Medical Team Interdependence as a Determinant of Use of Clinical Resources

Claude Sicotte, Raynald Pineault, and Jean Lambert

Objective. Our objective, based on organization theory, is to examine whether interdependence among physicians leads to coordination problems that in turn may explain variations observed in the use of clinical resources.

Data Sources/Study Setting. Secondary data about episodes of in-hospital care were collected over a 14-month period in two midsize acute care hospitals located in two suburbs of Montreal, Quebec.

Study Design. Hierarchical regression analysis was used to assess the marginal effect of medical team interdependence on clinical resource utilization after taking into account the effect attributable to the nature of several morbidities taken as specific and distinct tasks.

Principal Findings. Medical team interdependence is found within medical specialties as well as between specialties. The largest portion of resource utilization was explained by morbidity characteristics, whereas team interdependence had a weaker, but systematic effect for all morbidities studied (15 regression models out of 18 performed). Task coordination was found to become more difficult as the number of physicians coming from different specialties increased in the context of teamwork.

Conclusions. Results suggest that team practice does not entirely overcome coordination problems inherent to task (morbidity) interdependence. In considering the individual (especially the attending) physician as the main factor responsible for resource utilization, other factors related to team practice may too readily be overlooked.

Keywords. Medical practice variations, organization of medical practice, inpatient utilization and costs

The great variation in styles of practice among physicians has been well documented (Schroeder 1980; Myers and Schroeder 1981; Wennberg 1984; Eisenberg 1985, 1986; Hulka and Wheat 1985). It is also known that physicians enjoy a great degree of autonomy in their clinical decision making. Based on these facts, many authors have claimed that it is possible to achieve better cost containment through a greater standardization of the utilization of resources by physicians (Griner and Glaser 1982; Grossman 1983; Eisenberg 1986). This claim relies on the belief that clinical decisions may be largely influenced by external factors quite independent of clinical considerations. Among these external factors, individual characteristics of physicians (Eisenberg 1979; Eisenberg and Nicklin 1981; Greenwald, Peterson, Garrison, et al. 1984; Linn, Yager, Leake, et al. 1984; Johnson, Freeborn, and Mullooly 1985; Eisenberg 1986) and broad organizational characteristics such as the type of setting or the mode of remuneration (Pineault 1976; Rhee 1976; Luke and Thomson 1980; Gold and Greenlick 1981; Wolinsky and Marder 1985; Madison and Konrad 1988) have been investigated. Less attention has been paid to conditions closer to the actual practice of medicine. One of those conditions is the type and level of coordination required by organized teams of physicians to deliver inpatient care in hospitals.

The nature of inpatient care requires that physicians adjust their practices to face varying contingencies by organizing themselves into teams of the same or different medical specialties. Alone, a physician is unable to deliver a complete episode of inpatient care. First, the admitting physician regularly requires the help of physicians belonging to other medical specialties because of the complexity of the task. The extensive division of labor characterizing modern medicine, with its numerous specialties and subspecialties, leaves no alternative. Thus, increased specialization leads to interdependence (Thompson 1967; Galbraith 1973). Second, admitting physicians also need colleagues in their own medical specialty to occasionally take their place because of limited time availability and organizational imperatives outside the hospital. Patients need care on a continual basis, 24 hours a day, seven days a week. In this context, the time availability of one physician is

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Address correspondence and requests for reprints to Claude Sicotte, Ph.D., Assistant Professor, Department of Health Administration, Faculty of Medicine, University of Montreal, C.P. 6128, Succ. A, Montreal, Quebec, CANADA H3C 3J7. Raynald Pineault, M.D., Ph.D., and Jean Lambert, Ph.D., are Professors in the Department of Social and Preventive Medicine, Faculty of Medicine, University of Montreal. This article, submitted to *Health Services Research* on September 26, 1991, was revised and accepted for publication on January 6, 1993.

often limited. Colleagues are thus needed to replace the attending physician when he or she is not available, thus adding still more interdependence.

These two contingencies mean that most of the time, several physicians are required to collaborate on patient care. In this context of team practice, all physicians share the responsibility for the use of clinical resources, and a certain degree of coordination is necessary for their efficient use to avoid duplication. Consequently, coordination inefficiencies may explain variations in the forementioned utilization of clinical resources. The purpose of this study is to analyze whether the type and level of medical team interdependence leads to coordination problems that may in turn explain the variations observed in the use of clinical resources.

CONCEPTUAL FRAMEWORK

According to organization theory, the main problem associated with task interdependence is the difficulty of coordination (Lawrence and Lorsch 1967; Thompson 1967; Galbraith 1973). The more people depend on one another, especially when coming from different disciplines, the more difficult task coordination becomes. Differentiation (specialization) and coordination are interrelated concepts. The higher the level of differentiation gets, the stronger the effort that must be devoted to coordination becomes. Consequently, if coordination mechanisms fail, the utilization of resources may be inappropriate.

