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NON-MEDICAL INFLUENCES ON MEDICAL DECISION-MAKING

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Abstract—Background. The influence of non-medical factors on physicians' decision-making has been documented in many observational studies, but rarely in an experimental setting capable of demonstrating cause and effect. We conducted a controlled factorial experiment to assess the influence of non-medical factors on the diagnostic and treatment decisions made by practitioners of internal medicine in two common medical situations. Methods. One hundred and ninety-two white male internists individually viewed professionally produced video scenarios in which the actor–patient, presenting with either chest pain or dyspnea, possessed various balanced combinations of sex, race, age, socioeconomic status, and health insurance coverage. Physician subjects were randomly drawn from lists of internists in private practice, hospital-based practice, and HMO's, at two levels of experience. Results. The most frequent diagnoses for both chest pain and dyspnea were psychogenic origin and cardiac problems. Smoking cessation was the most frequent treatment recommendation for both conditions. Younger patients (all other factors being the same) were significantly more likely to receive the psychogenic diagnosis. Older patients were more likely to receive the cardiac diagnosis for chest pain, particularly if they were insured. HMO-based physicians were more likely to recommend a follow-up visit for chest pain. Several interactions of patient and physician factors were significant in addition to the main effects. Conclusions. The variability in decision-making evidenced by physicians in this experiment was not entirely accounted for by strictly rational Bayesian inference (the common prescriptive model for medical decision-making), in-as-much as non-medical factors significantly affected the decisions that they made. There is a need to supplement idealized medical schemata with considerations of social behavior in any comprehensive theory of medical decision-making.

INTRODUCTION

The way in which doctors make medical decisions can be viewed theoretically from either of two perspectives: a prescriptive theory of how medicine ought to be practiced, or a descriptive picture of how medicine is actually practiced. The prescriptive view holds that medical decision-making can and should be based on probabilities and rates, which are obtained from prior medical studies and sequentially adjusted by applications of Bayes' theorem to incorporate new findings on a particular patient [1–8]. The descriptive view highlights the influence of a range of social factors that are logically unrelated to the etiology or course of illness and puts emphasis on identifying and measuring sources of variability in decision-making [9–22].

Despite their 'objective' medical training, physicians remain human actors, socially conditioned to engage in stereotyping, whether consciously or not. In that respect, medical decision-making can be a function of *who the patient is* as much as *what the patient has*. Studies in social science have documented many non-medical factors that influence medical decisions, falling into three major categories [22–24]:

(1) *Characteristics of the patient*. These include age, sex, socioeconomic status, race or ethnicity, presence or type of health insurance, and individual features like assertive personality or physical attractiveness. While some of these factors (e.g. age and sex) may be associated with the probability of disease in some cases, they appear to be extraneous in many others.
(2) *Characteristics of the doctor*. These include medical specialty, level of training, length of clinical experience, and geographical location as well as the physician's age, sex, race, ethnicity, and personality. Ideally, these provider characteristics should not influence decision-making with respect to diagnosis, workup, or treatment.
(3) *Features of the practice setting*. These include the organization of the practice (fee-for-service, HMO, PPO), the form of physicians' compensation (entrepreneurial or salaried), insurors' schemes for management and reimbursement, and the physicians' financial investment in facilities providing ancillary services ('self-referral').

In this report we describe an experiment designed to identify and estimate non-medical influences on physicians' decision-making. The physicians were randomly sampled within strata defined by selected characteristics. The patients' characteristics were

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varied in realistic simulations, and the outcome of the doctor–patient encounter was examined in a statistically controlled manner. A *fractional factorial design* permitted balanced, cost-effective coverage of the many possible combinations of a large number of factors, in such a way that not only main effects but also interactive effects of any two characteristics could be assessed without confounding [25, 26].

METHODS

Medical scenarios

Dialogues were developed to depict two common types of doctor–patient encounter: complaint of chest pain and complaint of shortness of breath (dyspnea). These presenting conditions were chosen for their frequency (ranking 3 and 14 respectively among reasons for visiting an internist in the U.S. [27]) and for their latitude with respect to reasonable diagnosis and treatment. The scripts were based on cases provided by two experienced clinicians and were reviewed for authenticity by a panel of practicing physicians and experts in clinical decision-making.

