions, or higher mortality rates? This project was designed to study whether Italy's administrative data can be used to identify changes in patterns of care and potential changes in quality of care associated with the implementation of the new hospital financing system.

METHODS

Data from one region of Italy, Friuli Venezia Giulia, were analyzed for this project. Friuli Venezia Giulia is located in the northeast of Italy (the capital is Trieste) with a population of 1,189,000 in 1996. Discharge abstract data from the *SDO*, for the years 1993–1996, for all hospitals in the region (32 hospitals with 8,723 beds) were used to measure changes over time in "ordinary" hospital and "day hospital" admissions, length of stay, mortality rates, severity of illness, and readmission rates.[1]

In addition to studying aggregate hospital use, the analysis focused on nine frequently occurring medical and surgical conditions: appendicitis, diabetes mellitus, colorectal cancer, cholecystitis, bronchitis/chronic obstructive pulmonary disease, bacterial pneumonia, coronary artery disease, cerebrovascular disease, and hip fracture. Besides their high frequency of hospital use, the study conditions were chosen to include those typically treated by a variety of specialties: chronic conditions (e.g., diabetes mellitus) and acute problems (e.g., appendicitis); surgical procedures (e.g., hip fracture); and medical admissions (e.g., bacterial pneumonia), as well as conditions that may have either surgical or medical admissions (e.g., cholecystitis, colorectal cancer). Although prospective payment may not greatly affect the clinical management of some of the study conditions (colorectal cancer, appendicitis, cholecystitis, and hip fracture), prospective payment may affect the length of stay and outcomes for all conditions studied. For example, prospective payment may not alter the clinical decision to operate on an individual with suspected appendicitis, but it likely will influence the decision about how long to keep such a patient in the hospital after surgery.

Although data analysis was performed for all four study years, the results presented here compare 1993 (prior to reform) with 1996 (post-reform).

Admissions to both ordinary hospital beds and day hospitals were analyzed. Age-sex stratified population data for the region were used to standardize rates over the years of the study. Death registry data were linked with hospital discharge data to enable the assessment of post-discharge mortality.

Disease Staging (Gonnella, Hornbrook, and Louis 1984; Umesato et al. 1993; Taroni, Louis, and Yuen 1993) was used to assess changes in the severity of illness of hospitalized patients and to risk-adjust in comparisons of other dependent variables. Disease Staging defines severity of illness based on clinical definitions rather than on the use of resources, and it has been widely used in Italy (Taroni 1996; Taroni, Louis, and Yuen 1993; Umesato et al. 1993). It is a patient classification system with over 400 disease categories based on disease etiology, organ involvement, and the severity of complications. The computerized staging algorithm uses ICD-9-CM codes available in administrative data to classify hospital admissions. Each disease is divided into three stages: Stage 1, conditions with no complications or problems of minimal severity; Stage 2, problems limited to an organ or system, significantly increased risk of complications; and Stage 3, multiple site involvement, generalized systemic involvement, poor prognosis. The Disease Staging software also assigns to each patient an overall measure of expected mortality adjusted for severity of illness (MORTSCALE) (Gonnella, Louis, and Gozum 1997). Variables included in the MORTSCALE model include principal diagnosis, stage of principal diagnosis, unrelated comorbid conditions and their stages, patient age and sex, surgical procedure(s) performed, and type of admission (routine or emergent).

Overall and disease-specific relative admission rates for 1993 and 1996 were compared using direct age and sex standardization (StataCorp 1997). Chi-square tests were used to compare changes in the proportions of high-severity Stage 2 and 3 cases for each of the diseases. Changes in mean length of stay were assessed using the *t*-test of means. In length of stay analyses, in-hospital deaths and outliers[2] were excluded as they might have skewed the statistics.

MORTSCALE was used to calculate "expected" inpatient mortality rates for 1996 based on the 1993 and 1994 patterns in the Friuli Venezia Giulia region, which were then compared to observed 1996 mortality rates by chi-square tests. In addition, posthospital mortality was identified with regional mortality data, which were attached to each hospital discharge record. These data, which identified the death of regional residents through 1995, were used to calculate 300-day posthospital discharge mortality rates for 1993–1995.

