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This article is based on a paper prepared for the fourteenth Annual Symposiumon Computer Applications in Medical Care sponsored by the AmericanMedical Informatics Association. We wish to acknowledge the assistance ofRichard W. Campbell, M.D., Director of the Internal Medicine Residency Program,Alvin J. Haley, M.D., Director of the Family Practice Residency Program,David S. Wilson, M.D., Chief Resident of Internal Medicine, Keith J. Millay,M.D., Chief Resident of Family Practice, and Barbara Lucas, M.A., GraduateResearch Assistant; also, the comments of two anonymous reviewers.

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Influencing Test Ordering In Primary Care Using Influential Physicians

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ABSTRACT

The purpose of this study was to evaluate the use of influential physicians to influence test ordering in a primary care setting. Structured order forms for three commonly ordered tests were developed in conjunction with the chief residents in internal medicine and family practice at Methodist Hospital of Indiana, a 1120 bed private teaching hospital. After data were collected for a nine month baseline period, the forms were introduced by the chief residents to the house staff in the Adult Ambulatory Care Center and the Family Practice Center. After two months, the study was discontinued. The data were analyzed using a multivariate analysis of variance with repeated measures and paired t-tests. Test ordering rates for complete blood counts were significantly reduced in both centers. Urinalysis rates were significantly reduced in the Family Practice Center. There was no significant effect of the intervention on ordering rates for the chemistry-23 test. The findings suggest that the use of influential physicians is an effective way to change physician behavior in primary care settings.

Introduction

Clinical laboratory procedures account for an estimated 20 percent of total health care expenditures in the U.S.A. (Grady, 1988). It has been estimated that from 20 to 60 percent of medical tests and procedures may be unnecessary (Angell, 1985). Inappropriate tests are operationally defined as those tests which are performed but serve no medical purpose, lack indications to be performed, or are contraindicated.

A number of different approaches have been tried to modify physician test-ordering behavior. These include: administrative actions, educational programs, and feedback. Mozes and others (1989) found that when a hospital administration required written justification for coagulation tests, orders declined 50 percent. Educational programs have reported mixed results. Cheney and Ramsdell's (1987) study found that checklists placed on the front of the chart did not affect rates of testing for hematocrit, cholesterol, and occult blood in the stool, but did significantly increase the rates for mammography, pap smears, breast, pelvic and rectal examinations. Martin and others (1980) conducted a study using financial incentives and chart review in small discussion groups. The incentives had little effect but chart reviews led to a significant reduction in laboratory testing. A more recent study found that a letter placed on the chart when excessive tests were ordered had little effect on test-ordering rates (Williams and Eisenberg, 1986).

Other studies have emphasized feedback to the physician ordering tests. A series of studies by McDonald and colleagues found that providing physicians with a computerized summary of recent diagnostic test results (Wilson, et al., 1982), a computerized display of previous test results (Tierney, et al., 1987), and a prediction of the probability that a test will be positive for the abnormality being tested (Tierney, et al., 1988), all resulted in reduced rates of test ordering for a number of commonly ordered tests. Additional studies (Marton, et al., 1985; Spiegel, et al., 1989; Dowling, et al., 1989) have found that feedback of comparative rates of test-ordering to individual physicians resulted in reduced ordering rates for specific tests.

Reported here are the results of a study of an intervention designed to decrease house staff ordering of three common tests: urinalysis, complete blood count and chemistry 23. The intervention was based on studies that indicate that physicians rely upon one another for information concerning new practices and procedures (Anderson, et al., 1987; Burt, 1987; Coleman, Katz, and Menzel, 1966; Stross and Harlan, 1975; Weinberg, et al., 1981). Moreover, previous studies have demonstrated that influential physicians can be identified and used to introduce innovative procedures into clinical practice (Anderson, et al., 1990; Stross and Bole, 1980; Stross, et al., 1983).

Checklists of acceptable reasons for ordering the three tests were developed in conjunction with the chief residents on two hospital services, namely, family practice and internal medicine. These checklists were tested with residents in a Family Practice Center and an Adult Ambulatory Care Center.

Methods

Setting

The study was performed in two outpatient clinics at Methodist Hospital of Indiana, a 1120 bed private teaching hospital in Indianapolis, Indiana. The Adult Ambulatory Care Center is staffed by twenty-four residents. The study focused on the general medicine clinics that are held two days a week and the preinterview clinic that is used to determine whether or not to accept a patient. Approximately 150 patients are seen in these two clinics each month. The specialty clinics were omitted from the study in order to ensure a patient population that was comparable to the patient population of the Family Practice Center.