A fundamental characteristic of medical practice teams responsible for inpatient care is their changing composition, both in the number and type of physicians intervening during an episode of care. These changes are required to meet two types of task contingencies: complexity and continuity.

The first objective of team practice is to ensure that medical specialists intervene as needed in each episode of care in order to meet the patient's needs, and thus to achieve an optimal use of clinical resources. Primarily, the use of resources should thus be explained solely by the characteristics of the task. This kind of interdependence, occurring between or among different medical specialties to provide the comprehensive care needed by a patient, can be defined as *interdependence of complementarity*. This notion of interdependence is closely linked to specialization and expertise. Physicians tend to limit their competence to one field. When the nature of the morbidity extends beyond their field of expertise, they readily consult colleagues. Complementarity thus is related to the high degree of the division of labor (specialization) that characterizes modern medicine.

However, in addition to complementarity between specialists, there is another constraint confronting hospital medical practice: that is, the need to provide continuous care for patients, 24 hours a day, seven days a week. This constraint often requires the intervention of more than one physician of the same specialty. While the main contingency associated with complementarity interdependence is that of medical expertise, the constraint in this case is the physicians' availability. Physicians often need assistance from colleagues in their own medical specialty because they are simply not available at all hours of the day. Mechanisms such as rotation and on-call lists generally ensure continuous care within each medical specialty. They enable each physician to pursue other professional activities inside or outside of the hospital as well as personal activities (e.g., leisure time). This kind of interdependence, which ensures continuous coverage within a medical specialty, can be defined as *interdependence of substitution.* In order to render care without interruption during an episode, interdependence of substitution is necessary. The more coordinated the substitution, the more adequate and optimal the use of clinical resources. Both types of medical team interdependence adapt to the nature and severity of the morbidity, which remains the main determinant of clinical resource utilization (Hulka and Wheat 1985; Eisenberg 1985). As the nature of the morbidity grows in severity, complementarity and substitution both become more complex.

Interdependence of medical practice in hospitals is thus conceptualized in a framework of collaborative relationships established both between physicians in different medical specialties (complementarity), and physicians in the same medical specialty (substitution). Several factors may impair medical team coordination in view of the great discretion enjoyed by physicians in their practice (Mintzberg 1979). First, in theory, stereotyped behaviors may come into play as physicians apply routine procedures regardless of the particular needs of each patient or the action of colleagues. Second, the classification procedure of categorizing patients in specific morbidities may not be subtle enough to distinguish between fine categories of needs. Some patients may be indiscriminately classified into one diagnostic category or another, resulting in inappropriate resource allocation. A third problem is the difficulty of adapting resource utilization to exceptional cases that happen to be very complex. Tasks entailing exceptional cases require adaptation, leading to changes in priority-setting and resource use (Perrow 1967; Galbraith 1973). Finally, medical practice does not often identify a clear team leader who would ensure coherence in the clinical process. Each physician enjoys a large degree of discretion and autonomy in the use of resources, and the peer group does not impose sanctions as long as physician behavior remains within the range of acceptable limits (Freidson 1970, 1975).

In contrast with those factors impairing the coordination of care by medical teams in a hospital, there are other factors that contribute to increased coordination, namely, standardization of knowledge and mutual adjustment (Mintzberg 1979; Scott 1982). In medical practice, standardization of knowledge is achieved through a long socialization process that takes place during training in medical schools and practice in medical settings. From this process of knowledge standardization, physicians learn what to do and what to expect from their colleagues in a given task situation. Mutual adjustment is attained by exchanging information, mainly through the patients' medical charts and occasional informal discussions. By consulting the medical chart, a physician knows what actions other physicians have taken, and he or she takes this information into consideration in pursuing subsequent clinical activities for the patient.

According to this perspective, our research hypothesis is that medical team interdependence, as determined by the nature of the morbidities and thus of the medical task, does not explain any variation in the use of clinical resources when the characteristics of the task are controlled. The use of clinical resources is not accounted for either by team complementarity interdependence taking place across different medical specialties or by team substitution interdependence taking place among colleagues of the same medical specialty: this is because a certain uniformity is inherent in medical practice acquired through previous training (knowledge standardization) and frequent collaboration (mutual adjustment).