Changes in the rate of readmissions were analyzed for two surgical and two chronic medical conditions: appendicitis, hip fracture, diabetes, and chronic obstructive pulmonary disease. For surgical admissions, the readmission rate was defined as the number of hospitals 30 days after the surgery divided by the number of surgeries. For the chronic medical conditions, the readmission rate was the number of patients with two or more hospitalizations for either diabetes or COPD within the calendar year divided by the total number of patients hospitalized with those conditions. Chi-square tests were used to test differences in readmission rates.

RESULTS

The total number of ordinary (inpatient) hospital admissions in Regione Friuli Venezia Giulia decreased from 244,581 in 1993 to 204,054 in 1996, a population-based decrease of 17.3 percent ($p < .001$). At the same time, overall mean length of stay decreased from 9.1 days to 8.8 days ($p < .001$) resulting in a decrease in the number of inpatient bed days from 2.23 to 1.79 million ($p < .001$). Day hospital use increased sevenfold, from 16,871 encounters in 1993 to 108,517 encounters in 1996 (Table 1).

Disease-specific changes in the rate of admissions, severity of illness, and length of stay are summarized in Table 2. All medical conditions studied, except bacterial pneumonia where no changes were observed, showed significant decreases in age and sex-adjusted ordinary hospital admission rates.

Table 1: Admissions, Length of Stay and Days (Regione Friuli Venezia Giulia, 1993–1996)

	1993	*1994*	*1995*	*1996*	*1993–1996*
Ordinary Hospital					
Admissions	244,581	245,729	232,393	204,054	−17.3%*
LOS	9.1	8.9	8.5	8.8	−3.3%**
Bed days	2,229,520	2,189,704	1,977,669	1,791,693	−21.1%*
Day Hospital†					
Episodes	4,493	17,500	24,271	33,276	+624.4%*
Encounters	16,871	55,189	79,936	108,517	+530.7%*

*Change in age-sex adjusted rates, $p < .0001$.

**t-Test of means, $p < .0001$.

†The *SDO* (Italian discharge abstract summary) designates the beginning of an episode of care in the day hospital, as well as the number of encounters within a given episode.

Table 2: Admissions, Severity of Illness, and LOS for Selected Conditions (Regione Friuli Venezia Giulia, 1993–1996)

	Number of Ordinary Admissions		*Rate of Ordinary Admissions/1000**			*Severity of Illness Percent Stage 2–3†*			*ALOS Ordinary Admissions‡*		
Selected Conditions	*1993*	*1996*	*1993*	*1996*	*Rate Ratio (95% CI)*	*1993*	*1996*	p-*Value*	*1993*	*1996*	p-*Value*
Appendicitis, S	1613	1393	1.28	1.17	0.92 (.83,1.01)	10.1%	18.2%	.001	6.4	5.1	<.001
Bacterial pneumonia, M	2909	3009	2.49	2.53	1.01 (.97,1.07)	6.9%	9.6%	.001	12.8	12.7	.596
Diabetes mellitus, M	2626	1555	2.25	1.31	0.58 (.54,.63)	40.0%	52.5%	.001	9.1	9.6	.090
Colorectal cancer, M	1443	941	1.25	0.79	0.63 (.59,.70)	29.8%	60.8%	.001	7.7	9.9	<.001
Colorectal cancer, S	823	956	0.71	0.80	1.13 (1.03,1.24)	20.8%	34.9%	.001	29.8	24.2	<.001
Cholecystitis, M	1277	865	1.10	0.73	0.66 (.61,.72)	28.9%	42.8%	.001	8.9	8.6	.560
Cholecystitis, S	1550	1732	1.33	1.46	1.10 (1.02,1.17)	35.4%	46.0%	.001	14.1	10.8	<.001
Bronchitis/COPD, M	4664	4059	4.03	3.41	0.85 (.81,.89)	69.6%	86.9%	.001	14.3	11.9	<.001
Cerebrovascular disease/stroke, M	6298	5982	5.44	5.03	0.93 (.89,.96)	66.7%	77.8%	.001	13.1	11.5	<.001
Coronary artery disease/AMI, M	9816	9257	8.48	7.79	0.92 (.89,.95)	41.6%	56.9%	.001	9.5	8.7	<.001
Hip fracture, S	1205	1360	1.04	1.14	1.10 (1.02,1.19)	2.7%	2.6%	.795	19.8	17.7	<.001

Note: S = surgical admissions; M = medical admissions.