The Family Practice Center is staffed by twenty-one residents who see from 600 to over 1,000 patients each month. Some of the urinalyses are performed in the center's laboratory. All other urinalyses, complete blood counts (CBC) and chemistry 23s (CHEM 23) are performed in the hospital laboratory.

Intervention

Initially, the research team identified three frequently ordered tests, namely, urinalysis, complete blood count and chemistry 23. These three routinely ordered tests, which account for over $300,000 per month, frequently are ordered inappropriately (Kirk, 1985; Shapiro and Greenfield, 1987). Preliminary indications for ordering these tests were developed by reviewing the literature and consulting with the heads of the internal medicine and family practice residency programs.

The chief residents on internal medicine and family practice were identified as influential physicians among the house staff on these two services. Consequently, they were asked to assist the project staff in developing checklists of acceptable reasons for ordering each of the three tests. One of the checklists is shown in Figure 1. They also agreed to explain the study to the residents on the two services.

Structured Order Form

Dr. ________________________________

Patient ID ____________________ Date ____________

URINALYSIS ORDERED?	YES [ ]	NO [ ]
	If YES, Please Provide Indication	
Suspect UTI/Follow-up		[ ]
Blood in Urine		[ ]
Urinary Catheter>40hrs.		[ ]
Pyelonephritis		[ ]
Renal Failure		[ ]
Diabetes Mellitus		[ ]
Follow-up Chemotherapy/Radiation		[ ]
Work-up hypertension		[ ]
Uricacid, Calcium, Oxalate		[ ]
Systemic Disease? w/Renal Involvement		[ ]
Malabsorption, bowel surgery		[ ]
Other (specify)		
CBC ORDERED:	YES [ ]	NO [ ]
	If YES, Please Provide Indication	
Anemia or suspected hematologic disease		[ ]
Abnormal Leukocyte Count		[ ]
Platelet Abnormality		[ ]
Purpura		[ ]
Hypersplenism		[ ]
Infection		[ ]
Immunosuppressive therapy		[ ]
Other (specify)		
CHEM-23 ORDERED ?	YES [ ]	NO [ ]
	If YES, Please Provide Indication	
Diabetes Mellitus		[ ]
Occult Renal Disease		[ ]
Hepatitis		[ ]
Cancer		[ ]
Liver/Gilbert's Disease		[ ]
Anemia/Iron Deficiency		[ ]
Hyperparathyroidism		[ ]
Other (specify)		

Figure 1

Study Design

Prior to the implementation of the checklists, nine months of data (January-September 1989) on the number of patients seen and the number of study tests ordered were collected from the hospital laboratory system and from the laboratory in the Family Practice Center. The number of patients seen by each resident was obtained from the Centers' appointment books.

During October and November 1989, the checklists were attached to the chart each time a resident was scheduled to see a patient. Physicians were requested to indicate the reasons for ordering each of the study tests. Data for each resident were again obtained from the two laboratories and from the appointment books during the two month intervention period.

Statistical Analysis

The physician was the unit of analysis for this study. The primary outcome variable was the number of study tests ordered per patient. We calculated test-ordering rates for each resident during the baseline and intervention periods.

The response of physicians to the intervention may vary greatly because of differences in experience and background. Much of this variability is due to these differences that existed prior to the intervention. By separating this source of variability from treatment effects and experimental error, the sensitivity of the study can be increased.

In order to provide a control for differences between physicians, a repeated measures multivariate analysis of variance was performed on the data for each of the three tests. This design provides a control for individual differences between physicians which tend to be large relative to intervention effects. Also, we compared test ordering rates during the two time periods using paired t-tests with a two-tailed probability level of 0.05 accepted as significant.

Results

Tables 1-3 display the mean number of study tests ordered per 100 patients in the two centers during the baseline and intervention periods. They also provide the results of the multivariate analysis of variances with repeated measures. Internal medicine residents in the Adult Ambulatory Care Center saw 1,395 patients during the baseline period and 547 during the intervention period. In the Family Practice Center, residents saw 5,655 and 1,985 patients, respectively, during the two periods.