METHODS

STUDY SITES

Two midsize acute care nonteaching hospitals (250–300 beds) located in the suburbs of a large metropolitan area participated in the study. The study was undertaken in three main clinical departments of those hospitals: surgery, specialized internal medicine, and general practice. The two hospitals were comparable; although some characteristics of their respective medical staffs were statistically different, these differences were of little pertinence to the present study. The average number of years of medical experience differed significantly between the two hospital staffs (Hospital A: 9 years ± 6.1 years; Hospital B: 13 years ± 6.9 years; $p \approx .000$). While the difference was not statistically significant for surgery, it was for general practice (Hospital A: 6 years ± 4.4 years; Hospital B: 11.5 years ± 7 years; $p \approx .000$) and for specialized medicine (A: 9 years ± 4.1 years; B: 14 years ± 6.1 years; $p \approx .000$). The universities where the physicians had completed medical training were significantly different ($p \approx .0028$). The number of physicians per medical specialty was similar in both hospitals. Male and female representation among physicians was also similar between the hospitals.

The two hospitals are located in the province of Quebec, Canada. Although Canada has a public national health insurance system, the practice of medicine is very similar to that of the United States, with respect to incentives. All physicians are paid on a fee-for-service basis by a third party, the national health insurance board, for all services rendered in private clinics as well as in hospitals or elsewhere. There is a major preoccupation, similar to that seen in United States health care systems, with limiting the costs of health care and thus with rationalizing medical decisions. The demand for the use of hospital beds is high, and the tendency to diminish length of stay is constant.

SAMPLING STRATEGY

The unit of analysis was the episode of hospital care. Hornbrook, Hurtado, and Johnson (1985) define an episode of care as a series of temporally contiguous health care services related to the treatment of a given spell of illness or provided in response to a specific request by a patient or other relevant entity. An episode of hospital care may be defined as a subset of an episode of care that includes several outpatient and inpatient care services. The advantage of dealing with episodes of hospital care is that they are well circumscribed in time, having a clear beginning and ending point. Besides, the utilization of resources during that period of time can be determined with precision and can be related to the characteristics of the particular context of hospital care. Included in a hospital episode of care are services provided in the emergency department, in the case of emergency admissions, and those prescribed before hospitalization as in the case of elective surgery.

A systematic random sample of weekdays was drawn. Included in the sample were the episodes of care of all patients discharged from the hospital in surgery, general, and specialized medicine departments on the days selected. Weekdays were controlled to ensure even representation. The days were sampled from a 14-month period between September 1985 and December 1986. Atypical hospital periods, such as Christmas holidays and the summer vacation, were excluded. Because the study was limited to periods of typical and normal hospital activity, variations in team composition and practice patterns were less vulnerable to seasonal fluctuations. The samples from the two hospitals were pooled for the analysis. The total sample consisted of 6,841 episodes of hospital care evenly distributed between the two hospitals.

To identify the variation in the use of clinical resources specifically attributable to medical practice interdependence, hierarchical regression analyses were used. Four blocks of variables were introduced into each regression model. These blocks were introduced in accordance with the research framework. The contingencies associated with the task complexity were introduced first, with the interdependence variables in the last block. Introducing interdependence in the last block of variables made it possible to assess its marginal effect on clinical resources utilization after taking into account the effect of other variables.

The nature of the task was expressed in different ways. First, six different morbidities were selected representing specific and distinct tasks, and regression analysis was applied for each morbidity. To obtain a broad understanding of medical practice, those diagnostic categories that contained the most numerous episodes of hospital care were chosen (three in surgery and three in medicine). Each of those categories contained a different number of specific diagnoses. The objective was to minimize the number of conditions per diagnostic category required for maximal clinical homogeneity while, at the same time, capturing enough episodes of care to allow for valid statistical analyses. The diagnoses were identified by the three-digit codes of the International Classification of Diseases (World Health Organization 1978). The three diagnostic categories in surgery were (a) cholelithiasis (code: 574); (b) hernia of abdominal cavity (550, 552, 553); and (c) diseases of female genital organs (614 to 626). The three diagnoses in medicine were: (a) ischemic heart diseases (410, 411, 412); (b) chronic obstructive pulmonary diseases (490 to 496); and (c) diseases of the digestive system (530 to 579). Together, these six diagnostic categories accounted for 1,735 episodes, or 27 percent of the sample described earlier. This strategy enabled us to obtain a satisfactory number of observations for the purposes of statistical analysis. Furthermore, to improve the clinical homogeneity of the data, only the episodes of care that included surgical intervention were retained for surgical diagnoses; conversely, only the diagnoses that required no surgery were retained in the medicine category. Finally, to ensure the independence of observations when more than one episode was sampled for the same patient, only one of the episodes was retained for the statistical analysis.

For each of the six morbidities chosen as different tasks, we then used several indicators of task complexity that physicians face in their practice. We made the concept of complexity operational using clinical data available in the patients' medical charts, and we chose indicators commonly used in the literature to assess illness severity. The variables of illness severity were tested in two blocks: patient characteristics and episode characteristics. Each characteristic was chosen to show severity variations in the use of clinical resources. The patient characteristics were age and gender. The episode characteristics were type of admission (elective/emergency); number of secondary diagnoses; admission to intensive care (no/yes); any of the following unforeseen events (no/yes): illness complication, infection, transfer to another hospital, more than one admission to the operating room, cardiac resuscitation, and death; duration time of surgical interventions (number of minutes); the number of hospitalizations in the preceding year; and a death risk probability for each of the six morbidities, based on the subjective judgment of two different physicians using a ten-point scale. This last variable was operationalized as a dichotomous one (weak probability [0–10%]/higher probability [10–30%]) due to a lack of dispersion of the physicians' judgment on the scale.