The dialogues were enacted by professional actors and videotaped by the professional staff of Boston University Productions. Strict quality-control procedures were followed during videotaping, with a senior member of the research team present at all times for consultations with the production crew. One actor played the character of the doctor in all scenes. The patient's verbal and non-verbal behavior in each scenario was standardized. No characteristics of the patient other than those that were prescribed as part of the experiment (see below) were allowed to vary among different actors enacting the same scenario.

Patient characteristics

Five dichotomous patient characteristics were manipulated as experimental conditions: sex, race (black or white), age (30 or 62 years), coverage by health insurance (yes or no), and socioeconomic level (professional or workingclass, as evidenced by reported income and wording of dialogue). Each of these factors has been identified consistently as a significant influence on clinical encounters, although no study has yet considered all 5 simultaneously [28–32]. Of the 32 possible combinations of 5 binary characteristics, 16 combinations were chosen according to a standard half-factorial design, as illustrated in Fig. 1 [25–26]. The 16 'roles' were assigned to 16 different actors for videotaping. Each actor enacted both medical scenarios for his or her character. In all scenarios the patient was identified as a smoker.

Physician characteristics

Physicians were randomly selected from a sampling frame of 1011 names, provided in part by a commercial source (Business Mailers, Inc., Chicago, IL) and in part by complete listings from Boston-area hospitals and HMO's. Specialists in internal medicine were chosen as the population of interest because of their broad training and routine confrontation of patient management problems similar to those presented in the videotapes. Eligibility criteria included training in the U.S. and active provision of direct patient care, with a majority of professional time devoted to practice of internal medicine in the Boston area. The 192 participants represented 91.4% of eligible subjects contacted. Only white male physicians were sampled, because of the difficulty of locating sufficient female and minority subjects in all strata of the balanced factorial design.

Selection was made within six strata, defined by combinations of the physician's practice setting (three levels) and length of clinical experience (two levels). Experience was dichotomized according to time since graduation from medical school, with 15 years (an approximate median) as the dividing line. Practice settings were classified as private office, hospital, or HMO. Both of these physician characteristics have been repeatedly identified as important influences on clinical decision-making, test-ordering, and medication-prescribing practices [33–47]. Thirty-two eligible physicians were selected from each of the six strata, for a total sample of 192.

Experimental design

The half-factorial design of patient characteristics ($\frac{1}{2} \times 2^5$) was embedded in the full factorial stratification of physician characteristics (2×3) as depicted in Fig. 2. The videotapes were randomly assembled into 16 sets, in such a way that each set contained both medical scenarios and no actor appeared more than once. The 16 sets of videotapes were assigned randomly for showing to 16 physicians from each stratum. Each physician viewed both scenarios allocated to him. The entire experiment was repeated with another 16 physicians from each stratum, so that a total of 192 physicians viewed each scenario.

Field procedure

A trained interviewer visited the physician in his place of work and administered a structured

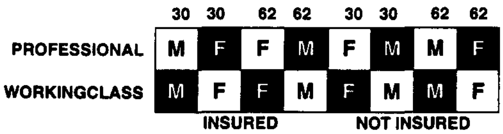

Fig. 1. Half-factorial design for patient characteristics. Enacted on videtape by professional actors, the medical scenarios comprised 16 of the possible 32 combinations of 5 dichotomous characteristics: age (30, 62), socioeconomic status (professional, workingclass), sex (M, F), race (black, white), and coverage by health insurance.