*Age-sex direct-adjusted to 1996 population. †Ordinary hospital admissions, chi-square test. ‡Deaths and outliers excluded, *t*-test of means.

However, rates of surgical admissions for colorectal cancer, cholecyctitis, and hip fracture increased significantly. Severity of patient mix as measured by the proportion of Stage 2 and 3 admissions increased significantly for all medical and surgical conditions studied, except hip fracture, where no change was observed. Mean length of stay decreased significantly for most medical and surgical admissions with the exception of medical admissions for colorectal cancer, where length of stay increased significantly, and bacterial pneumonia, medical cholecystitis, and diabetes mellitus, where no statistically significant changes were observed.

The largest decrease in admission rates was observed for diabetes mellitus, a population-based decrease of 42 percent from 1993 to 1996. Admission rates for Stage 1 diabetes mellitus decreased by 52 percent (adjusted RR = .48, 95% CI = 0.44, 0.52); Stage 2 admissions decreased by 30 percent (RR = .70, 95% CI = 1.46, 1.98). By contrast, the least change was observed for bacterial pneumonia, with virtually no change in admission rates or length of stay from 1993 through 1996.

Few significant differences were found in the mortality analysis (Table 3). Observed inpatient mortality was significantly higher than expected for medical admissions for colorectal cancer but significantly lower than expected for cerebrovascular disease and coronary artery disease. In the analysis of 30-day posthospital mortality, none of the selected conditions had significant differences in rates except cerebrovascular disease, where the rate of 30-day posthospital mortality increased from 1.38 to 1.87 ($p = .048$).

Significant decreases in the 30-day postsurgery hospital readmissions per year were seen for patients who had an appendectomy (Table 4). There was also a significant decrease in the number of patients who had two or more hospital admissions per year for diabetes mellitus within a calendar year between 1993 and 1996. However, for bronchitis/COPD, there was a significant increase in the number of patients who had multiple admissions.

DISCUSSION

Based on the assumption that acute care hospital utilization can be reduced without jeopardizing quality of care, incentives within the new DRG-based hospital financing system in Italy encourage the use of day hospital care and discourage the use of acute hospital beds. Consistent with these goals, observed trends showed significant decreases in admission rates, mean length of stay, and days of care rates from 1993 through 1996. Analysis of

Table 3: Observed and Expected Mortality for Selected Conditions (Regione Friuli Venezia Giulia, 1996)

Selected Conditions	*# Hospital Admissions*	*# In-Hospital Deaths*	*Observed Mortality Rate*	*Expected Mortality Rate†*	*Difference O-E*	p-*Value**
Diabetes mellitus, M	1555	92	5.95%	5.91%	0.01%	.999
Colorectal cancer, M	941	275	29.22%	24.23%	4.99%	.014
Colorectal cancer, S	956	100	10.46%	10.34%	0.12%	.941
Cholecystitis, M	865	10	1.16%	1.97%	−0.81%	.175
Cholecystitis, S	1732	11	0.64%	0.84%	−0.20%	.430
Bronchitis/COPD, M	4059	185	4.56%	5.14%	−0.58%	.215
Cerebrovascular disease/Stroke, M	5982	909	15.20%	17.48%	−2.28%	.001
Coronary artery disease/AMI, M	9257	849	9.17%	13.29%	−4.12%	<.001
Hip fracture, S	1360	79	5.81%	4.81%	1.00%	.231

Note: S = surgical admissions; M = medical admissions.

*Chi-square test.

†Expected mortality takes into account severity of illness using Mortality Scale in Disease Staging. For 1996 expected mortality is calibrated using *Friuli* data 1993–1994.