With the exception of the gender variable, the independent variables of the first two blocks were coded so that an increase in value corresponded to an increase in illness severity. We did not use any classification system that contained degree of clinical resource utilization as a proxy of severity. A higher use of clinical resources might indicate inefficiencies in operations rather than intrinsic differences in illness severity (Gertman and Lowenstein 1984). In avoiding such classifications, we prevented the independent variables from being contained in the dependent variables (use of clinical resources). However, two variables (intensive care admission and surgical time) were used. We think it is reasonable to use these two because they are conceptually distinct from the use of clinical resources as measured here. Admission into an intensive care unit (ICU) is a valid indicator of severity: it represents a type of care resource rather than intensity of utilization. This is why we operationalized this variable as a dichotomous one (no admission/admission). We did not use the length of stay in ICU, which is too closely related to resource utilization. However, one must still exercise caution in interpreting this variable. Whether or not to admit a patient to an ICU can still be subject to physician discretion (Strauss, LoGerfo, Yeltatzie, et al. 1986). Duration time of surgical interventions is also a good indicator of severity, and is conceptually distinct from resource utilization as measured here. Finally, a variable identifying the hospital was used as a control variable in the third block of variables to test whether clinical resource utilization differed in the two hospitals.

The fourth block of variables was designed to estimate the marginal contribution of medical practice interdependence once the effects attributable to the preceding blocks were accounted for. Four variables were used to describe the interdependence of medical practice. The basic information used to make the interdependence concept operational was the identity of all of the physicians intervening at the patient's bedside apart from the principal attending physician. This information was available in the patient's medical chart, especially in the sections dealing with clinical observations, consultation requests, and prescriptions. The first variable, the interdependence of complementarity, was defined as the number of different medical specialties intervening at the bedside.

Substitution was expressed by two categories: one for general practitioners and the other for specialists. Specialists are generally perceived as spending a higher proportion of their medical practice in hospital settings than general practitioners do. The different time availability for hospital practice between these two groups may influence the substitution mechanisms adopted by each group of physicians. Consequently, we operationalized two different variables that defined substitution as a dichotomous variable describing the absence (only one physician for each intervening medical specialty) or the presence (two or more physicians of any one of the medical specialties) of this type of interdependence. These variables were operationalized as dichotomous because, in most of the diagnostic categories, the levels of substitution exceeding two physicians were approximately 10 percent. A fourth dichotomous variable was used to test whether the absence or presence of general practitioners in an episode of care may affect resource utilization. This variable was included because we observed that a significant proportion of episodes of care were produced with no intervention by a general practitioner, especially in surgery.

Utilization of diagnostic tests was used as a dependent variable in the regression models. Such use does not represent all of the clinical resources allocated by physicians for hospital care, but it does offer many advantages in testing our hypothesis. First, the use of diagnostic tests does not lend itself to substitution for other types of resources. Second, it is a clinical activity present in all hospital episodes of care.

Third, all physicians, without exception, use diagnostic tests. Fourth, this is an area where the physicians can exert a high degree of discretion; the patient has little say in the matter, especially in inpatient care. And finally, medical practice variations in this area have been extensively documented (Freeborn et al. 1972; Schroeder et al. 1973; Hardwick, Vertinsky, Barth, et al. 1975; Lyle et al. 1976; Daniels and Schroeder 1977; Goldfarb, Hornbrook, and Higgins 1983; Greenwald, Peterson, Garrison, et al. 1984; Linn, Yager, Leake, et al. 1984; Johnson, Freeborn, and Mullooly 1985).

Three dependent variables measuring utilization of diagnostic tests were used in the regression models: (1) number of laboratory tests (biochemistry, hematology, and microbiology), (2) number of radiological exams, and (3) cost of diagnostic tests (the sum of the unit cost of the two preceding measures). Unit costs were estimated on the basis of the hospitals' public and internal financial reports. Laboratory test packages, such as SMA-12, were considered to be independent tests based on what physicians prescribed.

Quantitative analysis based on hierarchical regression was used in conjunction with qualitative evaluation methods. Interviews were carried out with the heads of all participating clinical departments in both hospitals. These interviews were conducted to assess the importance of potentially confounding events that might affect diagnostic resource utilization, such as budget cuts or increases, addition or closure of beds or technical equipment, and recruitment or resignation of key physicians. Any event that might explain variations in resource utilization did not occur in either hospital during the study period.

