IMPACT OF PATIENT OBTAINED MEDICAL INFORMATION (POMI) ON THE PHYSICIAN-PATIENT RELATIONSHIP

By

Bin Xie

Dissertation

Submitted to the Faculty of the

Graduate School of Vanderbilt University

in partial fulfillment of the requirements

for the degree of

DOCTOR OF PHILOSOPHY

in

Interdisciplinary Studies: Management of Technology

August, 2005

Nashville, Tennessee

Approved:

Professor David M. Dilts

Professor William R. Mahaffey

Professor Mikhael Shor

Professor Doris C. Quinn

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

This work would not have been possible without the support of the Management of Technology Program. Program director Dr. William Mahaffey, Director of Graduate Studies Dr. David Dilts, Program Secretary Mary Jane Buchanan, and fellow students all provide me with 360 degree support in my work.

I am grateful to all of those with whom I have had the pleasure to work during this and other related projects. Each of the members of my Dissertation Committee has provided me extensive personal and professional guidance and taught me a great deal about both scientific research and life in general. I would especially like to thank Dr. David Dilts, the chairman of my committee. As my teacher and mentor, he has taught me more than I could ever give him credit for here. He has shown me, by his example, what a good scientist (and person) should be. He also built a family of fellow students whose feedback and advice helped me achieve much more than I could alone. I would also like to thank Dr. William Mahaffey, who provided advice and help whenever I needed; Dr. Mikhael Shor, who not only advised me on health economics and game theory but also provided enormous help on my job search and other work and personal issues and whose friendship I always treasure; and Dr. Doris Quinn, who provided invaluable medical expertise to this dissertation and whose warm and kind help and advice provided much relieve to the hard journey of dissertation research. I would also like to thank my fellow students.

Nobody has been more important to me in the pursuit of this project than the members of my family. I would like to thank my parents, whose love and guidance are with me in whatever I pursue. Most importantly, I wish to thank my loving and supportive wife, Angela, whose support and encouragement make this work possible.

LIST OF TABLES

LIST OF FIGURES

Figure Page

CHAPTER I

INTRODUCTION

During the past several decades, there has been an irreversible change in the nature of the physician–patient relationship [1-5]. Patients are seeking more medical information and are actively participating in decisions affecting their health [6-10]. Such change has attracted substantial attention in a variety of fields including health policy [11-17], health economics [18-24], and medical practice [25-30]. There is agreement across board that informed patients should be one of the cornerstones of a patient-centered U.S. healthcare system in the future [31-41].

These studies, from different fields, investigate the impact of patient-obtained medical information (POMI) on the physician-patient relationship from very different view points, but they share one basic assumption: that one patient's relationship with his[1] physician would be impacted solely by his own POMI. For example, studies in medical practice and health policy investigated the impact of individual patient's POMI on his relationship with the physician, on his utilization or outcome, without any discussion on the potential influence of POMI of other patients on such aspects as utilization, outcome or relationship with the physician [11-17, 25-30]. Studies in health economics view the relationship as a one-to-one interaction in which the physician observes perfectly the patient's information level without any discussion of information of other patients or patient population [18-24].

But there is substantial evidence [38-41] that in medical practice, physicians draw inferences from characteristics of a patient population as surrogate for the characteristics of a particular patient and make medical decisions partly based on such population characteristics. For example, patients' demographic and/or socioeconomic characteristics are often used in medical registry or other forms of practice guidance or clinical decision tools to guide physician practice [38-41]. So it is entirely possible that physicians will also use patient population's POMI as surrogate for an individual patient's POMI.

[1] For convenience, we assume that the patient is a male and physician a female.

While existing studies on the impact of POMI on physician-patient relationship provide insights, we believe that additional insights will be gained by taking into account the impact of patient population's POMI on individual patient's relationship with the physician. The first reason for this is that physicians may not observe an individual patient's information level perfectly. For one thing, physicians usually do not have sufficient time to make a perfect observation of a patient's information level [42-46]. For another, while physicians can get some signal about a patient's information level from his socioeconomic or health status [47-49], studies show that physicians ability to predict patient's information level are far from perfect [50-56]. It has long been established in economics that such imperfect ability of service providers (i.e., physicians) to distinguish different customers (i.e., patients) means that service providers (physicians) may have to react to customers (patients) on a population basis [57-63], suggesting the possibility of one customer (patient) influencing another's relationship with the service provider (physician).

The second reason for my research is that there exist significant variances in utilization among patients with different socioeconomic characteristics [64-68] and in different geographic regions [69-77] that cannot be fully accounted for by known causes [78, 79]. It is possible that some variability is caused by the influence of one patient's POMI on another's utilization, as patients of the same socioeconomic group or geographic region usually seek services from the same group of physicians [79-82]. Physicians may act on a population basis, contributing the persistent socioeconomic and regional utilization variances.

In this dissertation, multidisciplinary studies were carried out to investigate if a patient's relationship with the physician could be influenced by a patient population's POMI when the physician does not observe perfectly the patient's information level. After reading this dissertation, you will discover that when a physician cannot distinguish the information levels of individual patients within a patient population, she would base part of her interaction with patients on information about the total population, not on the information of the particular patient she interacts with. In other words, a patient's relationship with his physician is partially shaped by the information of the patient population. For example, even if they have the same level of information, a 35-year-old Caucasian lady may be treated differently than a 60-year-old African American gentleman.

You will also discover that per capita utilization of several healthcare services in a county has a non-linear relationship with the POMI in that county, suggesting that one patient's utilization might be influenced by other patients' POMI in the same county. Finally you will discover that physicians of different demographic, socioeconomic and practice characteristics have different attitude towards POMI. So, while a patient's relationship with his physician is shaped by information of the population, a patient may be able to selectively choose physicians with more positive attitude towards POMI based on the physician's characteristics. In what follows, I will discuss these findings in more detail.

In chapter two, a game-theoretical model was built in which a physician interacts with a heterogeneously informed patient population. Using existing models [23-24] as benchmark, it was found that while more information in a patient population generally means more productive physician-patient relationship, a conclusion shared with existing models [21-27], introducing additional well-informed patients to the population discontinuously affects the physician's strategy, having no effect unless a sufficient quantity of such well-informed patients is added. In other words, the physician's interaction with a particular patient from a population is partially shaped by the information of the population, not solely by the information of that particular patient.

To empirically test the findings of chapter two and to see if the non-linear effects predicted contribute to the regional variations in healthcare utilization [69-77], an empirical test was performed in chapter three using data from the 2000-2001 Community Tracking Study (CTS) Household Survey and the 2003 Area Resource File (ARF). It was found that healthcare utilization in US counties does not increase in direct proportion to the ratio of patients with POMI in a county. As the POMI ratio increases in a county, utilization rates would increase in a non-monotonically fashion, remaining stable until the ratio crosses some critical value, at which point utilization rates increase suddenly. Such findings are consistent with predictions of chapter two, and they suggested that future study in regional variances should take into account the ratio of well-informed patients in a region, as such ratio was shown to have a non-linear effect on utilization.

Findings in chapter two and three suggest that the physician-patient relationship is influenced by the information of the population from which the patient comes from. Does this mean that the patient can do nothing to change his interaction with the physician? In chapter four, I turn attention to the differences in attitude and reaction towards POMI among physicians with different socioeconomic, demographic and practice characteristics, since individual patients can choose which physician to visit and receive services [35, 36]. Data from the 2000-2001 Community Tracking Study Physician Survey suggests that physicians of male gender, older age, international training, race other than white, and overall personal financial incentive favoring expanding services are more likely to have positive attitudes towards POMI and more willing to order tests, procedures or prescriptions upon patients' requests.

The dissertation shows that we can gain important insights by taking into account the influence of one patient's POMI on another patient's relationship with the physician: the physician-patient relationship under the impacts of POMI has important characteristics that are not captured by existing studies. For example, while existing models indicated that whenever we provide information to a patient, we make that patient (and only that patient) better off, the dissertation shows that we can make a whole patient population better off by educating some of patients within that population, but that providing information to some patients may have no impact on physician behavior. Such findings have important implications on our efforts to alleviate or eliminate the wide spread disparities in healthcare utilization among populations of different socioeconomic [64-68] characteristics and geographic regions [69-77] (more discussion on the conclusion section of the dissertation).

The findings of this dissertation should be interpreted within the context of the methodology and the data that were analyzed, and it is important to note several limitations (which are also opportunities for further study). For one thing, the theoretical study did not address the issue of a physician community serving a patient population. Such exclusion of physician community left out potentially important issues such as physicians learning from peers [79] and competition among physicians [83-85]. Inclusion of these issues in future studies may provide important insights. For another, the empirical study in chapter three used counties as the unit of analysis. Since patients in a county are likely to receive services from more than one local physician communities, using counties as the unit of analysis may leave out important local details [79]. Future studies using local community as the unit of analysis may provide important details.

References

1. Wolfe S. M. Direct-to-Consumer Advertising — Education or Emotion Promotion? *N Engl J Med*. 2002; 346: 524-526.

2. Miller TE, Derse AR. Between strangers: the practice of medicine online. *Health Affairs*. 2002; 21(4): 168-179.

3. Schneider CE. The Practice of Autonomy: Patients, doctors, and medical decisions. New York, Oxford University Press, 1998.

4. Strull WM, Lo B, Charles G. Do patients want to participate in medical decision making? *JAMA*. 1984; 252: 2990-2994.

5. Canter R. Patients and medical power. *BMJ.* 2001; 323(7310): 414.

6. Drazen JM. The Consumer and the Learned Intermediary in Health Care. *N Engl J Med.* 2002; 346: 523-524.

7. Greenfield S, Kaplan S, Ware JE. Expanding patient involvement in care. *Ann Intern Med*. 1985; 102: 520-528.

8. Emanuel EJ, Emanuel LL. Four Models of the Physician-Patient Relationship. *JAMA*. 1992; 267(16): 2221-2228.

9. Weissman JS, Blumenthal D, Silk AJ, Newman M, Zapert K, Leitman R, Feibelmann S. Physicians Report On Patient Encounters Involving Direct-To-Consumer Advertising. *Health Affairs Web Exclusive*, April 28, 2004

10. Baker M. Modernising the NHS: Patient care (empowerment): the view from a national society**.** *BMJ*. 2000; 320: 1660 - 1662.

11. Goldsmith J, Blumenthal D, Rishel W. Federal Health Information Policy: A Case Of Arrested Development. *Health Affairs.* 2003; 22(4): 44-55.

12. Fried BM et al. E-Health: Technologic Revolution Meets Regulatory Constraint. *Health Affairs.* 2000; 124–131.

13. Lumpkin JR. Perspective: E-Health, HIPAA, And Beyond. *Health Affairs.* 2000; 19(6): 149-151.

14. Brodie M, Flournoy RE, Altman DE, Blendon RJ, Benson JM, Rosenbaum MD. Health information, the Internet, and the digital divide. *Health Affairs.* 2000; 19(6): 255-265.

15. Wyatt JC. Will improved clinical information help realise the new NHS ? *BMJ.* 1998; 316: 298 – 299.

16. Iglehart JK. Global Health Policy And Free Access To Information. *Health Affairs*. 2004; 23(3): 7-8.

17. Goldsmith J. How will the Internet change our health system? *Health Affairs*. 2000; 19(1): 148-156.

18. De Jaegher K. Microeconomic Aspects of SID in Healthcare. Dissertation, Vrije Universiteit Brussel, 2002.

19. Calcott P. Demand Inducement as Cheap Talk. *Health Economics*. 1999; 8: 721-733.

20. Carlsen F, Grytten J. Consumer Satisfaction and Supplier Induced Demand. *Journal of Health Economics*. 2000; 19: 731-753.

21. Evans RG. Supplier-Induced Demand: Some Empirical Evidence and Implications. In Perlan, M. (Ed.), The Economics of Health and Medical Care. London, UK, Macmillan, 1974: 162-173.

22. Farley PJ. Theories of the Price and Quantity of Physician Services: A Synthesis and Critique. *Journal of Health Economics.* 1986; 5(4): 315-333.

23. Dranove D. Demand Inducement and the Physician/Patient Relationship. *Economic Inquiry*. 1988; 26(2): 281-298.

24. De Jaegher K, Jegers M. The Physician-Patient Relationship as a Game of Strategic Information Transmission. *Health Economics*. 2001; 10: 651-668.

25. Towle A, Godolphin W. Framework for teaching and learning informed shared decision making. *BMJ*. 1999; 319: 766-771.

26. Wade JC. Perspective: The Patient/Physician Relationship: One Doctor's View. *Health Affairs*. 1995; 14(4): 209-212.

27. Redelmeier DA, Rozin P, Kahneman D. Understanding Patients' Decisions. *JAMA*. 1993; 270 (2): 72-76.

28. Degner et al. Information needs and decisional preferences in women with breast cancer. *JAMA*. 1997; 277: 1485-1492.

29. Eaton L. A third of Europeans and almost half of Americans use internet for health information. *BMJ.* 2002; 325: 989.

30. Ziebland S, Chapple A, Dumelow C, Evans J, Prinjha S, Rozmovits L. How the internet affects patients' experience of cancer: a qualitative study. *BMJ.* 2004; 328(7439): 564.

31. Smith R. The future of health care systems. *BMJ*. 1997; 314:1495-1496.

32. Berry LL, Seiders K, Wilder SS. Innovations in Access to Care: A Patient-Centered Approach. *Ann Intern Med*. 2003; 139: 568 - 574.