Table 4: In-Hospital Readmissions for Selected Conditions (Regione Friuli Venezia Giulia, 1993–1996)

	# Patients with Readmissions		*Total # Patients*		*Readmission Rate*		
Selected Conditions	*1993*	*1996*	*1993*	*1996*	*1993*	*1996*	p-*Value**
Surgical conditions†							
Appendicitis	69	37	1594	1375	4.3%	2.7%	.0165
Hip fracture	279	272	1071	1168	26.1%	23.3%	.1296
Medical conditions‡							
Diabetes	383	230	2134	1557	17.9%	14.8%	.0105
COPD	711	668	3610	3071	19.7%	21.8%	.0385

*Chi-square test.

†For surgical conditions, readmission rate is number of hospitalizations 30 days after index admission where surgery was performed divided by the number of surgeries.

‡For medical conditions, readmission rate is number of patients with 2+ hospitalizations within calendar year divided by total number of patients.

disease-specific changes showed decreases in admission rates for all medical conditions studied except bacterial pneumonia, where no changes were observed, but increased rates of surgical admissions for colorectal cancer, cholecystitis, and hip fracture.

For all diseases studied except hip fracture, the proportion of advanced-stage admissions increased from 1993 through 1996. If appropriate care can be provided in the day hospital or other outpatient setting, this change in severity of illness of hospitalized patients may represent a more efficient use of inpatient resources. However, some concern is raised by the observed increase in the number and population-based rate of Stage 3 admissions for patients with diabetes mellitus. Stage 3 diabetes mellitus includes serious complications such as diabetic ketoacidosis and hyperosmolar coma. With an overall decline of 42 percent in the admission rate for diabetes mellitus, are appropriate alternatives available to provide care for these patients?

Upcoding also might have contributed to the increased severity of illness observed for many of the study conditions. It is possible that Italian hospitals, cognizant of the disincentives to hospitalize patients with low severity of illness, learned to code patients in such a manner that they appeared sicker. This phenomenon has come to be known as "DRG creep" in the United States (Hsia et al. 1992; Simborg 1981). We suspect that a portion of the change in severity of illness and expected mortality rates is due to upcoding, as one would expect to see less change in severity for conditions that always require admission (i.e., appendicitis). However, even for such conditions as appendicitis the decision about how early and how long to hospitalize are potentially influenced by prospective payment. Given the concomitant decreases in hospitalization, it is unlikely that all of the increase in severity of illness can be explained by upcoding.

Trends in the average length of stay declined for all conditions. In the aggregate, length of stay for ordinary admissions declined by 0.3 day from 9.1 to 8.8 days. These trends are expected as hospitals experience more budgetary constraints and as physicians are encouraged to care more efficiently for their patients. However, as the case mix of hospitalized patients becomes more severely ill, length of stay may instead increase as sicker patients are hospitalized and those who are less ill are treated in other settings.

Differences between severity-adjusted expected and observed in-hospital mortality rates were small. The fact that little or no change in mortality and readmission rates was observed is reassuring in light of the changes in admission patterns, increases in severity of illness, and decreases in ALOS. The one exception was an observed mortality rate 5 percent higher than expected for medical admissions for colorectal cancer.

We believe that several findings warrant additional analysis. For example, the 41 percent decrease in acute hospital admissions for patients with diabetes mellitus, coupled with an increase in the proportion of high-severity

diabetic admissions, suggests that additional analysis would be appropriate to assure that changes in the location of care are not adversely affecting patient outcomes.

Several limitations must be acknowledged in this study. First, as mentioned above, changes in the severity of illness mix of patients could indicate either a real change in severity mix or ICD-9 upcoding. Second, the accuracy and completeness of administrative data is an issue that must be addressed both for financing purposes and for use of these data in studies such as this one, which was designed to evaluate the impact of system changes. Coding audits designed to identify ICD-9 upcoding, as well as to encourage data quality, are obviously needed. Finally, an observational study such as this cannot demonstrate causality. Observed changes may have resulted from other factors, such as secular changes in medical practice, as well as from the changes in the financing system.