In sum, 18 regression models were tested for each of the three dependent variables describing use of diagnostic tests and for each of the six diagnoses. Use of resources and interdependence of medical practice team configurations were thus analyzed in different task situations. Each regression model was hierarchical with four blocks of variables. A stepwise inclusion was used to enter the independent variables in each block. The inclusion criterion was set at .05 and the exclusion criterion at .10.

DATA COLLECTION

The data source was the patients' medical charts. The medical chart is well suited for studying use of diagnostic resources because the data it contains are routinely documented in a hospital care context. The information was collected from the charts retrospectively by two medical record technicians after the patient had been discharged. A statistical analysis of a random sample of files was performed to assess the degree of agreement among and between judges. The Kappa statistic was used for categorical data (Fleiss 1983) and the coefficient of intraclass correlation for quantitative data (Fleiss 1986). These analyses showed high agreement between and among judges. Most of the coefficients of agreement concerning the variables used in the present analysis were over 95 percent.

RESULTS

Table 1 shows the distribution of the levels of the types of interdependence observed for each of the diagnostic categories. Interdependence takes place at a high rate in hospital medical practice, in terms of both complementarity and substitution. Team practice, comprising complementarity and substitution interdependencies, is the typical way in which hospital episodes of care are provided. This view diverges greatly from the widely held notion of the exclusive relationship between physician and patient. Furthermore, team practice does not appear as a planned or predetermined form of practice in which the same individuals always practice together. We analyzed the combinations of different individual physicians practicing together and found a high variation in team composition. This may be attributable in part to the large number of general practitioners involved in inpatient care. Such results indicate that hospital medical team practice is a fluid and evolving process that adapts to the many contingencies involved in caring for different patients.

With respect to our research hypothesis, the effects of medical team practice interdependence on the utilization of clinical resources have been assessed using the regression analyses shown in Tables 2, 3, and 4. The results can be interpreted with confidence due to the high level of performance of the regression models. First, the models account for a high degree of variance in clinical resource utilization. Several models explain more than 50 percent of the variance. Second, the three regression models specific to each diagnostic category reached similar levels in explaining resource utilization variations. Third, the analyses of residuals carried out for each regression model are conclusive. Fourth, the independent variables describing the severity of the morbidity vary in the expected direction: a higher value means a higher degree of clinical resource utilization.

The hypothesis that medical practice interdependence has no effect on clinical resource utilization is not supported by our analysis.

Table 1: Descriptive Statistics of Interdependence of Complementarity and Substitution

Distribution of Episodes of Care	*Surgery*			*Medicine*		
	Cholelithiasis	*Hernia of Abdominal Cavity*	*Diseases of Female Genital Organs*	*Ischemic Heart Diseases*	*Chronic Obstructive Pulmonary Diseases*	*Diseases of Digestive System*
	(N = *350*)	(N = *188*)	(N = *453*)	(N = *354*)	(N = *177*)	(N = *213*)
A. *Complementarity*						
Levels of complementarity (number of different medical specialties apart from the principal attending physicians)						
0	40.6%	42.6%	41.5%	28.5%	23.2%	13.6%
1	32.0	22.3	25.2	21.8	46.9	37.1
2	15.7	27.1	24.1	35.3	19.2	29.1
3 and more	11.7	8.0	9.2	14.4	10.7	20.2
	100 %	100 %	100 %	100 %	100 %	100 %
B. *Substitution: For General Practitioners (GPs)*						
Levels of substitution (Number of different GPs apart from one attending GP)						
0	65.3%	78.2%	65.1%	17.2%	71.3%	70.3%
1	25.9	16.4	24.5	11.8	13.5	16.5
2	7.6	2.7	8.3	8.4	4.7	6.6
3 and more	1.2	2.7	2.1	62.6	10.5	6.6
	100 %	100 %	100 %	100 %	100 %	100 %
Substitution: For Specialists						
Levels of substitution (number of different physicians apart from one physician for each intervening medical specialty)						
0	43.4%	61.7%	36.0%	25.6%	77.7%	70.8%
1	44.6	31.4	48.3	40.9	15.1	22.7
2	8.3	5.3	11.7	24.7	4.3	4.5
3 and more	3.7	1.6	4.0	8.8	2.9	2.0
	100 %	100 %	100 %	100 %	100 %	100 %