33. Charles C, Gafni A, Whelan T. Decision-making in the physician-patient encounter: revisiting the shared treatment decision-making model. *Soc Sci Med*. 1999; 49: 651-661.

34. Charles C, Gafnv A. Shared Decision-Making In The Medical Encounter: What Does It Mean? (Or It Takes At Least Two To Tango). *Soc. Sci. Med*. 1997; 44(5): 681-692.

35. Department of Health. The expert patient: a new approach to chronic disease management for the 21st century. London: DoH, 2001: 12.

36. Institute of Medicine, Crossing the Quality Chasm: A New Health System for the Twenty-first Century. National Academy Press, Washington, 2001.

37. Kassirer JP. Patients, Physicians, and the Internet. *Health Affairs.* 2000; 115–123.

38. Peter G et al. The International Registry of Acute Aortic Dissection (IRAD): New Insights Into an Old Disease. *JAMA*. 2000; 283: 897 – 903.

39. Rashbass J. The Patient-Owned, Population-Based Electronic Medical Record: A Revolutionary Resource for Clinical Medicine. *JAMA*. 2001; 285: 1769.

40. Roger VL et al. Sex Differences in Evaluation and Outcome of Unstable Angina. *JAMA*. 2000; 283: 646 - 652.

41. Yancik R et al. Effect of Age and Comorbidity in Postmenopausal Breast Cancer Patients Aged 55 Years and Older. *JAMA*. 2001; 285: 885 - 892.

42. Stapleton H, Kirkham M, Thomas G. Qualitative study of evidence based leaflets in maternity care. *BMJ*. 2002; 324: 639-643.

43. Mechanic D., McAlpine D. D., Rosenthal M.Are Patients' Office Visits with Physicians Getting Shorter? *N Engl J Med.* 2001; 344:198-204.

44. A second revolutionary period. In: Ludmerer KM. Time to heal: American medical education from the turn of the century to the era of managed care. New York: Oxford University Press, 1999; 370-399.

45. Burdi MD, Baker LC. Physicians' perceptions of autonomy and satisfaction in California. *Health Affairs.* 1999; 18(4):134-45.

46. Hadley J, Mitchell JM, Sulmasy DP, Bloche MG. Perceived financial incentives, HMO market penetration, and physicians' practice styles and satisfaction. *Health Service Research*. 1999; 34: 307-321.

47. McKinstry B. Do patients wish to be involved in decision making in the consultation? A cross sectional survey with video vignettes. *BMJ*. 2000; 321: 867 - 871.

48. Cotton SR and Gupta SS. Characteristics of online and offline health information seekers and factors that discriminate between them. *Social Science & Medicine.* 2004; 59: 1795-1806.

49. Kakai H, Maskarinec G, Shumay DM, Tatsumura Y, Tasaki K. Ethnic Differences in choices of health information by cancer patients using complementary and alternative medicine: an exploratory study with correspondence analysis. *Social Science & Medicine*. 2003; 56: 851-862.

50. Ende J et al. Measuring Patients' Desire for Autonomy: Decision-Making and Information-Seeking Preferences among Medical Patients. *Journal of General Internal Medicine*. 1989; 4: 23- 30.

51. Bruera E, Sweeney C, Calder K, Palmer L, Benisch-Tolley S. Patient preferences versus physician perceptions of treatment decisions in cancer care. *J Clin Onol.* 2001; 19: 2883-2885.

52. Gattellari M, Butow PN, Tattersall MH. Sharing decisions in cancer care. *Soc Sci Med.* 2001; 52: 1865-1678.

53. Dilts DM, Murphy B. Will Cancer Patients Use E-Mail for Medical Communication: Part II Characteristics of Patients Most Likely to Show Interest. under review at *Journal of Clinical Oncology.*

54. Rothenbacher D, Lutz MP, Porzsolt F. Decisions in Palliative Cancer Care: Ptients' Treatment Preferences for Involvement and Doctors' Knowledge About It. *European Journal of Cancer*. 1997; 33(8):1184-1189.

55. Arora NK. Interacting with cancer patients: the significance of physicians' communication behavior. *Social Science Medicine*. 2003; 57: 791-806.

56. Frosch DL, Kaplan RM. Shared Decision Making in Clinical Medicine: Past Research and Future Directions. *American Journal of Preventive Medicine*. 1999; 17(4): 285-294.

57. Akerlof G. The Market for Lemons: Quality Uncertainty and the Market Mechanism. *Quarterly Journal of Economics*. 1970; 84: 488-500.

58. Farrell J. Talk is Cheap. *American Economic Review*. 1995; 85: 186-190.

59. Rothchild M, Stiglitz J. Equilibrium in Competitive Insurance Markets: An Essay on the Economics of Imperfect Information. *Quarterly Journal of Economics*. 1976; 90: 629-649.

60. Spence M. Job Market Signalling. *Quarterly Journal of Economics*. 1973; 87: 355-374.

61. Molho I. The Economics of Information: Lying and Cheating in Markets and Organizations. Blackwell Publishers Ltd. Oxford, UK 1997.

62. Stigler GJ. The Economics of Information. *Journal of Political Economy*. 1961; 213-225.

63. Lancaster KJ. A New Approach to Consumer Theory. *Journal of Political Economy*. 1966; 74(2): 132-157.

64. Schulman KA, Berlin JA, Harless W, et al. The effect of race and sex on physicians' recommendations for cardiac catheterization. *N Engl J Med*. 1999; 340: 618-26.

65. Wenneker M, Epstein AM. Racial inequalities in the use of procedures for patients with ischemic heart disease in Massachusetts. *JAMA*. 1989; 261: 253-257.

66. Gornick ME, Eggers PW, Reilly TW, et al. Effects of race and income on mortality and use of services among Medicare beneficiaries. *N Engl J Med.* 1996; 335: 791-799.

67. Whittle J, Conigliaro J, Good CB, Lofgren RP. Racial differences in the use of invasive cardiovascular procedures in the Department of Veterans Affairs medical system. *N Engl J Med*. 1993; 329: 621-627.

68. Peterson ED, Shaw LK, DeLong ER, Pryor DB, Califf RM, Mark DB. Racial variation in the use of coronary-revascularization procedures: are the differences real? Do they matter? *N Engl J Med.* 1997; 336: 480-486.

69. Coulter A, Seagroatt V, McPherson K. Relation between general practices' outpatient referral rates and rates of elective admission to hospital. *BMJ*. 1990; 301(6746): 273-276.

70. Baicker K, Chandra A, Skinner JS, and Wennberg JE. Who You Are And Where You Live: How Race And Geography Affect The Treatment Of Medicare Beneficiaries. *Health Affairs Web Exclusive.* October 7, 2004.

71. Dimick JB, Finlayson SRG, and Birkmeyer JD. Regional Availability Of High-Volume Hospitals For Major Surgery. *Health Affairs Web Exclusive*. October 7, 2004.

72. O'Connor AM, Llewellyn-Thomas HA, and Flood AB. Modifying Unwarranted Variations In Health Care: Shared Decision Making Using Patient Decision Aids. *Health Affairs Web Exclusive*. October 7, 2004.

73. Wennberg JE. Perspective: Practice Variations And Health Care Reform: Connecting The Dots. *Health Affairs Web Exclusive*. October 7, 2004.

74. Weinstein JN, Bronner KK, Morgan TS, and Wennberg JE. Trends: Trends And Geographic Variations In Major Surgery For Degenerative Diseases Of The Hip, Knee, And Spine. *Health Affairs Web Exclusive*. October 7, 2004.

75. Goodman DC. Trends: Twenty-Year Trends In Regional Variations In The U.S. Physician Workforce. *Health Affairs Web Exclusive*. October 7, 2004.

76. Berenson RA. Perspective: Lumpers And Splitters: Different Approaches To Understanding Variations Research. *Health Affairs Web Exclusive*. October 7, 2004.

77. Fuchs VR. Perspective: More Variation In Use Of Care, More Flat-Of-The-Curve Medicine. *Health Affairs Web Exclusive*. October 7, 2004.

78. Phelps, CE. Physician Agency. In Newhouse JP and Curlyer, AJ (eds). *Handbook for Health Economics;* 2000.

79. Phelps, CE, Mooney C. Variations in Medical Practice Use. In Arnould RJ, Rich RF and White WD (eds), Competitive Approachs to Health Care Reform. University Press of America, Lanham, MD, 1993.

80. Saha S, Taggart SH, Komaromy M, Bindman AB. Do patients choose physicians of their own race? *Health Affairs.* 2000; 19(4): 76-83.

81. Cooper LA, Roter DL, Johnson RL, Ford DE, Steinwachs DM, Powe NR. Patient-Centered Communication, Ratings of Care, and Concordance of Patient and Physician Race. *Ann Intern Med.* 2003; 139: 907 - 915.

82. Bach PB, Hoangmai H. Schrag D, Tate RC, Hargraves JL. Primary Care Physicians Who Treat Blacks and Whites. *New England Journal of Medicine.* 2004; 351: 575-84.

83. Blumenthal D. Effects of market reforms on doctors and their patients. *Health Affairs.* 1996; 15(2): 170-184.

84. Feldstein PJ, Wickizer TJ, Wheeler JRC. The Effects of Utilization Review Programs on Health Care Use and Expenditures. *New England Journal of Medicine.* 1988; 318 (20): 1310-1314.

85. Hillman AL, Pauly MV, Kerstein JJ. How Do Financial Incentives Affect Physicians' Clinical Decisions and the Financial Performance of Health Maintenance Organizations? *New England Journal of Medicine.* 1989; 321 (2): 86-92.

CHAPTER II

THEORETICAL INVESTIGATION

Introduction

Recent studies indicate that patients not only obtain medical information from the Internet and other sources but also use this information to influence their clinical medical decisions [1-3]. Studies also show that physicians may respond to such patient-obtained medical information (POMI), as some physicians are even willing to order treatments, tests, or procedures that they would not otherwise order [4-5]. So POMI impacts the physician-patient relationship, as existing studies in the health economics predicted [6-10] and as studies in medical practice and health policy suggested or confirmed [11-15]. These studies also suggested that the physician's reaction would be based on an individual patient's POMI by linking a patient's interaction with the physician and/or the resulting utilization directly to the patient's POMI [6-15].

But we have reasons to believe that physicians may be unable to perfectly observe an individual patient's POMI and instead rely heavily on the patient's demographic, socioeconomic and/or health characteristics as imperfect signals for the patient's POMI [16-18]. Such reasons include physicians' time constrains [19-21] or the patients' collecting information from physician-independent sources *after* receiving a physician's treatment recommendation but before accepting such treatment [22-24]. If this is the case, the physician is actually reacting to the POMI of a patient population (i.e., patients with certain demographic, socioeconomic and/or health characteristics), not to the POMI of a particular patient. In other words, when a physician interacts with a patient, she sees the patient as one member of a patient group (population) with similar demographic, socioeconomic and/or health characteristics, and she uses the population POMI as surrogate for the POMI of this particular patient. The practice of using the characteristics of a patient population as surrogate for characteristics of a particular patient has been widely reported in the medical literature, as patients' demographic and/or socioeconomic characteristics are often used in medical registry or other forms of practice guidance to guide physician practice [25-28].

When the physician uses such a surrogate, the interaction between the physician and the patient may be different from the results of existing models, where the physician reacts to the POMI of the particular patient. In this study, we investigated such physician-patient interaction in which the physician relies on the POMI of a patient population as surrogate for the POMI of the patient. Using a game-theoretic approach, we found that when there are two levels of POMI in the population, one information level will be "dominant" in the sense that the physician will treat the entire population in the same way, decided solely by that information level.

Which information level becomes the dominant information level is determined by several factors, including the quality of information at each level, the relative number of patients at each information level, and the physician's and patients' payoffs. When the low information level is the "dominant" level (i.e., when few patients are well-informed), introducing additional well-informed patients to the population discontinuously affects the physician's strategy, having no effect unless a sufficient quantity of patients is added. Increasing the precision of the information level of the few well-informed patients has no effect on the physician's strategy. Alternately, when the high information level is the "dominant" level (i.e., when a sufficient number of well-informed patients exist), increasing the precision of their information allows all patients to free-ride by receiving more appropriate treatment recommendations. Counterintuitively, we also identify circumstances under which increasing the general level of information may potentially harm patients.

Literature

A series of models known as the supplier-induced demand (SID) literature was developed over the past several decades to study the physician-patient relationship when there exist information asymmetry and a conflict of interest between the physician and the patient. While criticism persists [29], the SID literature still attracts interest and has evolved over time.

Originally, physician-patient interactions were modeled as individual decision-making processes in which the physician prescribes treatment to maximize profit while the patient is assumed to accept the physician's recommendation. Evans [6] demonstrates that the physician induces the patient to buy more medical care than the patient would demand in the absence of information asymmetries. Farley [7] finds that even when the physician's incentives directly incorporate the patient's utility function, demand inducement beyond optimal levels still results.