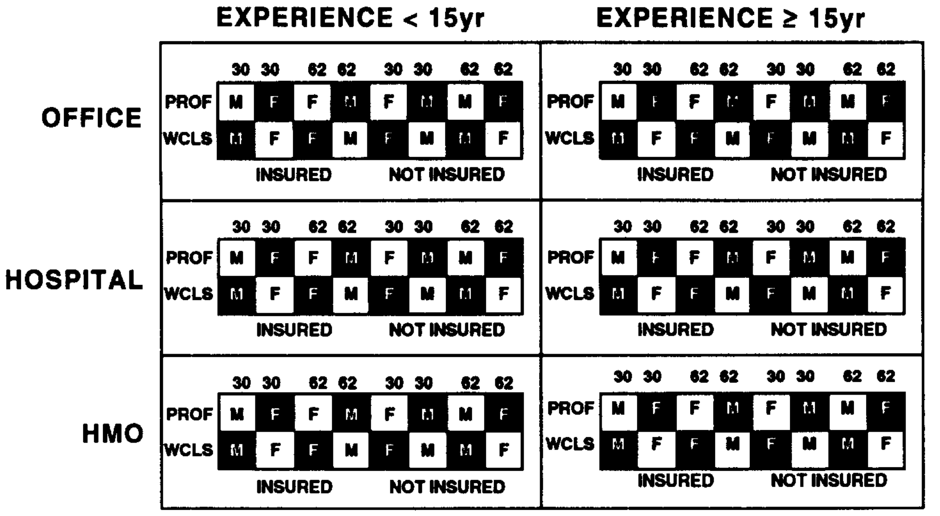

Fig. 2. Full factorial design for physician characteristics, with embedded half-factorial scheme of patient characteristics. Physicians were sampled randomly from a New England listing within two levels of experience (< 15 year, ≥ 15 year) and three categories of practice setting (office, hospital, HMO). Sixteen physicians were identified in each cell and allocated randomly to the 16 combinations of patient characteristics (see Fig. 1). The entire plan was replicated twice.

questionnaire, built around a screening of the scenarios. The order of screening was determined randomly. The subject was not informed of the study hypotheses.

In conjunction with each videotape the physician was provided with a simulated work-up sheet summarizing the patient's basic physiological measures from a prior physical examination, indicated as normal. The physician was repeatedly assured that the interviewer's questions had no right or wrong answers and that the questionnaire was designed to determine what he would typically do in his practice when encountering 'this type of patient'. The interview lasted approximately 1 hour. Each physician subject was compensated $75 for his time.

Outcome variables

Three principal categories of response were gathered in relation to each medical scenario: diagnosis, treatment, and prognosis. After viewing each tape and reviewing the accompanying data, the physician was asked to dictate a synopsis of the case; to list his working diagnoses, rank them in order of probability, and give his reasons; to suggest diagnostic tests or procedures, give reasons, and estimate the likelihood that he would actually order

Table 1. Response of physicians to videotaped scenario depicting a patient presenting with chest pain or dyspnea. Each scenario was viewed, with various combinations of patient characteristics, by 192 physicians

Response category	Response	Number (%) Chest pain	Dyspnea
Diagnosis	Psychogenic, primary	80 (42)	116 (60)
	Cardiac, primary	74 (39)	40 (21)
	Pulmonary, primary	3 (2)	2 (1)
	Gastrointestinal, primary	25 (13)	32 (17)
	Cardiac mentioned	180 (94)	127 (66)
	Psychogenic mentioned	122 (64)	145 (76)
	Pulmonary mentioned	9 (5)	168 (88)
	Condition rated moderate or severe	74 (39)	
Treatment	Change lifestyle	39 (20)	14 (7)
	Quit smoking	54 (28)	49 (26)
	Hospitalize	15 (8)	3 (2)
	Followup visit	22 (12)	17 (9)
	Record symptoms	13 (7)	25 (13)
	Stress reduction	7 (4)	16 (8)
	Cardiac drug	48 (25)	9 (5)
	Pulmonary drug	0 (0)	12 (6)
	Gastrointestinal drug	1 (1)	0 (0)
	Over-the-counter pain medication	3 (2)	0 (0)
	Over-the-counter antacid	30 (16)	0 (0)

Table 2. Odds ratios for response to chest pain and dyspnea presentation, as influenced by characteristics of physician and simulated patient