Table 2: Hierarchical Regression Results: Utilization of Laboratory Tests*

Standardized Partial Regression Coefficients	*Surgery*			*Medicine*		
	Cholelithiasis	*Hernia of Abdominal Cavity*	*Diseases of Female Genital Organs*	*Ischemic Heart Diseases*	*Chronic Obstructive Pulmonary Diseases*	*Diseases of Digestive System*
	(N = *350)*	(N = *188)*	(N = *453)*	(N = *354)*	(N = *177)*	(N = *213)*
1. Patient characteristics						
Age	.05	.11	.18	—	.30	—
Sex	—	.07	na	—	—	-.16
R^2 (1)	.11	.14	.05	—	.27	.06
2. Episode characteristics						
Admission	.52	.27	.26	na	na	na
No. secondary diagnoses	.11	.11	.10	.12	.13	.15
Intensive care	.13	na	na	.20	na	.12
Unforeseen events	—	.12	.04	—	—	—
Surgical time	.12	.17	.22	na	na	na
No. previous hospitalizations	—	—	.10	—	-.07	—
Death risk	na	na	na	—	.21	na
R^2 (2/1)	.48	.34	.19	.10	.16	.10
3. Hospital	—	—	—	-.43	.16	.27
R^2 (3/1,2)	0	0	0	.05	.09	.09
4. Medical interdependence						
Complementarity	.19	.33	.29	.31	.24	.22
Substitution						
• Specialists	—	—	-.09	.31	—	—
• GPs	—	—	.12	—	.14	—
Absence of GPs	—	—	—	—	—	—
R^2 (4/1,2,3)	.02	.06	.10	.17	.07	.04
R^2 (1,2,3,4)	.61	.54	.34	.32	.59	.29
F-ratio	87.6	29.8	25.8	31.9	34.5	16.8
p	.000	0	.000	.000	0	.000

*Logarithmic transformation was used to normalize the otherwise skewed distribution of the dependent variable.

Table 3: Hierarchical Regression Results: Utilization of Diagnostic Exams*

Standardized Partial Regression Coefficients	*Surgery*			*Medicine*		
	Cholelithiasis	*Hernia of Abdominal Cavity*	*Diseases of Female Genital Organs*	*Ischemic Heart Diseases*	*Chronic Obstructive Pulmonary Diseases*	*Diseases of Digestive System*
	(N = *350*)	(N = *188*)	(N = *453*)	(N = *354*)	(N = *177*)	(N = *213*)
1. Patient characteristics						
Age	.32	.49	.39	—	.19	.10
Sex	—	—	na	—	—	.05
R^2 (1)	.30	.34	.13	0	.16	.06
2. Episode characteristics						
Admission	.32	.13	.32	na	na	na
No. secondary diagnoses	.10	.07	.06	.05	.15	.19
Intensive care	.04	na	na	.15	na	—
Unforeseen events	—	—	.05	—	—	—
Surgical time	.16	—	—	na	na	na
No. previous hospitalizations	—	-.17	—	—	-.08	-.25
Death risk	na	na	na	—	.23	na
R^2 (2/1)	.25	.10	.16	.08	.17	.17
3. Hospital	-.28	—	-.17	—	—	—
R^2 (3/1,2)	.04	0	.01	0	0	0
4. Medical interdependence						
Complementarity	.17	.37	.29	.24	.35	.37
Substitution						
• Specialists	—	—	—	.39	—	—
• GPs	.09	—	—	—	—	—
Absence of GPs	—	.15	—	.21	—	—
R^2 (4/1,2,3)	.02	.08	.07	.21	.10	.11
R^2 (1,2,3,4)	.61	.52	.37	.29	.43	.34
F-ratio	67.6	32.6	43.3	27.6	26.2	21.2
p	.000	.000	.000	.000	.000	0

*Logarithmic transformation was used to normalize the otherwise skewed distribution of the dependent variable.

Table 4: Hierarchical Regression Results: The Cost of Diagnostic Tests*

Standardized Partial Regression Coefficients	Surgery			Medicine		
	Cholelithiasis	*Hernia of Abdominal Cavity*	*Diseases of Female Genital Organs*	*Ischemic Heart Diseases*	*Chronic Obstructive Pulmonary Diseases*	*Diseases of Digestive System*
	(N = 350)	(N = 188)	(N = 453)	(N = 354)	(N = 177)	(N = 213)
1. Patient characteristics						
Age	.15	.31	.18	.17	.25	—
Sex	—	.05	na	—	—	-.07
R^2 (1)	.16	.20	.03	.03	.20	.03
2. Episode characteristics						
Admission	.47	.18	.35	na	na	na
No. secondary diagnoses	.09	.13	.05	—	.07	.16
Intensive care	—	na	na	—	na	—
Unforeseen events	—	.09	.08	—	—	—
Surgical time	.18	—	.02	na	na	na
No. previous hospitalizations	—	-.22	—	—	-.07	-.18
Death risk	na	na	na	.12	.25	na
R^2 (2/1)	.41	.22	.22	.02	.16	.16
3. Hospital	-.22	—	-.24	—	.06	-.02
R^2 (3/1,2)	.02	0	.02	0	.04	.02
4. Medical interdependence						
Complementarity	.21	.34	.37	—	.45	.43
Substitution						
• Specialists	—	—	—	.29	—	—
• GPs	.08	—	—	—	—	.14
Absence of GPs	—	—	—	—	.12	—
R^2 (4/1,2,3)	.04	.06	.11	.08	.17	.16
R^2 (1,2,3,4)	.63	.48	.38	.13	.57	.37
F-ratio	81.4	24.0	39.6	17.9	31.8	20.5
p	.000	.000	0	.000	.000	.000

*Logarithmic transformation was used to normalize the otherwise skewed distribution of the dependent variable.