Recent game theoretic models recognize that patients may also act strategically. Patient-physician encounters become an interaction between two asymmetrically-informed decision makers each acting to maximize his or her respective utility [8-9]. These approaches provide insight into the strategic situation physicians and patients face when information is asymmetric and their interests do not fully coincide. Dranove [8] endows the patient with some (albeit imperfect) information which is used to evaluate the prescribed treatment and potentially reject the demand set by the physician. Equilibrium demand induced by the physician is still higher than what the patient deems optimal but it depends on the level of a patient's initial information. The more accurate such information is, the closer equilibrium demand is to the patient's optimal level. Following the ideas of strategic information transmission from Crawford and Sobel [30] and Pitchik and Schotter [31], De Jaegher and Jegers [9] model the physician-patient relationship as a game of strategic information transmission. While the patient is uninformed about his optimal treatment, his ability to make the final decision as to which treatment option to choose compels the physician to reveal some information in equilibrium. One additional contribution of De Jaegher and Jegers [9] is that they used ideas of credence goods [32] to allow for inducement. Their argument is that only when the patient is unable to tell even *ex post* the effectiveness of at least some treatment options (i.e., such treatments are credence goods) is the SID hypothesis relevant.

We adopt the approach of De Jaegher and Jegers [9], assuming that the physician knows with certainty a patient's true medical state but recommends a treatment option strategically. In modeling patients' medical information, we use an approach similar to Dranove [8], where quality of information is reflected in the accuracy of his estimate about his medical state. In our model, information serves the sole purpose of increasing the accuracy, or level of confidence, of the patient's estimation about his medical state, and his medical state is defined as which treatment option is the best for him. De Jaegher [10] extended their original paper [9] by adding patient information, but in his model, information is added as a "cue" from Nature so the information is either present or not without the possibility of modeling various levels of information, and the focus in his model is to see how adding patient information to their one-to-one model would change their original result. In our model, the focus is on how information distribution among the population impact the interaction. So we extend both models by introducing a patient population within which there are multiple levels of information. By modeling this way, we are able to setup and vary multiple levels of information to study the impact of such changes on the physician-patient relationship. By taking a similar approach to existing models, we isolate the role of heterogeneously informed patient populations on the physician-patient interaction.

Conceptual Overview of the Model

While most patients prefer having POMI [3], the impact of POMI on the physician-patient relationship depends greatly on the situation. It is conceivable that there are situations when the patient may not have either the incentive (e.g., minor condition such as cold) or time (e.g., time critical condition such as internal bleeding) to use POMI to challenge/influence the physician or to seek a second opinion when not satisfied, or when the patient's condition is so critical (e.g., heart attack) or expected outcomes of some treatment options are likely to lead to malpractice lawsuits (e.g., prescription of large dose of Celebrex) that concerns over the patient's welfare and/or possible malpractice lawsuits are likely to overweigh any personal preference of the physician. In situations like these, POMI may have minimal impacts on the interaction.

On the other hand, there are many situations where POMI impacts the interaction significantly. An example would be when the patient's condition is serious but not urgent, and none of the treatment option is the obvious optimal choice. In such a situation the patient has incentive to gather POMI and POMI would have significant impact on the interaction because the physician has incentive to use her superior information to pursue her own preference and the patient has incentive to use POMI to counteract the physician's behavior.

We conceive of a population of patients who share a common medical condition and a physician who treats such patients. Two treatment options (A and B) are available, with the physician preferring one (B) to the other (A). There are many possible reasons for the physician's preference, including limited resource for a particular option or a desire for increased monetary return. Patients do not always share this preference; they desire the option that brings them the most individual benefit. Prior to the physician visit, patients gather information and make an estimation of the two available options. Different patients may prefer different treatment options, and such differences may depend on such factors as a patient's lifestyle, resilience to side effects, and risk tolerance. During the encounter, the physician and the patient exchange information and make a decision on which treatment option to implement. As Charles et al pointed out [33], in such a shared-decision making process when the two parties have different information and treatment preferences, they may agree on a treatment option, or they may fail to reach agreement and the patient has to go to another physician.

The results of such shared-decision making process obviously depend on the structure of the process, but to the extend that such process can be modeled as formal bargaining process, it can be shown that under reasonable assumptions and certain conditions, the bargaining process can be effectively modeled as a "take-it-or-leave-it" model in which the physician makes a "take-it-or-leave-it" offer and the patient can either accept and receive the offered treatment or reject and go to another physician.

To begin with, given the facts that the physician is the expert and the gatekeeper of the healthcare system, it is reasonable to assume that only the physician can make offers. Moreover, given the fact that a typical physician-patient interaction takes about 15 minutes [19-21], it is reasonable to assume the time cost of delaying agreement takes the form of possible termination of bargaining after the first round if no agreement has been reached, as discounting future payoff is not appropriate for such a short time period. Finally, given the fact that there is only one way for the two players to share the surplus if trade occurs (i.e., the physician keeps the payoff from performing the agreed-upon treatment, while the patient keeps the payoff of receiving such treatment), it is reasonable to assume that the physician's offer is in the form of the probability of "truth-telling" (i.e., $\pi(A \mid \alpha)$ in a mixed strategy. We will give a more formal definition of this degree of "truth-telling" shortly after).

Given the information structure of the model, it will be shown in Appendix A.4 that in equilibrium, if agreement can be reached, it will be reached within two periods since there is no reason to postpone agreement after two periods. The existence of the second period depends on the relative values of the parameters. If screening cannot occur, in equilibrium the bargaining will end in the first round; otherwise, in equilibrium the physician makes an offer in the first round which is accepted by the lesser-informed patient but rejected by the more informed patient, and she makes another offer in the second period if bargaining is not terminated and such offer is accepted by the more informed patient. If the physician can successfully screen different types of patients, then the equilibrium results of the first type to be screened would be different than those under full information, but the equilibrium results of the second type to be screened would be the same as those under full information.

Since the results under full information have been widely studied [8-9], this paper focuses on the situation where the physician cannot successfully screen different types of patients. Such focus is further justified because when the number of types of patients increase, the physician's ability and willingness to screen decreases, and empirical evidences show that physicians' ability to distinguish the information levels of patients with similar socioeconomic and health characteristics is very limited [16-18]. So we model the physician-patient interaction as "take it or leave it" nature; the physician makes a treatment recommendation, the patient can then either accept or reject the recommended treatment but may not negotiate with the physician to reconsider.

Since patients may prefer A or B depending on various factors, the physician actually faces two subgroups of patients, one initially preferring treatment A, the other B. Note that within each subgroup, different patients may have different confidence levels of their initial assessments, although every patient within the subgroup shares the same initial assessment.

When these two subgroups of patients visit the physician, the interactions are quite different. For patients who initially prefer treatment B, the same as the physician, the interaction would be straightforward: the patient requests treatment B and the physician happily obliges. While it is possible that some patients in this subgroup are better served by treatment A, there is no reason for the physician to recommend A since patients will certainly accept B. On the other hand, the interaction between the physician and patients whose preferences are opposite to hers exhibits tension: the physician has to persuade the patients to change their minds if she wants them to take her preferred option. Thus, the amount of information conveyed in a physician's recommendation becomes of central importance. For this reason, we focus our attention on the interaction between a physician and the subgroup of patients whose initial preference is for treatment A, contrary to the physician's interest. In the rest of this paper, a "patient" or "patient population" will refer to this subgroup.

The likelihood that a patient will accept the physician's recommendation depends on how certain the patient is about his state, which, in turn, depends on the quality of information the patient has gathered. While physicians are endowed with superior medical information, the possibility that the physician's interests may differ from the patient's leads patients to keep a cautious ear when considering the physician's recommendation. Such suspicion, in turn, makes the physician think twice before recommending a non-preferred option because doing so regardless of an individual patient's situation will lead patients to reject the physician's services outright.

If all patients are similarly informed, existing models describe the resulting physician-patient interaction [8, 9]. We envision different patients within the same socioeconomic group potentially having varying levels of information. Sacchetti and Zvara [34], for example, note the quality differences of medical information patients obtained on the Internet. Alternatively, we can think of dissimilar qualities of information resulting from different predictive powers of various screening tests patients may undertake. Some patients may be quite informed about the treatment options due to accessibility to information or their ability to adequately research and assimilate such information. These patients can have a fairly accurate assessment as to which option is best for them, and they may be unwilling to follow the physician's recommendation if that recommendation differs from what they believe is best for them. Other patients may be particularly uninformed and tend to follow the physician's recommendation even if it differs from their initial beliefs. Certainly, the physician's incentive to recommend the "right" treatment from the patient's perspective is greater when facing a more informed patient who is more likely to reject a less desirable suggestion.

Model

We study the interaction between a physician and a patient population, and we focus on how the physician will act when she does not or cannot observe the information level of an individual patient and therefore must balance the greater value captured from ill informed patients against a greater chance of rejection from well informed patients. We model the interaction as a Bayesian game of incomplete information [35, 36, 37]. The physician knows only the distribution of information levels in the patient population.

Each patient is in one of two *states*, either α or β, corresponding to the patient's best treatment option, *A* or *B*. Thus, a patient in state α is best serviced by treatment *A* and treatment *B* is best for patients in state β. We denote the set of patient states by $S \equiv \{\alpha, \beta\}$ with arbitrary element *s* and the set of treatment options by $T \equiv \{A,B,0\}$ with arbitrary element *t* where $t=0$ reflects *no treatment*. Patients are unaware of their state but the physician, who is assumed to have perfect information about the patients' medical condition, assesses the state with complete accuracy. Denoted by $u(t|s)$ is the patient's utility from receiving treatment *t* when he is in state *s*.

Assumption 1. $u(A \mid \alpha) > u(0 \mid \alpha) = 0 > u(B \mid \alpha)$ and $u(B \mid \beta) > u(0 \mid \beta) = 0 > u(A \mid \beta)$.

We interpret the treatment t=0 as rejecting the physician's recommendation and normalize its utility to 0. The utility $u(0|s)$ may be thought of as the cost of rejecting the recommendation and going to another physician. The assumption that both $u(0|\alpha)$ and $u(0|\beta)$ are equal to zero is made to simplify the analysis but is not important to the nature of the equilibrium under study. Further, we assume that obtaining the less desirable treatment is strictly worse than rejecting the current recommendation and getting another chance for the desired treatment. Otherwise, the patient will accept any recommendation by the physician which in turn implies that the physician will always recommend her preferred treatment.

Prior to their accepting any physician recommendations, patients obtain medical information which provides some imperfect information about their state. We consider two types of patients, *high types* with more accurate information and *low types* with worse information, denoted by $i \in \{h,l\}$. A patient is a high type with probability *q* and a low type with probability 1-*q*. A patient of type i has a likelihood of being in state α given by $p_i \equiv \Pr\{s = \alpha \mid i\}$. A patient with high information is more likely to be correct about his true state $(1 \geq p_h > p_l > 0)$. We are interested in situations in which the interests of the patients and the physician diverge. Thus, we assume that a physician always prefers treatment *B* while the patient population of interest initially prefers treatment *A*.

Assumption 2: $p_h u(A \mid \alpha) + (1 - p_h) u(A \mid \beta) > p_l u(A \mid \alpha) + (1 - p_l) u(A \mid \beta)$

$> \quad 0$

$> \quad p_l u(B \mid \alpha) + (1 - p_l) u(B \mid \beta) > p_h u(B \mid \alpha) + (1 - p_h) u(B \mid \beta)$

Assumption 2 implies that prior to the encounter with a physician, patients prefer treatment *A* to *0* to *B*. Also, better informed, high type patients have stronger preferences than low types. Better information implies a greater certainty that one is in state α and thus a greater expected utility from accepting treatment *A*. Denote by *v(t)* the physician's utility from performing treatment *t*. Since we wish to focus on disjoint patients' and physician's interests, we assume that *v(B)>v(A)>v(0)* and normalize *v(0)=0*. To summarize the timing of the game:

1. Nature determines the patient's type, or information level, $i \in \{h,l\}$ with $\Pr\{i=h\}=q$. The type is observed by the patient but not the physician. Nature also determines the patient's state, $s \in \{\alpha, \beta\}$ with $\Pr\{s = \alpha \mid i\} = p_i$. The state is observed only by the physician.
2. The physician recommends a treatment option *t* from two possible options *A* and *B*.
3. The patient either accepts or rejects this recommendation.
4. The players receive their payoffs $v(t), u(t \mid s)$.

The extensive form representation (game tree) of this game is shown in Figure 2.1. In the next section we proceed to locate a Perfect Bayesian equilibrium.