Table 1
Mean Number of Urinalyses Ordered per 100 Patients by House Staff in the Adult Ambulatory Care Center and the Family Practice Center

Adult Ambulatory Care Center

Residents	Baseline Period	Intervention Period	Both Periods
2nd Year	12.33	15.44	13.89
3rd Year	11.63	7.00	9.32
2nd & 3rd Years	12.00	11.47	11.74

Family Practice Center

Residents	Baseline Period	Intervention Period	Both Periods
2nd Year	12.38	8.63	10.50
3rd Year	9.43	6.43	7.93
2nd & 3rd Years	11.00	7.60	9.30

Multivariate Analysis of Variance

Sources of Variation	df	Mean Square	F Ratio	Significance
Between Subjects				
Center	1	90.40	2.92	0.098
Residents	1	202.76	6.55	0.016
Center X Residents	1	15.95	0.52	0.479
Within Cells	28	30.93		
Within Subjects				
Period	1	67.75	1.84	0.186
Center X Period	1	27.20	0.74	0.398
Residents X Period	1	48.42	1.31	0.262
Center X Residents X Period	1	71.45	0.94	0.175
Within Cells	28	36.90		

Table 2

Mean Number of Complete Blood Counts Ordered per 100 Patients by House Staff in the Adult Ambulatory Care Center and the Family Practice Center

Adult Ambulatory Care Center

Residents	Baseline Period	Intervention Period	Both Periods
2nd Year	36.78	11.22	24.00
3rd Year	42.25	11.50	26.88
2nd & 3rd Years	39.35	11.35	25.35

Family Practice Center

Residents	Baseline Period	Intervention Period	Both Periods
2nd Year	12.25	3.25	7.75
3rd Year	10.86	2.43	6.64
2nd & 3rd Years	11.60	2.87	7.24

Multivariate Analysis of Variance

Sources of Variation	df	Mean Square	F Ratio	Significance
Between Subjects				
Center	1	5281.87	18.47	0.000
Residents	1	12.40	0.04	0.837
Center X Residents	1	62.93	0.22	0.643
Within Cells	28	285.95		
Within Subjects				
Period	1	5393.91	66.13	0.000
Center X Period	1	1499.52	18.39	0.000
Residents X Period	1	21.20	0.26	0.614
Center X Residents X Period	1	32.98	0.40	0.530
Within Cells	28	81.56		

Table 3
Mean Number of Chemistry-23 Tests Ordered per 100 Patients by House Staff in the Adult Ambulatory Care Center and the Family Practice Center

Adult Ambulatory Care Center

Residents	Baseline Period	Intervention Period	Both Periods
2nd year	31.89	37.00	34.45
3rd Year	36.00	30.00	33.00
2nd & 3rd Years	33.82	33.71	33.76

Family Practice Center

Residents	Baseline Period	Intervention Period	Both Periods
2nd Year	4.38	4.88	4.63
3rd Year	6.57	7.86	7.21
2nd & 3rd Years	5.40	6.27	5.83

Multivariate Analysis of Variance

Sources of Variation	df	Mean Square	F Ratio	Significance
Between Subjects				
Center	1	12270.35	43.31	0.000
Residents	1	5.20	0.02	0.893
Center X Residents	1	64.57	0.23	0.637
Within Cells	28	283.29		
Within Subjects				
Period	1	0.80	0.01	0.929
Center X Period	1	7.10	0.07	0.791
Residents X Period	1	105.77	1.07	0.310
Center X Residents X Periods	1	140.42	1.42	0.244
Within Cells	28	99.01		

For two of the tests, CBCs and Chemistry 23s, ordering rates were significantly ($p < 0.000$) higher in the Adult Ambulatory Care Center which is staffed by internal medicine residents. Overall, 25.35 percent of the patients had CBCs and 33.76 percent had Chemistry 23s ordered. Comparable rates in the Family Practice Center were 7.24 and 5.83 percent, respectively. For about 1 out of 10 patients in both centers, urinalyses were ordered during the two periods.

The higher rates of tests ordered by the internal medicine residents is largely a function of their training. These house officers are exposed to a wide variety of medical conditions and are expected to develop their diagnostic skills to a much greater extent than residents in other programs.

While the overall rate of urinalyses were about the same in both centers, second year residents ordered significantly ($p < 0.016$) more tests than third year residents. These differences are probably a function of experience. Interns and residents experience a great deal of uncertainty when they first begin to see patients in the centers. As a result, they are inclined to order more tests than the more experienced house officers.