As shown by the marginal coefficients of multiple determination of the fourth block of variables, the effects of interdependence on clinical resource utilization reach the statistical significance threshold for all of the regression models tested. However, the effects of interdependence are less significant than those explained by the variables describing the severity of morbidity in the majority (15 out of 18) of the regression models. The regression models most consistent with our hypothesis were obtained in the surgery category. The proportion of resource utilization explained by task characteristics is high, while the proportion explained by interdependence is much lower, and most of the time under 10 percent. For medicine, the results are much less conclusive. Interdependence variables explain a substantial portion of clinical resource utilization, even exceeding 15 percent in some regression models. For one diagnosis, ischemic heart diseases, the results are diametrically opposed to the results predicted by our hypothesis. It is the only case where interdependence is more significant than severity of the morbidity in explaining clinical resource utilization.

In order to better understand which type of interdependence has an effect on clinical resource utilization, we need to analyze the standardized partial regression coefficients for the variables included in the models. However, one must be cautious in interpreting those coefficients. They are calculated at the last step of the stepwise regression analysis procedure without taking into account the hierarchical order of the blocks of variables. It is then possible that interdependence variables, even if they are tested last in the models, can capture part of the effects of the variables of the preceding blocks. Only the differences between coefficients of multiple determination (R^2) show the effective contribution of the variables in explaining an additional portion of total variation in clinical resource utilization. Partial coefficients are useful in identifying which type of interdependence best explains the magnitude of the effect shown by marginal coefficients of multiple determination (R^2), as well as the direction of the relationship between the independent and the dependent variables.

The interdependence of complementarity is statistically significant in all 18 models with only one exception. As assessed by the standardized partial regression coefficients, the contribution of this interdependence dimension in explaining the use of clinical resources was strong compared to the other variables included in the regression models. The minus or plus signs qualifying the partial regression coefficients for complementarity are all positive, indicating that an increase in complementarity is correlated with an increase in clinical resource utilization. This result is congruent with our conceptual framework to the extent that complementarity interdependence is perceived as an adjustment mechanism to task complexity: the greater the complexity, the higher the number of different medical specialties intervening. Nevertheless, the fact that the relationship between complementarity and use of resources is statistically significant in so many models, and that it is often the only statistically significant relationship in the fourth block of variables, means that a portion of resource utilization is explained by this type of interdependence; this was contrary to our expectations.

The results concerning substitution interdependence are more in line with our hypothesis. Substitution variables are far less capable of explaining the use of clinical resources. Even if the relationships of substitution and the dependent variables did come out as statistically significant in eight models (44 percent), these relationships failed to show a systematic pattern, either by morbidity, type of clinical resources, or type of physicians. Furthermore, the standardized partial regression coefficients for the substitution variables are smaller than those of the complementarity variables, with one exception. In cardiology, substitution is statistically significant for the three measures of clinical investigation. Furthermore, the effect, as shown by the standardized partial regression coefficients, is stronger than those observed for complementarity and the other variables describing morbidity. The strong effect of substitution in this case runs contrary to our hypothesis.

DISCUSSION

The ability of medical practice to find ways to overcome interdependence contingencies inherent in team practice appears less conclusive than anticipated. Team interdependence has a statistically significant and systematic effect in all of the regression models, even if the largest portion of clinical resource utilization is explained by task characteristics in almost all of the regression models. The following explanations may shed some light on these mixed results.

First, when one looks at the type of interdependence explaining resource utilization, complementarity is by far the most explanatory factor. According to organization theory, task coordination becomes more difficult as the number of different specialists working together increases. Thus, it is possible that as the number of medical specialties increases, team coordination becomes more difficult, and variation in resource utilization increases. To explore this hypothesis, we did a secondary analysis, applying an F-test to clinical resource utilization variance, to compare the degree of variance observed among the episodes in which several specialties were called into play (high complementarity) with the variance of episodes in which fewer specialties were involved (low complementarity). Seventeen tests out of the 18 models were statistically significant at the .01 level. Therefore, there is a difference in utilization variation between a low level and a high level of complementarity. Use of resources is always higher at high complementarity levels.

These results support the idea that interdependence effects are manifest in difficult and uncertain cases in which the coordination capability of the team practice is subject to the greatest stress.