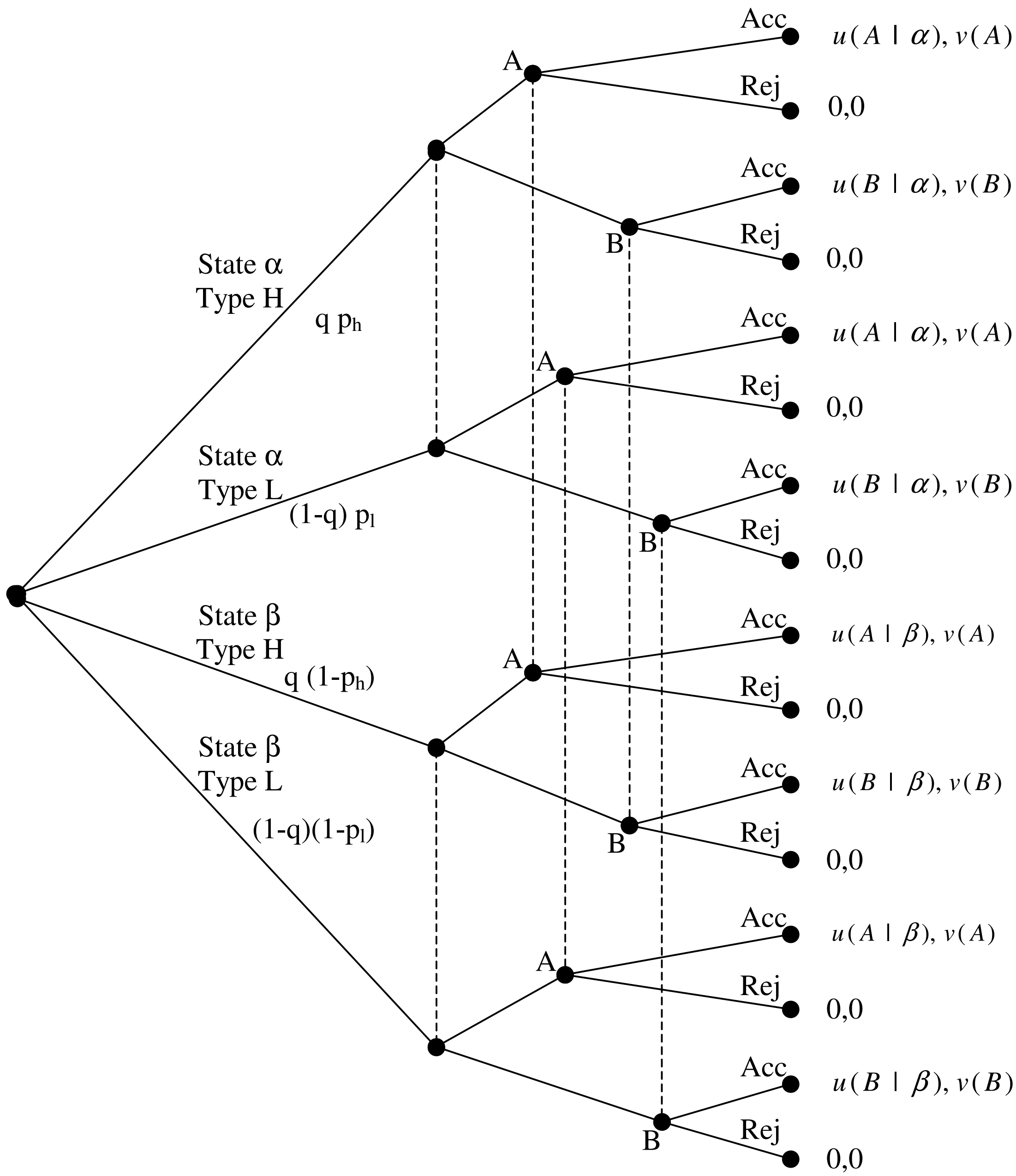

Figure 2.1 The extensive form of the game

Equilibrium Analysis

Physician's Strategy Space

The physician has four possible pure strategies in the form of recommending one of two treatments *t* upon observing one of two states *s*. Denote by $\pi(t \mid s)$ the probability with which the physician recommends treatment *t* in state *s*. A mixed strategy profile for the physician is represented by the pair $\pi(A \mid \alpha)$ and $\pi(B \mid \beta)$ indicating the likelihood that a physician prescribes treatment *A* (*B*) when the patient is in state α (β). We define the level of information transmission from the physician to the patient as:

$$I = \pi(A \mid \alpha) \times \pi(B \mid \beta)$$

Obviously, $0 \leq I \leq 1$. $I = 0$ implies that there is no information transmission in the interaction; $I = 1$ implies that the physician's recommendation perfectly and accurately reveals the patient's state (please note that when $\pi(A \mid \alpha) = \pi(B \mid \beta) = 0$, we have $I = 0$ but technically one could argue that there is perfect information transmission since the patient can infer perfectly his true state. But since we would never expect a physician to act in such a way as always lie to the patient, we can safely ignore such situation.). We use *I* as a key indictor of the physician-patient relationship and physician behavior (in fact, we will show in Proposition 6 later in this section that *I* is proportional to patient welfare, so *I* captures both the level of information transmission and the level of patient welfare). Because the physician has strictly ordered preferences over the treatments, $v(B)>v(A)>0$, perfect information transmission (I=1) cannot occur in equilibrium , as noted in the following proposition.

Proposition 1. In equilibrium, $I<1$

The proof of this and all other propositions is in the appendix.

Patient's Strategy Space

Each patient type (low and high information) has four possible pure strategies, in the form of accepting or rejecting each of the two possible recommendations. Denote by $\pi_i(t)$ the probability that a patient of type $i \in \{h,l\}$ accepts recommendation $t \in \{A,B\}$. Thus, a strategy profile for the patient consists of a four-tuple, $\{\pi_h(A), \pi_h(B), \pi_l(A), \pi_l(B)\}$.

The values of $\pi_h(A)$ and $\pi_h(B)$ or $\pi_l(A)$ and $\pi_l(B)$ reflect the level of trust patients place in the physician: larger values indicate a greater willingness to accept the physician's recommendations. Because a high type patient is more certain about his state than a low type $(p_h > p_l)$, we have the following relationship when both options are recommended with positive probabilities:

Proposition 2. In any equilibrium in which both treatment options are recommended with positive probability, we have:

(i) $\pi_l(A) > 0 \Rightarrow \pi_h(A) = 1$

(ii) $\pi_h(A) < 1 \Rightarrow \pi_l(A) = 0$

(iii) $\pi_h(B) > 0 \Rightarrow \pi_l(B) = 1$

(iv) $\pi_l(B) < 1 \Rightarrow \pi_h(B) = 0$.

Corollary 2.1. In equilibrium, $\pi_h(A) \geq \pi_l(A)$, $\pi_h(B) \leq \pi_l(B)$.

Part (i) of Proposition 2 arises because, if $\pi_l(A) > 0$, a low type must view accepting treatment *A* at least as favorably as rejecting it. Since the high type is even more likely to be in state α (his prior is higher than the low type, by assumption 2), he can expect strictly positive expected utility from accepting treatment *A*. Similar arguments can be made to parts (ii) ~ (iv).

Corollary 2.2. In equilibrium, $\pi_h(B) < 1$.

Intuitively, if a highly-informed patient always accepted recommendation *B*, then low types would also accept recommendation *B*. Faced with *B* being universally accepted, the physician will find it profitable to always recommend *B*. But then both types of patients will find it profitable to always reject recommendation *B*, leading to a contradiction.

Equilibrium

The behavior of patients and physician from the previous two subsections allows us to deduce the equilibria of the physician-patient interaction game. Signaling games often permit a multiplicity of equilibria because the players can entertain a whole range of out-of-equilibrium beliefs. However, as we demonstrate below, all but one class of equilibria are quite unappealing. For example, a physician may believe that patients will always reject any of her recommendations. Then, the physician is indifferent between all of her strategies. An equilibrium is found in which the physician always misrepresents – proposes treatment A for patients in state β and treatment B for those in state α. Patients, of course, reject both recommendations, confirming the physician's beliefs.

While some such equilibria seem absurd, most nevertheless survive multiple refinements, including perfection [38] and sequential rationality [39]. In what follows below, we concentrate on one equilibrium in particular. Before turning to this equilibrium, in the appendix we carefully derive alternate equilibria. However, all other equilibria fall into one of two classes. First are equilibria in which patients reject all physicians' recommendations. Thus, the physician-patient interaction never yields any treatment option adopted by the patient, negating the role of the physician entirely. Second are equilibria in which the physician simply recommends the treatment that patients already believe to be the better option prior to the encounter with the physician. That is, the physician simply recommends treatment A to all patients, and all patients accept. This class of equilibria envisions the physician as an open pharmacy, dolling out whatever treatment the patient believes to be in his best interest. While such an outcome may be appealing in the sense that the patient always gets what he asks for, the physician's expert knowledge becomes worthless as the patient never gains from the physician's expertise.

Both of the alternate equilibria described above paint a stark picture of the physician-patient interaction. Either no treatment is accepted or the patient always receives what he desires. Even the latter scenario may be bad for the patient because even if he is wrong about his state, and even when informing him that he is wrong is in both his and the physician's interest, the physician refrains from passing along this information. Below, we present the candidate equilibrium which does not suffer from the above drawbacks, and then note several reasons for selecting this candidate equilibrium.

Proposition 3: The following is an equilibrium of the patient-physician interaction game:

$$\pi(B \mid \beta) = \pi_h(A) = \pi_l(A) = 1$$

$$\pi_h(B) = \begin{cases} 0 & q \leq q^* \\ \dfrac{v(A)}{v(B)} - \dfrac{p_l}{p_h}\dfrac{(1-q)}{q}\left[1 - \dfrac{v(A)}{v(B)}\right] & q > q^* \end{cases}$$

$$\pi_l(B) = \begin{cases} \dfrac{v(A)}{v(B)}\left[1 + \dfrac{p_h}{p_l}\dfrac{q}{(1-q)}\right] & q < q^* \\ 1 & q \geq q^* \end{cases}$$

$$\pi(A \mid \alpha) = \begin{cases} 1 + \dfrac{(1-p_l)}{p_l}\dfrac{u(B \mid \beta)}{u(B \mid \alpha)} & q < q^* \\ 1 + \dfrac{(1-p_h)}{p_h}\dfrac{u(B \mid \beta)}{u(B \mid \alpha)} & q > q^* \end{cases}$$

$$\pi(A \mid \alpha) \in \left[1 + \frac{(1-p_l)}{p_l}\frac{u(B \mid \beta)}{u(B \mid \alpha)}, \cdots, 1 + \frac{(1-p_h)}{p_h}\frac{u(B \mid \beta)}{u(B \mid \alpha)}\right] \quad q = q^*$$

where

$$q^* = \frac{V(A) - V(B)}{\dfrac{p_h}{p_l}V(A) + [V(B) - V(A)]}$$

The equilibrium strategies depend on the value of q, the proportion of the population with high information. Specifically, the frequency with which the physician recommends option A to type α patients and the probability with which patients accept treatment B depends on whether the proportion of high types is above or below a critical threshold q^*. The implications of this equilibrium are presented in the next section. First, we note several properties of this equilibrium that are not shared by the other equilibria discussed above and presented in the appendix.

The equilibrium of Proposition 3 is the only equilibrium in which the physician's strategy conveys any useful information and it is the only equilibrium in which both treatment options are accepted by patients with positive probability. These properties suggest that the physician-patient relationship, while not perfect (in the sense of the information transmission level being less than one), is more than a buyer-seller relationship. The properties also suggest that when a patient goes to a physician, he is willing to listen to the physician, albeit suspiciously, and the physician is willing to take the patient's demand into account, albeit not fully as there exists a conflict of interest. It is our belief that real-world physician-patient interactions, while not perfect because of possible conflicts of interest and information asymmetry, do achieve a positive level of trust and information transmission as predicted by this equilibrium.

Proposition 4. The candidate equilibrium is the only equilibrium in which the information transmission level I is strictly greater than 0.

The parameter I is also an indictor of the physician-patient relationship and physician behavior. When $I = 0$, the patient gains no information from the relationship, and the physician does not take the patient's interest into account at all.

Beyond being the only equilibrium with positive information transmission, we may appeal to focal point theory to rule out other equilibria. If one equilibrium has some property that conspicuously distinguishes it from other equilibria (such as being Pareto optimal), and if this property is common knowledge among the players, then this equilibrium is likely to be the unique outcome [40]. The assumption that players can coordinate on a Pareto optimal (or payoff dominant) outcome has proven useful in many applications. For example, see Katz and Shapiro [41] in a network context and De Jaegher and Jegers [9] in a model underlying this work.

The candidate equilibrium has two focal properties. First, the physician receives higher expected profit in this equilibrium than in any other. As the first mover, it may be reasonable to conceive of the physician as selecting the equilibrium. Second, under specific conditions, this equilibrium Pareto dominates all others.

Proposition 5. The physician receives higher expected utility under the candidate equilibrium than under any other equilibrium. Further, the candidate equilibrium Pareto dominates all other equilibria when $p_h(1-p_l)u(A \mid \alpha)u(B \mid \beta) < p_l(1-p_h)u(A \mid \beta)u(B \mid \alpha)$.

While the information transmission is important, what matters most to policy makers is patient welfare. If we define patient welfare U as the expected utility of the patient in equilibrium, then in the candidate equilibrium, U is proportional to *I*, as indicated in Proposition 6 below.

Proposition 6. In the candidate equilibrium, $U = u(A \mid \alpha)I\left[qp_h + (1-q)p_l\right]$.

Please see appendix for proof. Because of this property, we will focus our attention on *I* in our discussion.

Information, Patient welfare and the Physician-Patient Relationship

In this section, we examine the properties of the established equilibrium outcome. First and foremost, we are concerned with patient welfare, U (or *I*, since U is proportional to *I*). Then, a successful efficient physician-patient encounter requires that the physician uncovers a patient's true type and the patient accepts the associated treatment option. Hence, the information transmission level, *I*, reflects the quality of physician-patient relationship as it denotes the amount of *candor* in the physician's recommendation. Further, the value of *I* may reflect the interests of public policy institutions for whom q, p_h and p_l may serve as policy instruments that can be changed by such institutions to achieve desired outcomes. In the text that follows, we will focus on *I*. Please note that because we focus on the patient population whose initial preference is option A, when we change the information level of some patients (p_h or p_l), or when we change the relative ratio of the two types of patients (q), we necessarily change the overall probability that option A is the true optimal option. The following four theorems establish the influence of POMI on the physician-patient relationship.