Despite these limitations, we support the feasibility and significant value of ongoing reporting mechanisms that use administrative data to monitor trends in utilization and quality in light of the new hospital financing system in Italy. The results of such analyses can be used to identify areas where more focused analysis is desirable. These types of analyses become increasingly important for international health policy as countries in Europe and elsewhere restructure hospital financing systems (McKee et al. 1998). Follow-up studies could include additional analysis using administrative data such as population-based studies to explore variation in geographic areas such as local health units and to compare findings in individual hospitals. Other types of follow-up will require additional data (such as medical record review) as well as administrative data. One model for organizing such studies is the Peer Review Organizations (PROs) in the United States. Findings of studies such as this can serve as the basis for educational programs, for clinicians and for hospital and regional administrators, that are designed to improve the quality of the medical record, the specificity of diagnostic labels, and the appropriate use of ICD codes. The review of these types of data by clinicians and by hospital and regional administrators can serve as the basis for their understanding of observed trends in utilization and quality and for the introduction of change where appropriate.

NOTES

1. In Italy, the *SDO* is used to document "ordinary" acute hospital admissions in a manner similar to that of the United States: one discharge abstract for each

hospital admission. For "day hospital" care, one form is used for each episode with the total number of encounters documented on the form.

2. Outliers were defined at the disease-specific level as three times the interquartile range plus the 75th percentile.

REFERENCES

Bevan, G., G. France, and F. Taroni. 1992. "Dolce Vita: Inside Italy's NHS." *The Health Services Journal* (27 February): 20–23.

Del Favero, A., and G. Barro. 1996. "Health Services: An Italian Market." *Lancet* 348: 167–75.

Gonnella, J. S., D. Z. Louis, and M. Gozum. 1997. *Disease Staging Clinical Criteria, 4th Ed.* Ann Arbor, MI: The MEDSTAT Group.

Hsia, D. C., C. A. Ahern, B. P. Ritchie, L. M. Moscoe, and W. M. Krushat. 1992. "Medicare Reimbursement Accuracy Under the Prospective Payment System, 1985 to 1988." *Journal of the American Medical Association* 268 (7): 896–99.

Kahn, K. L., E. B. Keeler, M. J. Sherwood, W. H. Rogers, D. Draper, S. S. Bentow, E. J. Reinisch, L. V. Rubenstein, J. Kosecoff, and R. H. Brook. 1990. "Comparing Outcomes of Care Before and After Implementation of the DRG-based Prospective Payment System." *Journal of the American Medical Association* 264 (15): 1984–88.

Langiano, T. 1997. *DRG: Strategie, Valutazione, Monitoraggio.* Rome: *Il Pensiero Scientifico Editore.*

McKee, M., L. Aiken, A. M. Rafferty, and J. Sochalski. 1998. "Organisational Change and Quality of Health Care: An Evolving International Agenda." *Quality in Health Care* 7: 37–41.

Nonis, M., G. Corvino, and A. Fortino. 1997. *La Scheda di Dimissione Ospedaliera.* Rome: *Il Pensiero Scientifico Editore.*

Rogers, W. H., D. Draper, K. L. Kahn, E. B. Keeler, L. V. Rubenstein, J. Kosecoff, and R. H. Brook. 1990. "Quality of Care Before and After Implementation of the DRG-based Prospective Payment System: A Summary of Effects." *Journal of the American Medical Association* 264 (15): 1989–94.

Simborg, D. W. 1981. "DRG Creep: A New Hospital-Acquired Disease." *The New England Journal of Medicine* 304 (26): 1602–1604.

StataCorp. 1997. Stata Statistical Software: Release 5.0. College Station, TX: Stata Corporation.

Taroni, F. 1996. *DRG/ROD e Nuovo Sistema di Finanziamento degli Ospedali.* Rome: *Il Pensiero Scientifico Editore.*

Taroni, F., D. Z. Louis, and E. J. Yuen. 1993. "Outcomes Management: The Italian Case-Mix Project." In *Diagnosis Related Groups in Europe: Uses and Perspectives,* edited by M. Casas and M. Wiley. Berlin: Springer-Verlag.

Umesato, Y., D. Z. Louis, E. J. Yuen, F. Taroni, and M. Migliori. 1993. "Variation in Patient Mix and Patterns of Care: A Study at Three Teaching Hospitals in Italy, Japan, and the USA." *Japan Journal of Medical Informatics.*