Scenario	Response category	Response	Components of odds ratio	Subgroup	Odds ratio for response (95% confidence interval)	
Chest pain	Diagnosis	Psychogenic, primary	Age 62:age 30	—	0.22	(0.11–0.43)
			Black:white	Office	0.62	(0.20–1.95)
			Black:white	Hospital	1.85	(0.60–5.73)
			Black:white	HMO	0.24	(0.07–0.77)
		Cardiac, primary	Age 62:age 30	—	20.90	(8.77–49.80)
			Insured:not insured	Age 62	4.11	(1.53–10.98)
			Insured:not insured	Age 30	0.81	(0.22–3.01)
		Gastrointestinal, primary	Black:white	Office	7.89	(0.82–75.85)
			Black:white	Hospital	0.34	(0.06–2.05)
			Black:white	HMO	6.75	(1.22–37.48)
		Psychogenic mentioned	Female:male	Office	0.88	(0.31–2.45)
			Female:male	Hospital	0.27	(0.09–0.83)
			Female:male	HMO	9.15	(2.20–38.05)
		Moderate–severe rating	Age 62:age 30	—	2.47	(10.48–61.87)
	Treatment	Followup visit	Office:all	—	0.53	(0.09–3.04)
			Hospital:all	—	0.12	(0.02–0.98)
			HMO:all	—	15.48	(3.66–65.58)
		Cardiac drug	Age 62:age 30	—	15.38	(4.64–51.02)
Dyspnea	Diagnosis	Psychogenic, primary	Age 62:age 30	—	0.18	(0.09–0.36)
		Psychogenic mentioned	Age 62:age 30	—	0.18	(0.08–0.41)
		Gastrointestinal, primary	Age 62:age 30	—	53.34	(6.67–426.68)

them; to rate the severity of the condition and its impact on quality of life; and to recommend treatment. Thirty-seven endpoints were examined for this report (Table 1).

Statistical analysis

All outcome variables reported in this paper were dichotomous. For each variable, a hierarchical set of three binary logistic regression models was fitted by maximum likelihood to the full set of data: (1) main effects only (87 residual *df*); (2) main effects plus all two-factor interactions (61 *df*); and (3) main effects plus only the statistitically significant two-way interactions. Parameters were estimated from the latter model.

Goodness-of-fit was determined by the residual chi-squared statistic [48]. If the full model fitted poorly ($P < 0.05$), the endpoint was not analyzed further. Seven endpoints were discarded for this reason, while 84 were modelled successfully.

The critical value for each of the 7 main effects was taken as $P = (1 - 0.99^{1/7}) = 0.0014$, providing 99% probability that no Type I error would be made if all main-effect inferences were independent. For the 21 two-factor interactions the critical value was similarly taken as $P = (1 - 0.99^{1/21}) = 0.0005$. The expected number of Type I errors per outcome was therefore $0.0014 \times 7 \times 84 = 0.8$ for main effects and $0.0005 \times 21 \times 84 = 0.8$ for interactions, regardless of the independence of testing.

The magnitude of each significant effect is reported in this paper as a conditional odds ratio. An odds ratio of unity represents no effect. Conditional odds are defined by

$$\text{Odds[Outcome} \mid \text{Condition A]} = \frac{\text{Prob[Outcome occurs} \mid \text{Condition A]}}{\text{Prob[Outcome does not occur} \mid \text{Condition A]}}. \quad (1)$$

For a dichotomous main effect comprising two conditions A and B, the odds ratio is defined as

$$\text{OR[A:B]} = \frac{\text{Odds[Outcome} \mid \text{Condition A]}}{\text{Odds[Outcome} \mid \text{Condition B]}}. \quad (2)$$

In the case of practice setting (the sole trichotomous factor), the main-effect odds are reported relative to overall odds

$$\text{OR[A:All]} = \frac{\text{Odds[Outcome} \mid \text{Condition A]}}{\text{Odds[Outcome} \mid \text{Condition A or B or C]}}. \quad (3)$$

SAS software was used for maximum-likelihood logistic regression analysis [49]. Odds ratios were obtained by exponentiating appropriate coefficients in the fitted model [48]. An asymptotic 95% confidence interval for the odds ratio was constructed by exponentiating limits of $\pm$ 1.96 standard error about the coefficient. Any confidence interval that included unity was left unreported, except for purposes of comparison.