Theorem 1. In equilibrium,

$$\frac{\partial I}{\partial q} = 0 \text{ when } q \neq q^*.$$

That is, for constant information levels p_h and p_l, a local change in the proportion of well-informed patients will not impact the information transmission level.

The above theorem notes that the information transmission level, I, does not change with q except when q cross the threshold value q^*. Since the physician cannot observe a specific patient's information level, she treats every patient in the same way. How exactly would she treat every patient depends on the likelihood of encountering a patient of each type. On one hand, if almost all patients are low types (i.e., $q < q^*$, as shown in Figure 2.2 as patient population 1), there is little harm from inducing demand. On the other hand, if most are well-informed (i.e., $q > q^*$, as shown in Figure 2.2 as patient population 2), then the gains from prescribing the physician's preferred treatment even when it is not best for the patient are likely smaller than the losses from well-informed patients refusing such treatments. More specifically, she will act to make the high type indifferent between accepting and rejecting B recommendation if q is sufficiently large, and to make the low type indifferent if q is low. In the first case, the value of I depends only on p_h, and the second only on p_l. We call the high type in the first case or the low type in the second case the "dominant" type since the POMI level of such type dictates physician behavior. Figure 2.2 illustrates this result.

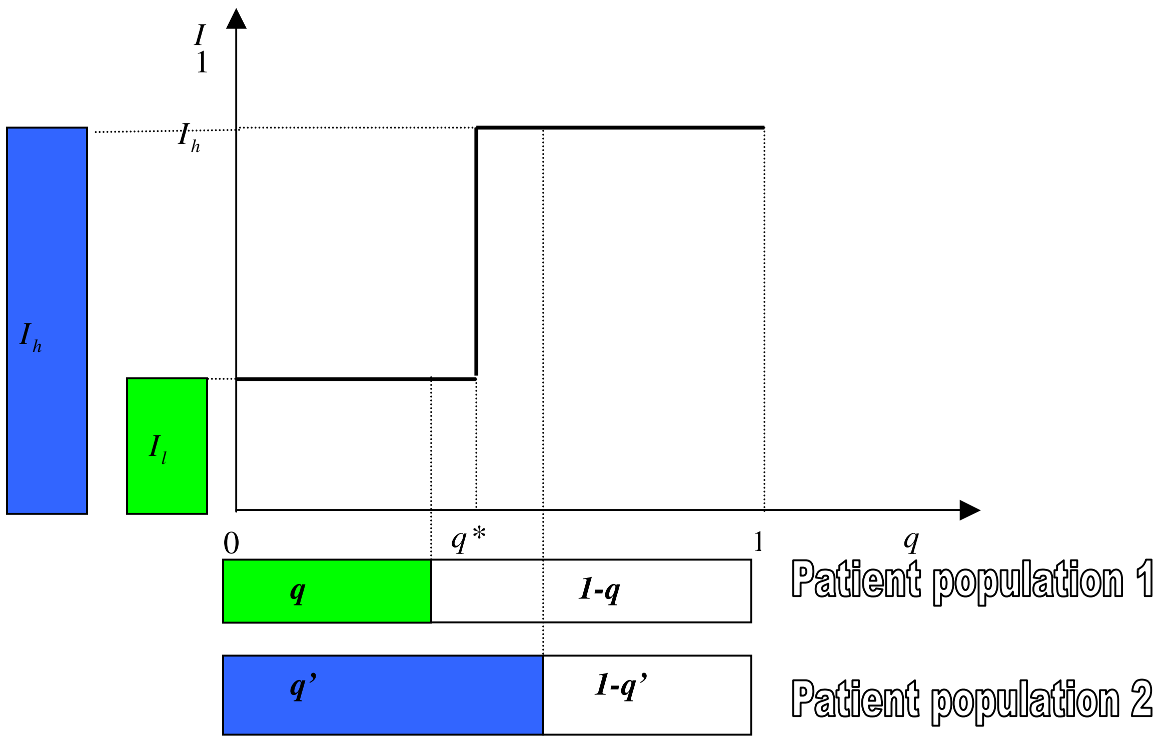

Figure 2.2 Impact of change in the proportion of well-informed patients (*q*) on the level of information transmission (*I*)

In some sense, the physician has two pre-defined strategies (represented by I_h and I_l), and when seeing a particular patient, she bases her choice of strategy on the perceived POMI characteristic of the patient population. When the patient population is perceived to have few highly informed patient ($q<q^*$, patient population 1 on Figure 2.2), the physician chooses I_l; when the patient population is perceived to have many highly informed patient ($q>q^*$, patient population 2 on Figure 2.2), the physician chooses I_h. In other words, there exist two separate regimes of the physician-patient relationship. We call them the "well-informed regime" and the "ill-informed regime". A change in q has no effect on I within a regime but may potentially shift us from one regime to the other.

Efforts to increase the quality of care (represented by the information transmission level *I*) by increasing the number of patients well-informed (direct-to-consumer advertising, public education programs, etc.) are effective only if the number of patients informed reaches a certain critical mass. Otherwise, the physician will just ignore the well-informed patients as long as the number of such patients remains small. So in efforts to help patients with lower socioeconomic status, it is very important to make sure that a large enough portion of such patients obtain POMI so that there will be significant change in physician behavior.

We now briefly discuss what (if anything) changes if we allow the patient to ask strategically for options. This would add another step to the game (the patient asks for an option) after nature moves but before the physician makes the recommendation. It can be shown (interested readers can show this by using an approach similar with that used in the appendix) that in equilibrium, a patient will always ask for A regardless of his initial preference, and a patient with initial preference of B will always accept the physician's recommendations regardless of his POMI level. So basically, in this expanded game, the physician will have three patient types (the original high type and low type plus the additional type of patients who prefer B), instead of two in the original model. But since in both models the physician cannot tell a patient's type, the equilibrium results are similar in both models. The physician will treat everyone the same way, to be decided by a "dominant" type. Since our main interest is the feature of the equilibrium, we can safely assume that patients always tell the physician their initial preferences.

The following result notes the impact of information precision on this critical value q^*.

Theorem 2. The threshold value q^* increases with p_l and decreases with p_h.

(i) $\frac{\partial q^*}{\partial p_l} > 0$; (ii) $\frac{\partial q^*}{\partial p_h} < 0$.

Theorem 2 notes that the threshold value is not exogenous but instead may be lowered either by increasing p_h or by decreasing p_l. This implies that changes in the information level potentially have two effects. The direct effect, of course, is that better information leads to less demand inducement by the physician and thus a higher level of information transmission. However, a secondary effect implies that changes in information levels may also influence the critical value q^* and bring about a regime change. These two effects are summarized in Theorems 3 and 4.

Theorem 3. In equilibrium,

(i) $\frac{\partial I}{\partial p_h} > 0$ when $q > q^*$;

(ii) $\frac{\partial I}{\partial p_h} = 0$ when $q < q^*$'.

(iii) for small ε>0, there exists a q<q^* such that $I|_{p_h} << I|_{p_h+\varepsilon}$

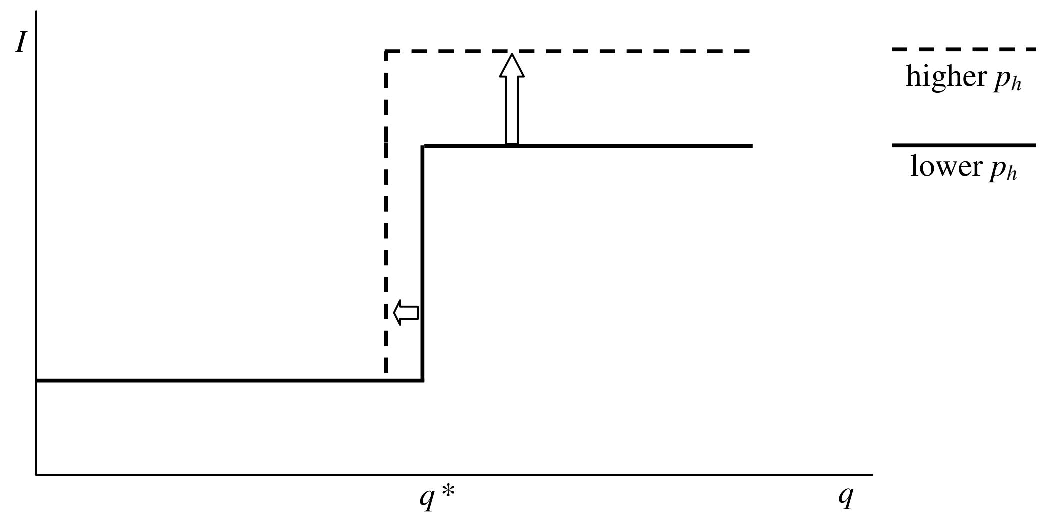

Figure 2.3 Impact of an increase in the precision of high-type information (*q*) on information transmission (*I*).

Theorem 3 suggests that a change in p_h has two effects. The primary effect is to increase the level of information transmission to the right of q^*. The secondary effect is to lower the threshold value of q for the well-informed regime. Thus, part (iii) of the theorem indicates that a small change in the precision of information may change the regime leading to a marked increase in the level of information transmission. Figure 2.3 illustrates this result.

Increasing p_h makes the well-informed patients even more informed. For example, if the Internet is used to increase distribution of information about clinical trial openings or new treatment options, then the patients with Internet access become more informed while leaving the general level of information among those without access unchanged. Theorem 3 indicates that such programs will have influence on the physician-patient relationship *only* when we are in or quite close to the well-informed regime. The effect is most drastic when the proportion of well-informed patients is just below the critical value. By raising the accuracy of information, physicians now find it optimal to concern themselves with the well-informed patients. This regime change increases the overall level of information transmission.

Theorem 4. In equilibrium,

(i) $\frac{\partial I}{\partial p_l} > 0$ when $q < q^*$'; (ii) $\frac{\partial I}{\partial p_l} = 0$ when $q > q^*$.

(iii) for small $\varepsilon>0$, there exists a $q>q^*$ such that $I\,|_{p_l} >> I\,|_{p_l+\varepsilon}$

Theorem 4 implies that better information precision among the lesser informed patients is only beneficial when in the ill-informed regime, or when the proportion of high types is sufficiently small. However, an increase in the precision of information can cause a *decrease* in the level of information transmission if the greater precision precipitates a regime change which makes physicians more cautious of these low types. This is demonstrated in Figure 2.4.

This result seems counter-intuitive as an increase in the general information level generally makes the physician more cautious. The reason lies in the heart of the physician's strategic calculation: in equilibrium, she makes one patient subgroup indifferent between rejecting and accepting her preferred recommendation B (i.e., she choose *I* between I_h and I_l). Since lesser informed patients are always more willing to accept treatment B than more informed ones, we have $I_h > I_l$. We also know that the higher q is, the more likely she will pick I_h, since picking I_l will force all more informed patients to reject her B recommendations. When there is just enough number of more informed patients to make I_h the best choice (i.e., the expect payoff from I_h is equal to or only marginally larger than that from I_l), an increase in p_l will make I_l more attractive, because while sticking to I_h would not change expected payoff, switching to I_l would increase expected payoff: increasing p_l will force I_l to increase, therefore inducing more lesser informed patients to accept recommendation B. Under such situation, increasing the information level of lesser informed patients will cause a decrease in the information transmission level *I*.

An increase in p_l implies raising the level of information among the least informed patients, possibly through health literacy education. Theorem 4 suggests that such programs will have influence on the physician-patient relationship only when we are in the ill-informed regime. However, the effect need not be positive. By increasing the general level of information, the physician may begin to care about the ill-informed patient when before, she concerned herself only with the well-informed. This regime change, bringing us from the well-informed regime to the ill-informed regime, implies that physician will switch her focus from the well-informed patients to the ill-informed ones, treating all patients as if they possess the lower level of information. This change will actually lower *I* and lead to less information transmission from the physician to the patient.

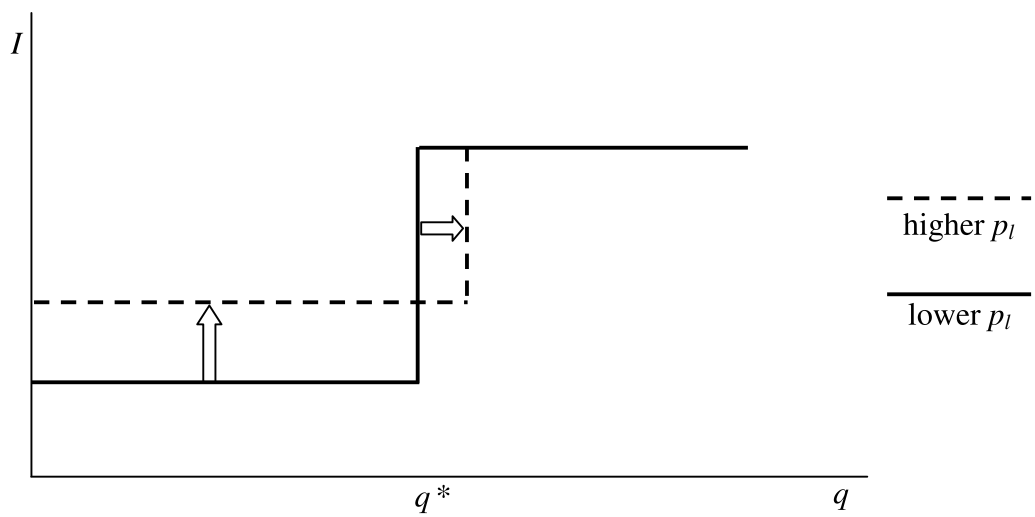

Figure 2.4 Impact of an increase in the precision of low-type information (*q*) on information transmission (*I*).