Second, the unexpected results regarding ischemic heart disease may be linked to the high proportion (86 percent) of patients who were admitted to the intensive care unit (ICU) for this disease. This phenomenon may have had two consequences with respect to interdependence. On the one hand, the highly standardized nature of the care given in the ICU may have eliminated resource utilization variations. Patients admitted to an ICU are perceived as highly difficult cases, and clinical monitoring may therefore be applied more uniformly (Griner and Liptzin 1971; Schoeder, Schiftman, and Piemme 1974). This relation may even lead to a poor match between the patient's needs and resource utilization, explaining the weak performance of the regression models for this particular diagnosis. On the other hand, according to the same rationale, the ICU is an organizational response designed to ensure a tight clinical follow-up procedure, and therefore the frequency of physicians' bedside visits is very high. In such a context, medical team interdependence is directly affected, and is presumably determined more by organizational norms than strictly by the patient's needs. This may explain the higher percentages of variance obtained for the interdependence variables than for task characteristics in explaining use of clinical resources. Congruent with this interpretation is the fact that (1) substitution interdependence appeared systematically in all the regression models tested for ischemic heart disease, and (2) its effect on use of clinical resources was consistently high. In the other regression models, complementarity usually came out as significant and explained more of the variance.

Third, the effects of interdependence on resource utilization are considerably less in surgery than in medicine. This observation may be explained by a fundamental difference of complexity between surgery and medicine. Episodes of care in medicine are generally perceived as entailing a higher degree of complexity than those in surgery (Perrow

1965; Luke 1979; Hornbrook 1982). It is therefore possible that the variables measuring the severity of morbidities are less sensitive to extreme degrees of severity found in medicine, leaving a portion then explained by the interdependence variables. It is indeed possible that complementarity interdependence, which was systematically significant in all models and which showed the strongest effect as expressed by partial regression coefficients, compensated for the failure of the severity indicators to fully capture the task complexity. More medical specialties are needed as the severity of morbidity increases.

Fourth, a similar comment can be made about the degree of homogeneity reached in defining some of the diagnostic categories. The regression models where the largest numbers of medical conditions were retained yield the most prominent interdependence effects. This is especially true for two diagnostic categories, diseases of female genital organs and diseases of the digestive system, in which 13 and 28 conditions were used, respectively. Greater heterogeneity of the clinical conditions in those diagnostic categories may have contributed to a reduction in the explanatory value of illness severity indicators. Congruent with this interpretation is the fact that the regression models tested for those two diagnostic categories were the least powerful in explaining resource utilization, with the exception of ischemic heart diseases.

A final word of caution is in order about the generalizability of these results to larger hospitals—particularly to teaching hospitals. The hospitals studied were medium-sized community hospitals, and the size of the medical staff composing each medical specialty was relatively small. The most numerous medical specialties—general surgery or orthopedics—consisted of five to six physicians. In that context, physicians frequently practice together, thus setting up optimal conditions for the standardization process related to mutual adjustment to take place. It is possible that the standardization process is less efficient in larger hospitals, particularly in teaching hospitals, with the presence of residents who are temporary members of the organization. This organizational context might favor a hospital medical practice involving less frequent contacts between individual physicians and giving rise to a greater variety of practice styles (Feinglass, Martin, and Sen 1991).

We intentionally excluded length of patient stay as an independent variable in the regression models, even though it would appear to be an interesting variable to analyze in relation to the present research topic. Obviously, length of stay and use of diagnostic tests are highly correlated (Goldfarb, Hornbrook, and Higgins 1983). Even if it is logical to believe that a longer length of stay may provide an opportunity for more complementarity and especially substitution by other physicians, this variable addresses different questions and is conceptually different. We were concerned with the use of diagnostic tests, not the use of hospital days. Further, according to our conceptual framework, it is the medical decision that determines length of stay as well as the use of clinical resources in general. Hence, the inclusion of length of stay in the regression models as an independent variable would have been misleading and would even have led to an overcontrolling situation from a methodological point of view.

The focus of this article was the relationship between medical team interdependence and one aspect of resource use (diagnostic tests). Our results showed strong evidence that hospital medical practice is a highly adaptive work organization that seems to overcome, to a large extent, the interdependence problems influencing clinical resource utilization. However, team mechanisms appear to be less efficient as interdependence levels increase. They then become responsible for a significant portion of resource utilization. This last finding remains nonetheless congruent with organization theory, to the extent that task coordination is perceived as more difficult when the number of different specialists increases.

The implications of these results are clear for researchers and managers concerned with health care cost containment. The individual physician, and especially the attending physician, is perhaps too often looked upon as being solely responsible for resource utilization variations, whereas less apparent factors are too quickly dismissed. This study may serve to shed light on one of those factors, the interdependence problems inherent in the fundamental nature of inpatient medical care in the context of team practice.

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