RESULTS

Chest pain

The two most frequent primary diagnoses in the case of chest pain were psychogenic origin (42%) and cardiac problems (39%) (Table 1). The older patients (age 62) were significantly less likely than the younger patients (age 30) to receive a primary psychogenic diagnosis; the odds ratio was 0.22, significantly less than unity (Table 2). The older patients were significantly more likely to receive a primary cardiac diagnosis (odds ratio 20.90). Among the older patients, those with insurance were significantly more likely to receive the primary cardiac diagnosis than those without insurance (odds ratio 4.27), whereas among younger patients insurance had no effect (Fig. 3).

HMO-based physicians mentioned psychogenic origin as a diagnostic possibility significantly more often in female than in male patients (odds ratio 9.15), whereas hospital-based physicians included the psychogenic diagnosis significantly less frequently in females than in males (odds ratio 0.27). HMO-based physicians gave gastrointestinal problems as the primary diagnosis significantly more often in black than in white patients (odds ratio 6.75), and psychogenic causes significantly less often in black than in white patients (odds ratio 0.24).

The most frequent treatment recommendations for chest pain were smoking cessation (28%), cardiac drugs (25%), and other lifestyle changes (20%) (Table 1). Older patients were given a treatment recommendation of cardiac drugs significantly more often than younger patients (odds ratio 15.88, Table 2). The HMO physicians were far more apt to recommend a follow-up visit than the office- or hospital-based physicians.

Dyspnea

The two most frequent primary diagnoses for the dyspnea scenario were the same as for chest pain: psychogenic (60%) and cardiac (21%) (Table 1). Pulmonary causes were listed as primary in only 2 cases. The cardiac diagnosis was not significantly influenced by any of the patient or physician characteristics.

Older patients received a primary gastrointestinal diagnosis significantly more often and, as in the case of chest pain, a psychogenic diagnosis, whether primary or secondary, significantly less often than the younger patients (Table 2). Smoking cessation was the most frequent treatment recommendation (26%) for dyspnea and was not influenced by patient or physician characteristics. Cardiac drugs and lifestyle changes were prescribed infrequently for the dyspnea scenario.

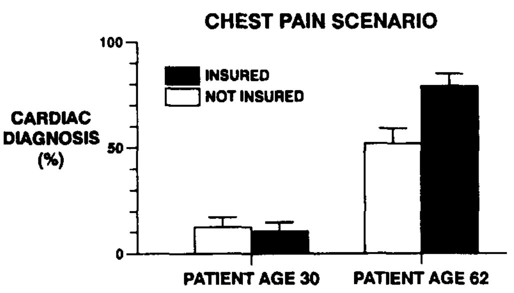

Fig. 3. Influence of patient's age and insurance status on probability of primary cardiac diagnosis, as made by physicians after viewing chest-pain scenario. Cardiac diagnosis was more frequent for older patients than for younger ($P < 0.0001$; see Table 2), and, among older patients, more frequent for those with insurance. Error bars indicate ± 1 S.E.; total sample size 192 physicians.

DISCUSSION

The prescriptive theory of medical decision-making relies exclusively on two variables: the presentation of symptoms and the probability of disease. Most of a patient's personal characteristics, as well as characteristics of the provider and the setting in which medical care is delivered, are excluded from consideration in the formulation of decisions concerning diagnosis, workup, and treatment. Descriptive theorists challenge that viewpoint as an over-rationalized view of human behavior and prefer to emphasize the identification and measurement of those additional sources of variablity.

Observational studies have borne out the descriptive approach by demonstrating that non-medical factors, ranging from the patient's physical appearance to the organizational setting in which medical care is delivered, may have as much influence on medical decisions in some areas as the actual signs and symptoms of disease. The methodological challenge in such studies is to disentangle the many influences on medical decision-making so as to estimate their independent and combined influence. Confounding, which is virtually inevitable in observational studies, is particularly prevalent in the sociological setting, where such variables as race and socioeconomic status, when left uncontrolled, tend to be strongly correlated and therefore largely inseparable.

Investigators in the United Kingdom and elsewhere have conducted research in this area which, to varying degrees, attempted to control for the confounding influences of sociological variables. No experimental manipulation was possible in many of these designs, which included observational or case studies [50–52], mail surveys of practice patterns [53–54], retrospective or prospective review of medical records [55–58], or a combination of those [59]. While such studies may suggest the relationship between background characteristics of the patient and decision-making patterns, they cannot unequivocally demonstrate its presence. Nevertheless, some such research has been used to clarify prescriptive decision-making rules [52].