Our results share certain features with models which incorporate a single patient type. In De Jaegher and Jegers [9], the nature of the interaction induces the physician to reveal some information about the patient's state but this revelation is necessarily imperfect. Similarly, Dranove [8] examines a single treatment option that can be offered in different quantities and finds that the level of demand inducement is a function of the patient's information level. Thus, the quality of the physician-patient relationship depends directly on the level of the POMI. In a one-to-many interaction, this conclusion still holds but only in a qualified way. When the physician cannot observe an individual patient's information level, it is the quality of information of the dominant patient type that matters to the physician. In other words, the physician will respond to an increase or decrease in the accuracy of the dominant patients but she will not respond to a change in the level of information of other patients, unless such change switches the dominant patient type. So only the information level of the dominant patient type matters.

Policy Implications

Physicians sometimes fail to recommend the treatment option most desirable for a patient with a specific condition. As many as one-third of physicians "sometimes," "often," or "very often" do not offer a useful service to a patient because of health plan rules [42]. Not surprisingly, physicians whose own rewards were closely tied to controlling costs were more likely to withhold information. Beyond the financial, other concerns may further distort physicians' interests away from that of the patient, for example, if, from the physician' a patient requires an undue amount of physician time the physician may not supply all the information a patient demands. Partly to arm themselves, patients are increasingly using computer-mediated tools to gather information about their condition.

Our study confirms that higher POMI level helps improve the physician-patient interaction, or the patient-centered medical system and the shared decision making model we envision as the direction of the 21st century healthcare system [43]. Together with our efforts to align physicians' incentives with patients' objectives, we should spare no effort to provide high quality medical information to the public to shape the patient-physician relationship. While we may never eliminate the information asymmetry or conflict of interests between the patient and the physician, informing the patients can definitely help our efforts to create a quality, equality healthcare system.

While our study and several other studies suggest that POMI helps create a patient-centered healthcare system in which physicians and patients share the decision-making [44, 45], we know that access to outside medical information is linked to patient's socioeconomic status [16-18]. Those with poorer socioeconomic status usually have less access to information, and have less ability to understand and use such information in the medical encounter [22-24]. So as a society armed with the powerful tool of POMI in reshaping the physician-patient interaction, how do we use such tool to decrease or eliminate the persistent healthcare disparities among different socioeconomic groups [46-50]?

Our study suggests that when the physician cannot distinguish the information level of individual patients within the same population, every patient may be treated by the same way regardless of his information level. The physician may respond only to change in the overall information structure of the population, not to change in information level of a particular patient. So individual patients of a certain socioeconomic group may find themselves in a situation where they cannot change the behavior of their physicians even if they try to become more informed. This is evident as empirical studies show that there exist wide-spread disparities in access and utilization of health care among patients with different socioeconomic characteristics [46-50].

To help alleviate or even eliminate the disparities in healthcare among different socioeconomic groups using POMI, we should target efforts towards different subgroups within a population depending on the existing information structure of the population. For example, our study suggests that when the low information level is the dominant one (e.g., for patient population with low socioeconomic status), the most effective way to enhance information transmission and patient welfare is to increase the ratio of highly informed patient so that a "regime change" occurs. Efforts to increase the information level of those already informed would have no impact at all. On the other hand, when the high information level is the dominant one (e.g., for patient population with high socioeconomic status), the most effective way to enhance information transmission and patient welfare is to increase the information level of those already informed. Efforts to increase the information level of those not informed within such population would have no impact at all.

Given the fact that patients of lower socioeconomic status are in a disadvantaged position as to access to understandable information, we should focus our resources and efforts to provide understandable medical information to those patient groups so that enough patients become informed to cause “regime change”. Increasing the health literacy and the portion of informed patients in the lower socioeconomic group will likely to help all patients within this group, since when the portion of informed patients in a population is low, an increase in information level will improve the welfare of all patients in this group. So the most effective way to utilize POMI as a tool to address the healthcare disparity issue is to focus on those groups with the least access and/or ability to understand medical information.

Acknowledgements

We thank two anonymous referees for their comments. We also thank participants of the 4th iHEA conference in San Francisco for helpful comments. We are also grateful to Mythreyi Bhargavan, Kris De Jaegher, and Jeff Rubin for their comments.

Appendix

Notation

As in the text, we denote by $\pi_i(t)$ the probability that a patient of type $i\in\{h,l\}$ accepts recommendation $t\in\{A,B\}$. Denote by $\mu_i(s \mid t)$ the probability that a patient of type i assigns to being in state s upon receiving a treatment recommendation t. If treatment t,is prescribed with positive probability, we have:

$$\mu_i(\alpha \mid t)=\frac{p_i\pi(t \mid \alpha)}{p_i\pi(t \mid \alpha)+(1-p_i)\pi(t \mid \beta)} \text{ and}$$

$$\mu_i(\beta \mid t)=\frac{(1-p_i)\pi(t \mid \beta)}{p_i\pi(t \mid \alpha)+(1-p_i)\pi(t \mid \beta)}$$

If a treatment option is not on the equilibrium path, then a Bayesian equilibrium permits the patient to hold any beliefs. Further, denote by $U_i(t)$ the expected utility of a patient of type i from accepting treatment t and by $V(t \mid s)$ the expected utility of the physician from recommending treatment t to a patient in state s. These are given by:

$$U_i(t)=\mu_i(\alpha \mid t)u(t \mid \alpha)+\mu_i(\beta \mid t)u(t \mid \beta)$$

$$V(t \mid \alpha)=v(t)\frac{qp_h\pi_h(t)+(1-q)p_l\pi_l(t)}{qp_h+(1-q)p_l}$$

$$V(t \mid \beta)=v(t)\frac{q(1-p_h)\pi_h(t)+(1-q)(1-p_l)\pi_l(t)}{q(1-p_h)+(1-q)(1-p_l)}$$

Equilibria Analysis

As discussed in the text, the model permits multiple equilibria. In this section, we enumerate all equilibria and demonstrate that the list is exhaustive. In Table A.1, we classify equilibria into three categories. Equilibrium C1 (more correctly, a continuum of equilibria when $q=q^*$) is the candidate equilibrium analyzed in the text. Equilibria in C2 share a common feature that no patient will ever accept any recommendation. Because in this case the physician always receives an expected payoff of 0 regardless of which state the patient is in or which option the physician recommends, she is always indifferent between recommending two options, so she can choose $\pi(A \mid \alpha)$ and $\pi(B \mid \beta)$ freely as long as such choice does not make any patient better off accepting any recommendation than rejecting it.

Table 2-A-1 List of equilibria

Equilibrium		Physician Strategy		Patient Strategy			
		$\pi(A \mid \alpha)$	$\pi(B \mid \beta)$	$\pi_h(A)$	$\pi_l(A)$	$\pi_h(B)$	$\pi_l(B)$
	q>q*	$1+\frac{(1-p_h)}{p_h}\frac{u(B \mid \beta)}{u(B \mid \alpha)}$				$\frac{v(A)}{v(B)}-\frac{p_l}{p_h}\frac{(1-q)}{q}\left[1-\frac{v(A)}{v(B)}\right]$	1
C1	q<q*	$1+\frac{(1-p_l)}{p_l}\frac{u(B \mid \beta)}{u(B \mid \alpha)}$	1	1	1	0	$\frac{v(A)}{v(B)}\left[1+\frac{p_h}{p_l}\frac{q}{(1-q)}\right]$
	q=q*	$\left[1+\frac{(1-p_l)}{p_l}\frac{u(B \mid \beta)}{u(B \mid \alpha)},\cdots,1+\frac{(1-p_h)}{p_h}\frac{u(B \mid \beta)}{u(B \mid \alpha)}\right]$				0	1
C2	C2.1	$p_i\pi(A \mid \alpha)u(A \mid \alpha) \le (1-p_i)(1-\pi(B \mid \beta))[-u(A \mid \beta)]$ and $(1-p_i)\pi(B \mid \beta)u(B \mid \beta) \le p_i(1-\pi(A \mid \alpha))[-u(B \mid \alpha)]$		0	0	0	0
	C2.2	0	1				
C3		1	0	1	1	$0 \le \pi_h(B) \le \min\left\{\frac{v(A)}{v(B)}+\left[\frac{(1-q)}{q}\frac{p_l}{p_h}\right]\left[\frac{v(A)}{v(B)}-\pi_l(B)\right], \frac{v(A)}{v(B)}+\left[\frac{(1-q)}{q}\frac{(1-p_l)}{(1-p_h)}\right]\left[\frac{v(A)}{v(B)}-\pi_l(B)\right],1\right\}$	

$$q^* = \frac{V(A)-V(B)}{\frac{p_h}{p_l}V(A)+[V(B)-V(A)]}$$

Equilibria in C3 share a common feature that only option A is recommended. Because patients' prior beliefs are that option *A* yields positive utility, both types of patients will always accept this recommendation. To support these equilibria, the out-of-equilibrium beliefs (when option *B* is recommended) must lead to rejection of *B* with high enough probability. First, we establish as a lemma a condition on the equilibrium.

Lemma 1. In any equilibrium in which both treatment options are recommended with positive probability,

(i) If $\exists\ i \in \{h,l\}$ such that $U_i(A) \le 0$, then $\pi_j(B) = 0,\ j \in \{h,l\}$;

(ii) If $U_i(A) > 0,\ i \in \{h,l\}$, then $\exists\ j \in \{h,l\}$ such that $\pi_j(B) > 0$.

Proof: (i) We proceed by contradiction. Assume that $U_i(A) \le 0$ for some *i* but that $\pi_j(B) > 0$ for some *j*. First, note that

$$U_i(A) \le 0 \quad \Rightarrow \mu_i(\alpha \mid A) < p_l \text{ by assumption 2}$$

$$\Rightarrow \pi(A \mid \alpha) + \pi(B \mid \beta) < 1$$

But,

$$\pi_j(B) > 0 \quad \Rightarrow U_j(B) \ge 0$$

$$\Rightarrow \mu_j(\beta \mid B) \ge 1 - p_l \text{ by assumption 2}$$

$$\Rightarrow \pi(A \mid \alpha) + \pi(B \mid \beta) \ge 1$$

leading to a contradiction. Therefore, $\pi_j(B) = 0$.

(ii) First, note that, for $i \in \{h,l\}$,

$$U_i(A) > 0 \quad \Rightarrow \pi_i(A) = 1$$

$$\Rightarrow V(A \mid \alpha) = V(A \mid \beta) = v(A)$$

But for *B* to be recommended with positive probability, $\exists\, s \in \{\alpha, \beta\}$ such that $V(B \mid s) \ge V(A \mid s) = v(A) > 0$, which implies $\exists\ j \in \{h,l\}$ such that $\pi_j(B) > 0$. ■

We now proceed to prove the main result of this subsection.

Proposition A1. Table A.1 contains an exhaustive list of equilibria of the game.

Proof: We classify possible equilibria into four categories:

(i) Equilibria in which only treatment *B* is recommended in equilibrium;

(ii) Equilibria in which only treatment A is recommended in equilibrium;

(iii) Equilibria in which both treatments are recommended with positive probability and in which either $U_l(A) \leq 0$ or $U_h(A) \leq 0$ (or both).

(iv) Equilibria in which both treatments are recommended with positive probability and $U_h(A)$, $U_l(A) > 0$.

We construct equilibria in each category.

(i) If only treatment B is recommended in equilibrium, then $\pi(A \mid \alpha)=0$ and $\pi(B \mid \beta)=1$.

$$\pi(A \mid \alpha)=0,\ \pi(B \mid \beta)=1 \quad \Rightarrow \mu_i(\beta \mid B) = 1 - p_i$$

$$\Rightarrow U_i(B) < 0,\ i \in \{h,l\}, \text{ by assumption 2}$$

$$\Rightarrow \pi_i(B) = 0,\ i \in \{h,l\}$$

$$\Rightarrow V(B \mid \alpha) = 0$$

But since $\pi(A \mid \alpha)=0$, $V(A \mid \alpha) \leq V(B \mid \alpha)=0$. But for $V(A \mid \alpha)$ to equal 0, the probability of either type accepting A must be zero; thus $\pi_i(A) = 0$. This corresponds to equilibrium C2.2.

(ii) If only treatment A is recommended in equilibrium, then $\pi(A \mid \alpha)=1$, $\pi(B \mid \beta)=0$.

$$\pi(A \mid \alpha)=1,\ \pi(B \mid \beta)=0 \quad \Rightarrow \mu_i(\alpha \mid A) = p_i$$

$$\Rightarrow U_i(A) > 0,\ i \in \{h,l\}, \text{ by assumption 2}$$

$$\Rightarrow \pi_i(A) = 1,\ i \in \{h,l\}$$

$$\Rightarrow V(A \mid \alpha) = V(A \mid \beta) = v(A)$$

But since $\pi(A \mid \alpha)=1$, it must be true that $V(B \mid \alpha) \leq V(A \mid \alpha) = v(A)$ and for $\pi(B \mid \beta)=0$, it must be true that $V(B \mid \beta) \leq V(A \mid \beta) = v(A)$. These conditions are equivalent to:

$$0 \leq \pi_h(B) \leq \min\left\{ \frac{v(A)}{v(B)} + \left[\frac{(1-q)}{q}\frac{p_l}{p_h}\right]\left[\frac{v(A)}{v(B)} - \pi_l(B)\right], \right.$$
$$\left. \frac{v(A)}{v(B)} + \left[\frac{(1-q)}{q}\frac{(1-p_l)}{(1-p_h)}\right]\left[\frac{v(A)}{v(B)} - \pi_l(B)\right], 1 \right\}$$

which corresponds to equilibrium C3. For example, the above is satisfied when $\pi_h(B) \leq \pi_l(B) = \frac{v(A)}{v(B)}$ and $\frac{v(A)}{v(B)}$, so such equlibria always exist.