Test ordering rates for chemistry 23s remained fairly constant in both clinics during the intervention period. Use of the checklists appears to have had no significant effect on the ordering of this test battery. However, the rate of CBCs declined significantly in both centers ($p < 0.0000$); from 39.35 to 11.35 per 100 patients during the two month intervention period in the Adult Ambulatory Care Center and from 11.60 to 2.87 per 100 patients in the Family Practice Center. There was a significantly larger decrease in the number of tests ordered by internal medicine residents than by family practice residents. The center X period interaction was significant ($p < 0.000$).

Also, the number of urinalyses ordered by family practice residents decreased significantly during the intervention period ($t = 2.94$, $p < 0.011$). The number of tests ordered per 100 patients went from 11.00 to 7.60.

Discussion

The purpose of this study was to evaluate the use of influential physicians to influence test-ordering in primary care settings. Structured order forms were developed in conjunction with and introduced into two hospital outpatient centers by the chief residents of internal medicine and family practice. The results of a two month trial indicated that test-ordering rates for complete blood counts were significantly reduced on both centers while the urinalysis rate was significantly reduced on the Family Practice Center. Based on these results, we conclude that the identification and use of influential physicians is an effective means of altering practice behavior.

The reductions in the rate of CBC orders were not only significant but were large enough to be important in a practical sense as well. Given the volume of outpatients seen by the house staff in the two centers, cost savings from the reduction in CBCs ordered for the two month intervention period were approximately $4,000.

A major advantage of the approach used in this study is the minimal effort required by the medical and hospital staff. The project required about four one-hour meetings with physicians to develop criteria and checklists for ordering the study tests. Clerical staff in the two centers attached the checklists to the patient's chart before each visit and collected them afterward. This approach could become an ongoing activity within the hospital at little cost and without requiring excessive time on the part of physicians and the hospital personnel.

At the same time a number of questions need to be addressed in future research. First, the lack of a control group in this study raises questions about the conclusions. Without an appropriate control group, it is difficult to be certain that the changes that occurred in test-ordering rates were caused by the intervention and not by some other factor. For example, it might be argued that general learning occurs during the course of residency programs. Consequently, changes in test ordering may be the result of this more general learning on the part of the house staff. However, examination of the test ordering rates during the previous twelve months did not indicate changes of the magnitude that occurred during the two month intervention period. Nevertheless, the use of a suitable control group in a future study would resolve this issue.

Second, using change in testing rates as an outcome measure fails to distinguish whether the intervention caused appropriate or inappropriate changes in test use. We believe that the former is more likely since the criteria for the tests represented a consensus of the literature, the faculty and the chief residents who teach the house staff about appropriate testing. Chart reviews of a sample of patients seen by residents during the intervention period might shed light on this question.

Third, the finding that the use of influential physicians to introduce checklists resulted in a significant reduction in the rate at which only two of the three tests were ordered, suggests that this approach may be effective with certain tests and not with others. This is an important area for future investigation.

Moreover, while it appears that the success of the intervention was due to the use of influential physicians, it may be that the checklists served as reminders as to the appropriate reasons for ordering tests. This fact alone may account for the change in physician behavior. This issue might be resolved in a future study by comparing the results from two groups that use checklists, only one of which is introduced by the chief resident.

Also, the chief residents were used to develop the acceptable reasons for ordering the tests and to introduce the checklists to the other residents in their programs. This raises an important issue as to the nature of the role relationships involved. While chief residents provide information and leadership, they also supervise the clinical work of the junior house staff. They both praise them for clinical work well done and censure them for poor work and mistakes. It is possible that the reduction in tests resulted from this authority relationship rather than from role modeling through a collegial relationship. This question might be answered by using influential colleagues among the residents to introduce checklists in a future study rather than using the chief residents.

Finally, no specific efforts were made to encourage residents to use the checklists after their initial introduction by the chief residents. Consequently, it is not known whether active promotion of the checklists during the intervention might have resulted in a further reduction in test ordering rates. This is one area for future investigation. Also, the next phase of the study will investigate whether feedback of comparative data on test ordering rates will further alter physicians' behavior and reduce unnecessary laboratory tests. The results of other studies (Dowling, et al., 1989; Marton, et al., 1985; Spiegel, et al., 1989; Tierney, et al., 1987, 1988; Wilson, et al., 1982) suggest that feedback can bring about large reductions in the rate at which some tests are ordered.

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