Other studies have presented written vignettes to practicing physicians for their review [60–63]. This approach has been helpful, especially when combined with a 'delphi' panel, in identifying optimal decision rules for physicians and in establishing framing effects when physicians present choices to their patients. Some investigators have been particularly sophisticated in manipulating variables of interest, so as to examine precisely the intricacies involved in physicians' decision-making [63–65]. Another benefit of these methods is the identification of training needs of medical students. A limitation, however, is the lack of realism in written vignettes as compared with videotaped vignettes. Finally, some studies have used videotaped vignettes presented to physicians, but these vignettes did not represent tightly controlled conditions that would allow the identification of unconfounded influences on the decision-making process [66–68]. It is the combination of videotaped vignettes and factorial design that made the experiment reported here unique.

The present experiment, conducted with thorough control, strict balance, and sophisticated analysis, offered the opportunity to evaluate the contributing factors independently. A large number of factors demanded inclusion on the basis of prior work: patient's age, race, sex, socioeconomic status, and health insurance, and doctor's experience and practice setting [69]. These were accommodated by the use of a stratified fractional factorial design, which furnished perfect balance, and by a structured scheme of statistical inference to control the expected rate of Type I error due to multiple comparisons. Video production being the most expensive component of this study, the half-factorial design served as an important cost-saving device while preserving the capability of estimating all main effects and two-factor interactions.

It is reasonable to ask whether the behavior of physicians under experimental conditions accurately represented their behavior in everyday clinical practice. Several steps were taken to maximize external validity: (1) Considerable effort was expended to ensure the realism of the videotaped presentation. A majority of physicians thought the actor was a real patient. (2) Physician subjects viewed the videotapes in the context of their practice day, rather than in their homes or at a professional, educational, or scientific meeting. (3) Physician subjects were instructed at the outset of the interview to view the patient on the videotape as one of their own cases and to respond as they would respond in their own practice. The physicians often made comments like, 'I have a case like that,' or, 'I saw this case this morning'. (4) Participants were asked whether their suggested management of the hypothetical patient was the same as they would provide for their own patients; any differences were recorded.

Compared with published reports from observational studies, the number of significant effects demonstrated in this carefully designed experiment were relatively few. Because the sample of physicians was of necessity relatively homogeneous (all white male internists), the small number of significant physician effects is not surprising. The strongest physician effect observed was the tendency of HMO-based physicians to make a primary cardiac diagnosis less often (in the chest-pain scenario) and a primary psychogenic diagnosis more often (for white patients in the dyspnea scenario) than office- or hospital-based subjects. This finding might reflect differences in the prevalence of disease among the respective populations served. Alternatively, it might be interpreted in terms of the higher cost implications of a cardiac diagnosis, although no corresponding tendency was observed in treatment recommendations. More direct evidence of economic influence was the significant effect of insurance coverage on cardiac diagnosis for chest pain in the older patients.

The strong impact of patient's age on the rate of primary cardiac diagnosis for a presentation of chest pain obviously reflects the physicians' expectations that few young adults will have heart disease. The odds ratio in our experiment, exceeding 20, was in fact considerably higher than the population age trends for morbidity and mortality from heart disease. The magnitude of this effect suggests that the physicians may have an inclination to overdiagnose heart disease in older patients, while in younger patients they may tend to underdiagnose heart disease or misdiagnose the symptoms as psychogenic. The overwhelming influence of the patient's age on cardiac diagnosis may mask smaller effects related to the other patient factors.

The effect of patient's age on prescription of cardiac drugs for chest pain is consistent with the cardiac diagnosis. The perception that older patients are less amenable to behavior modification would also lead to prescription of drugs in preference to recommending lifestyle changes.

In summary, this experiment showed that physicians' expressed tendencies in relation to testing, diagnosis, and treatment for two common medical situations were not completely explained by rational clinical decision-making. These findings point to the need to take account of non-medical influences on the interpretation of medical data.

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