(iii) If $U_h(A) \leq 0$ or $U_l(A) \leq 0$, then by Lemma 1, $\pi_h(B) = \pi_l(B) = 0$. Since neither type accepts treatment B, and both options are recommended with positive probability, we have:

$$V(B \mid \alpha) = V(B \mid \beta) = 0$$

$$\Rightarrow V(A \mid \alpha) = V(A \mid \beta) = 0$$

$$\Rightarrow \pi_h(A) = \pi_l(A) = 0$$

But, for $i \in \{h, l\}$,

$$U_i(A) \le 0 \qquad \Rightarrow p_i \pi(A \mid \alpha) u(A \mid \alpha) + (1 - p_i)(1 - \pi(B \mid \beta)) u(A \mid \beta) \le 0$$

$$U_i(B) \le 0 \qquad \Rightarrow p_i (1 - \pi(A \mid \alpha)) u(B \mid \alpha) + (1 - p_i) \pi(B \mid \beta) u(B \mid \beta) \le 0$$

which correspond to equilibrium C2.1. Note that this equilibrium exists since the above conditions are satisfied in a neighborhood around $\pi(A \mid \alpha) = \pi(B \mid \beta) = 0$.

(iv) By Lemma 1, if $U_h(A), U_l(A) > 0$, then $\pi_j(B) > 0$ for some $j \in \{h, l\}$. From Proposition 2 and Corollary 2.2, either:

(iv-a) $0 \le \pi_h(B) < 1$, $\pi_l(B) = 1$; or

(iv-b) $\pi_h(B) = 0$, $1 \ge \pi_l(B) > 0$.

We consider both of these cases.

(iv-a) If both treatment options are recommended with positive probability then $U_h(A) > 0$, $U_l(A) > 0$, $0 \le \pi_h(B) < 1$, and $\pi_l(B) = 1$, imply that $\pi_h(A) = \pi_l(A) = 1$, and

$$\pi_l(B) = 1 \qquad \Rightarrow U_l(B) \ge 0$$

$$\Rightarrow p_l[1 - \pi(A \mid \alpha)] u(B \mid \alpha) + (1 - p_l) \pi(B \mid \beta) u(B \mid \beta) \ge 0 \tag{A.1}$$

$$U_h(A) > 0 \qquad \Rightarrow \pi(A \mid \alpha) > 0$$

$$0 \le \pi_h(B) < 1 \qquad \Rightarrow U_h(B) \le 0$$

$$\Rightarrow p_h[1 - \pi(A \mid \alpha)] u(B \mid \alpha) + (1 - p_h) \pi(B \mid \beta) u(B \mid \beta) \le 0 \tag{A.2}$$

$$\Rightarrow \pi(A \mid \alpha) < 1$$

So $0 < \pi(A \mid \alpha) < 1$ which implies indifference on the part of the physician:

$$V(B \mid \alpha) = V(A \mid \alpha) \qquad \Rightarrow v(A)[q p_h + (1 - q) p_l] = v(B)[\pi_h(B) q p_h + (1 - q) p_l]$$

$$\Rightarrow \pi_h(B) = \frac{v(A)}{v(B)} - \frac{p_l (1 - q)}{p_h q} \left[1 - \frac{v(A)}{v(B)} \right]$$

for which no solution exists when $q < q^*$. But when $q \ge q^*$, $\pi(B \mid \beta) = 1$ since

$$V(B \mid \beta) - V(A \mid \beta) = \frac{(1 - q)(p_h - p_l)[v(B) - v(A)]}{p_h [q(1 - p_h) + (1 - q)(1 - p_l)]} > 0$$

Substituting into (A.1) and (A.2), we obtain:

$$p_l[1-\pi(A\,|\,\alpha)]u(B\,|\,\alpha)+(1-p_l)u(B\,|\,\beta)\ \geq 0 \qquad \text{(A.1')}$$

$$p_h[1-\pi(A\,|\,\alpha)]u(B\,|\,\alpha)+(1-p_h)u(B\,|\,\beta)\leq 0 \qquad \text{(A.2')}$$

When $q>q^*$, $\pi_h(B)>0$ implies that $U_h(B)\geq 0$. But from above, $U_h(B)\leq 0$. Thus, $U_h(B)=0$ and (A.2') holds with equality. Since $p_h > p_l$, (A.1') holds with strict inequality. So we have:

$$\pi(A\,|\,\alpha)=1+\frac{(1-p_h)}{p_h}\frac{u(B\,|\,\beta)}{u(B\,|\,\alpha)}$$

When $q=q^*$, (A.1') and (A.2') require that

$$1+\frac{(1-p_l)}{p_l}\frac{u(B\,|\,\beta)}{u(B\,|\,\alpha)}\leq\pi(A\,|\,\alpha)\leq 1+\frac{(1-p_h)}{p_h}\frac{u(B\,|\,\beta)}{u(B\,|\,\alpha)}.$$

The above conditions correspond to equilibrium C1 when $q\geq q^*$.

(iv-b) If both treatment options are recommended with positive probability then $U_h(A)>0$, $U_l(A)>0$, $\pi_h(B)=0$ and $0<\pi_l(B)\leq 1$, imply that $\pi_h(A)=\pi_l(A)=1$, and

$$0<\pi_l(B)\leq 1 \qquad \Rightarrow U_l(B)\geq 0$$

$$\Rightarrow p_l[1-\pi(A\,|\,\alpha)]u(B\,|\,\alpha)+(1-p_l)\pi(B\,|\,\beta)u(B\,|\,\beta)\geq 0 \qquad \text{(A.3)}$$

$$U_h(A)>0 \qquad \Rightarrow \pi(A\,|\,\alpha)>0, \text{ and}$$

$$\pi_h(B)=0 \qquad \Rightarrow U_h(B)\leq 0$$

$$\Rightarrow p_h[1-\pi(A\,|\,\alpha)]u(B\,|\,\alpha)+(1-p_h)\pi(B\,|\,\beta)u(B\,|\,\beta)\leq 0 \qquad \text{(A.4)}$$

$$\Rightarrow \pi(A\,|\,\alpha)<1$$

So $0<\pi(A\,|\,\alpha)<1$ which implies indifference on the part of the physician:

$$V(B\,|\,\alpha)=V(A\,|\,\alpha) \qquad \Rightarrow v(A)[qp_h+(1-q)p_l]=v(B)(1-q)p_l\pi_l(B)$$

$$\Rightarrow \pi_l(B)=\frac{v(A)}{v(B)}\left[1+\frac{p_h q}{p_l(1-q)}\right]$$

for which no solution exists when $q>q^*$. But when $q\leq q^*$, $\pi(B\,|\,\beta)=1$ since

$$V(B\,|\,\beta)-V(A\,|\,\beta) \quad =\frac{v(B)(1-q)(1-p_l)\pi_l(B)-v(A)\left[q(1-p_h)+(1-q)(1-p_l)\right]}{q(1-p_h)+(1-q)(1-p_l)}$$

$$=\frac{(1-p_l)\frac{p_h}{p_l}-(1-p_h)}{q(1-p_h)+(1-q)(1-p_l)}qv(A)\ >0$$

Substituting into (A.3) and (A.4),

$$p_l[1-\pi(A \mid \alpha)]u(B \mid \alpha)+(1-p_l)u(B \mid \beta) \geq 0 \tag{A.3'}$$

$$p_h[1-\pi(A \mid \alpha)]u(B \mid \alpha)+(1-p_h)u(B \mid \beta) \leq 0 \tag{A.4'}$$

When $q<q^*$, $\pi_l(B)<1$ implies that $U_l(B) \leq 0$. But from above, $U_l(B) \geq 0$. Thus, $U_l(B)=0$ and (A.4') holds with equality. Since $p_h > p_l$, (A.4') holds with strict inequality. So we have:

$$\pi(A \mid \alpha)=1+\frac{(1-p_l)}{p_l}\frac{u(B \mid \beta)}{u(B \mid \alpha)}$$

When $q=q^*$, $\pi_l(B)=0$, (A.4') and (A.5') require that

$$1+\frac{(1-p_l)}{p_l}\frac{u(B \mid \beta)}{u(B \mid \alpha)} \leq \pi(A \mid \alpha) \leq 1+\frac{(1-p_h)}{p_h}\frac{u(B \mid \beta)}{u(B \mid \alpha)}.$$

The above conditions correspond to equilibrium C1 when $q \leq q^*$. ■

Proofs

Proposition 1. In equilibrium, *I<1*.

Proof. We proceed by contradiction. Assume that $I=\pi(A \mid \alpha)\times\pi(B \mid \beta)=1$. This means that $\mu_i(\alpha \mid A)=\mu_i(\beta \mid B)=1$, $i \in \{h,l\}$, implying (by Assumption 1) that both types of patients will accept either recommendation. But if $\pi_i(A)=\pi_i(B)=1$, $i \in \{h,l\}$, and since v(*B*)>v(*A*), the physician will always recommend option B. Then, $\pi(A \mid \alpha)$=0, leading to a contradiction. ■

Proposition 2. In any equilibrium in which both treatment options are recommended with positive probability, we have:

(i) $\pi_l(A)>0 \Rightarrow \pi_h(A)=1$

(ii) $\pi_h(A)<1 \Rightarrow \pi_l(A)=0$

(iii) $\pi_h(B)>0 \Rightarrow \pi_l(B)=1$

(iv) $\pi_l(B)<1 \Rightarrow \pi_h(B)=0$.

Proof. We demonstrate parts (i) and (ii) as the others are obtained analogously. If $\pi_l(A) > 0$, the low type patient must weakly prefer accepting recommendation *A* to rejecting it. Since $p_h > p_l$, we have:

$$\begin{aligned}\pi_l(A) > 0 \quad &\Rightarrow U_l(A) \geq 0\\ &\Rightarrow p_l \pi(A \mid \alpha) u(A \mid \alpha) + (1 - p_l)(1 - \pi(B \mid \beta)) u(A \mid \beta) \geq 0\\ &\Rightarrow p_h \pi(A \mid \alpha) u(A \mid \alpha) + (1 - p_h)(1 - \pi(B \mid \beta)) u(A \mid \beta) > 0\\ &\Rightarrow U_h(A) > 0\\ &\Rightarrow \pi_h(A) = 1\end{aligned}$$

Note that (ii) is logically equivalent to (i). Analogous arguments demonstrate (iii)-(iv). ■

Corollary 2.1. In equilibrium, $\pi_h(A) \geq \pi_l(A)$, $\pi_h(B) \leq \pi_l(B)$.

Proof. Follows immediately from Proposition 2. ■

Corollary 2.2. In equilibrium, $\pi_h(B) < 1$.

Proof. If $\pi_h(B) = 1$, then by Proposition 2, $\pi_l(B) = 1$. Thus, both patient types accept treatment *B*. Since $v(B) > v(A)$, the physician would always recommend treatment *B*, which would, by Assumption 2, be rejected by both patient types, leading to a contradiction. ■

Proposition 3. (C1) is an equilibrium of the patient-physician interaction game.

Proof. Follows directly from Proposition A1.

Proposition 4. The candidate equilibrium (equilibrium C1 from Table A.1) is the only equilibrium in which the information transmission level *I* is strictly greater than 0.

Proof. For equilibria in C2 and C3, *I=0*. For equilibrium C1,

$$I \geq 1 + \frac{(1 - p_l)}{p_l} \frac{u(B \mid \beta)}{u(B \mid \alpha)} > 0$$

where the first inequality follows from $p_h > p_l$ and $u(B \mid \beta) > 0 > u(B \mid \alpha)$ and the second inequality follows from Assumption 2. ■

Proposition 5. The physician receives higher expected utility under the candidate equilibrium (C1 in Table A.1) than under any other equilibrium. Further, the candidate

equilibrium Pareto dominates all other equilibria when
$p_h(1-p_l)u(A\mid\alpha)u(B\mid\beta) < p_l(1-p_h)u(A\mid\beta)u(B\mid\alpha)$.

Proof. First, note that in all equilibria in C2, the physician and both types of patients receive an expected payoff of 0, while in C1, all players receive positive expected payoffs.

Denote by $E\,[v]$ the physician's expected utility in equilibrium, and by $E[U_h]$ and $E\,[U_l]$ the high and low type patients' expected utilities in equilibrium. We use $E[v]\mid_{C1}$ and $E[v]\mid_{C3}$ to denote the physician's expected utility in equilibrium C1 and C3; similarly, $E[U_i]\mid_{C1}$ and $E[U_i]\mid_{C3}$ denote the expected utility of a patient of type i in equilibrium C1 and C3. By direct computation, we obtain

$$
\begin{aligned}
E[v]\mid_{C1} = \;& v(A)\left[qp_h+(1-q)p_l\right]\pi(A\mid\alpha) \\
&+\; v(B)\left[\pi_h(B)q(1-p_h)+\pi_l(B)(1-q)(1-p_l)\right] \\
&+\; v(B)\left[\pi_h(B)qp_h+\pi_l(B)(1-q)p_l\right]\left[1-\pi(A\mid\alpha)\right] \\
=\;& v(A)\left[qp_h+(1-q)p_l\right] + v(B)\left[\pi_h(B)q(1-p_h)+\pi_l(B)(1-q)(1-p_l)\right] \\
=\;& \begin{cases} v(A)\left[\dfrac{qp_h+(1-q)p_l}{p_h}\right]+v(B)\left[\dfrac{(1-q)(p_h-p_l)}{p_h}\right] & q>q^* \\[2ex] v(A)\left[\dfrac{qp_h+(1-q)p_l}{p_l}\right] & q\le q^* \end{cases} \\
>\;& v(A) \\
=\;& E[v]\mid_{C3}
\end{aligned}
$$

Hence the physician receives higher expected utility under C1 than C3. In equilibrium C3, patients' payoffs are given by:

$$E[U_i]\mid_{C3} = p_i u(A\mid\alpha)+(1-p_i)u(A\mid\beta) \;\text{ for }\; i\in\{h,l\}.$$

In equilibrium C1,

$$E[U_i]\mid_{C1} = \begin{cases} p_i u(A\mid\alpha)+\dfrac{(1-p_h)p_i u(B\mid\beta)u(A\mid\alpha)}{p_h u(B\mid\alpha)} & q>q^* \\[2ex] p_i u(A\mid\alpha)+\dfrac{(1-p_l)p_i u(B\mid\beta)u(A\mid\alpha)}{p_l u(B\mid\alpha)} & q<q^* \end{cases}$$

and

$$p_i u(A\mid\alpha)+\frac{(1-p_l)p_i u(B\mid\beta)u(A\mid\alpha)}{p_l u(B\mid\alpha)}$$

$$\leq E[U_i]|_{C1} \leq \; p_i u(A|\alpha) + \frac{(1-p_h)p_i u(B|\beta)u(A|\alpha)}{p_h u(B|\alpha)}$$

Because $p_h > p_l$, we have:

$$E[U_i]|_{C1,q>q^*} \geq E[U_i]|_{C1,q=q^*} \geq E[U_i]|_{C1,q<q^*}$$

So we need only to show that $E[U_i]|_{C1,q<q^*} > E[U_i]|_{C2}$.

$$E[U_i]|_{C1,q<q^*} - E[U_i]|_{C2} = \; p_i u(A|\alpha) + \frac{1-p_l}{p_l} p_i \frac{u(B|\beta)}{u(B|\alpha)} u(A|\alpha) -$$

$$- \; p_i u(A|\alpha) + (1-p_i)u(A|\beta)$$

$$= \; [(1-p_l)p_i - (1-p_i)p_l] \frac{u(B|\beta)u(A|\alpha) - u(B|\alpha)u(A|\beta)}{p_l . u(B|\alpha)}$$

which is positive when $p_h(1-p_l)u(A|\alpha).u(B|\beta) < p_l(1-p_h)u(A|\beta)u(B|\alpha)$. ■

Proposition 6. In the candidate equilibrium, $U = u(A|\alpha)I\left[qp_h + (1-q)p_l\right]$.

Proof. As we just showed, in the candidate equilibrium,

$$E[U_i]|_{C1} = \begin{cases} p_i u(A|\alpha) + \dfrac{(1-p_h)p_i u(B|\beta)u(A|\alpha)}{p_h u(B|\alpha)} q > q^* \\ p_i u(A|\alpha) + \dfrac{(1-p_l)p_i u(B|\beta)u(A|\alpha)}{p_l u(B|\alpha)} q < q^* \end{cases}$$

and

$$I = \begin{cases} 1 + \dfrac{(1-p_h)u(B|\beta)}{p_h u(B|\alpha)} & q > q^* \\ 1 + \dfrac{(1-p_l)u(B|\beta)}{p_l u(B|\alpha)} & q < q^* \end{cases}$$

So:

$$\begin{aligned} U &= qE[U_h] + (1-q)E[U_l] \\ &= q[p_h u(A|\alpha) + (I-1)p_h u(A|\alpha)] + (1-q)[p_l u(A|\alpha) + (I-1)p_l u(A|\alpha)] \\ &= u(A|\alpha)I[qp_h + (1-q)p_l] \end{aligned}$$

■

Theorem 1. In equilibrium (C1), $\frac{\partial I}{\partial q} = 0$ when q≠q*.

Proof: Follows directly from the form of C1. ■

Theorem 2. The threshold value q^* increases with p_l and decreases with p_h.

(i) $\frac{\partial q^*}{\partial p_l} > 0$; (ii) $\frac{\partial q^*}{\partial p_h}$ <0.

Proof: This follows directly from the form of $q^* = \frac{V(A) - V(B)}{\frac{p_h}{p_l}V(A) + [V(B) - V(A)]}$.■

Theorem 3. In equilibrium (C1),

(i) $\frac{\partial I}{\partial p_h} > 0$ when $q > q^*$; (ii) $\frac{\partial I}{\partial p_h} = 0$ when $q < q^*$'.

(iii) for small ε>0, there exists a q<q^* such that $I|_{p_h} << I|_{p_h + \varepsilon}$

Proof. (i) and (ii) follow directly from the form of C1.

(iii) Define $\delta \equiv q^*(p_h) - q^*(p_h + \varepsilon) > 0$. Then, there exists a q such that $q^* - \delta < q < q^*$. ■

Theorem 4. In equilibrium (C1),

(i) $\frac{\partial I}{\partial p_l} > 0$ when $q < q^*$'; (ii) $\frac{\partial I}{\partial p_l} = 0$ when $q > q^*$.

(iii) for ε>0, there exists a q>q^* such that $I|_{p_l} >> I|_{p_l + \varepsilon}$

Proof. (i) and (ii) follow directly from the form of C1.

(iii) Define $\delta \equiv q^*(p_l + \varepsilon) - q^*(p_l) > 0$. Then, there exists a q such that $q^* < q < q^* + \delta$. ■

Modeling the negotiation between the physician and the patient

In the body of this manuscript, we model the bargaining procedure over treatment options as a take-it-or-leave-it offer proposed by the physician. In this section, we discuss more robust bargaining models. Traditional models of two-player bargaining assume both continuity of the set of possible outcomes and a cost of delay which encourages earlier agreements. For example, Rubinstein's classic model of sequential bargaining considers a division of a pie of unit size, with the pie "shrinking" at a predetermined rate after each round of unsuccessful negotiation [51]. In our scenario, since bargaining is likely to occur in a span of minutes rather than years, discounting is unlikely to be relevant. Instead, we adopt the "uncertain termination" approach of Binmore, Rubinstein, and Wolinsky in which a rejection of the current proposal implies some positive probability that bargaining will terminate rather than continue into another period [52]. This probabilistic termination model is more intuitive in the present context and, in many settings, is isomorphic to a model in which the surplus vanishes with time [52].

The discrete set of bargaining outcomes is either treatment A or treatment B. Institutionally, there is no ability for the patient and physician to split the surplus through side payments, such as through a monetary payment by the physician to the patient in consideration of the patient accepting a less desirable treatment option. Further, any such side payments would limit the generality of our model as they would require interpersonal comparisons of utility. Instead, we "convexify" the set of treatment options by considering that a proposal by the physician is of the form $\pi(A \mid \alpha)$ and $\pi(B \mid \beta)$; the physician proposes a probability of treatment *A* to a patient in state α and a probability of treatment B in state β.

For concreteness (though quite divorced from reality), we can imagine a computer program carrying out the proposal according to the following rules: if the patient accepts a proposal $\{\pi(A \mid \alpha), \pi(B \mid \beta)\}$, the physician inputs the patient's state and the proposal into the computer program. The computer then recommends a treatment option according to the proposal and the patient's state. By accepting a proposal, the patient also commits himself to accepting any recommendation that is a result of such proposal. More realistically, envision the physician sharing her "treatment philosophy" prior to examining the patient: "For patients who exhibit conditions similar to yours, I usually (e.g., with some known probability) suggest treatment A or B."

We construct an infinite horizon one-sided offer bargaining model with incomplete information. In each period, *t*, the physician proposes a probability pair $\{\pi^t(A \mid \alpha), \pi^t(B \mid \beta)\}$. A patient of type $i \in \{h, l\}$ accepts the proposal with probability Acc_i^t. If it is accepted, the implemented treatment option (*A* or *B*) is randomly drawn according to the probability $\pi(A \mid \alpha)$ or $\pi(B \mid \beta)$ corresponding to the patient's state. If the offer is rejected, bargaining terminates with probability λ. With complementary probability 1-λ, the physician makes another offer in the following period. The termination probability λ represents the chance of breakdown in negotiations; either the physician or the patient may find such seesaw negotiations awkward or costly and decide to end further bargaining. This model is a (simple) instance of the sequential bargaining with one-sided incomplete information model of Ausubel, Cramton and Deneckere [53], to which we refer the reader for a more general discussion. In what follows, we solve for the equilibria of this model.

Denote the history of the game through period *t*-1 by

$$h^t = \left\{\pi^\tau(A \mid \alpha), \pi^\tau(B \mid \beta), Acc_i^\tau\right\}_{\tau=1}^{t-1}.$$

We concentrate on stationary equilibria of this model in which a player's strategy depends only on whether or not an acceptance has occurred, and not on the period, *t*. For the patient, since an acceptance implies the end of the game, his strategy is independent of history. The physician's strategy, on the other hand, is independent of *t* but may take on a different value if the patient has previously rejected an offer. Thus, an equilibrium strategy for the physician may be denoted by the four-tuple: $\{\pi^1(A \mid \alpha), \pi^1(B \mid \beta), \pi^2(A \mid \alpha), \pi^2(B \mid \beta)\}$, in which $\{\pi^1(A \mid \alpha), \pi^1(B \mid \beta)\}$ is the offer in period 1, and { $\pi^2(A|\alpha), \pi^2(B|\beta)$ } is the offer in all subsequent periods (t>1) if previous offers have been rejected.

Denote $U_i[\pi(A|\alpha), \pi(B|\beta)]$ as the expected utility a type i patient receives when he accept proposal { $\pi(A|\alpha), \pi(B|\beta)$ }, $V_i[\pi(A|\alpha), \pi(B|\beta)]$ as the expected utility the physician receives from type i patient when the patient accept proposal { $\pi(A|\alpha), \pi(B|\beta)$ }, and $V[\pi(A|\alpha), \pi(B|\beta)]$ as the expected utility the physician receives when both types of patients accept proposal $V[\pi(A|\alpha), \pi(B|\beta)]$. Obviously:

$$U_i[\pi(A|\alpha), \pi(B|\beta)] = p_i\pi(A|\alpha)u(A|\alpha) + (1-p_i)\pi(B|\beta)u(B|\beta) + (1-p_i)[1-\pi(B|\beta)]u(A|\beta) + p_i[1-\pi(A|\alpha)]u(B|\alpha)$$

$$V_i[\pi(A|\alpha), \pi(B|\beta)] = p_i\{v(B) + \pi(A|\alpha)[v(A)-v(B)]\} + (1-p_i)\{v(A) + \pi(B|\beta)[v(B)-v(A)]\} \quad \text{and}$$

$$V[\pi(A|\alpha), \pi(B|\beta)] = qV_h[\pi(A|\alpha), \pi(B|\beta)] + (1-q)V_l[\pi(A|\alpha), \pi(B|\beta)].$$

The following proposition characterizes the unique stationary equilibrium:

Proposition A.4.1.

Define $q^{**} = \dfrac{V_l[\pi^{1*}(A|\alpha),1] - V_l[\pi^h(A|\alpha),1]}{\lambda V_h[\pi^h(A|\alpha),1] + V_l[\pi^{1*}(A|\alpha),1] - V_l[\pi^h(A|\alpha),1]}$ where

$\pi^h(A|\alpha) = 1 + \dfrac{(1-p_h)}{p_h}\dfrac{u(B|\beta)}{u(B|\alpha)}$ and

$\pi^{1*}(A|\alpha) = (1-\lambda)\pi^h(A|\alpha) - \lambda\dfrac{u(B|\beta) - p_l[u(B|\beta) - u(B|\alpha)]}{p_l[u(A|\alpha) - u(B|\alpha)]}$, then the following is a unique stationary equilibrium of the model:

(i) if q < q^{**}:

$$\pi^1(A|\alpha) = \pi^2(A|\alpha) = \pi^h(A|\alpha)$$

$$\pi^1(B|\beta) = \pi^2(B|\beta) = 1$$

$$Acc_i^t = 1 \;\forall t, i \in \{l,h\}$$

(ii) if q > q^{**}:

$$\pi^1(A|\alpha) = (1-\lambda)\pi^h(A|\alpha) - \lambda\frac{u(B|\beta) - p_l[u(B|\beta) - u(B|\alpha)]}{p_l[u(A|\alpha) - u(B|\alpha)]}$$

$$\pi^2(A \mid \alpha) = \pi^h(A \mid \alpha)$$

$$\pi^1(B \mid \beta) = \pi^2(B \mid \beta) = 1$$

$$Acc_l^t = 1 \; \forall t, \; Acc_h^1 = 0, Acc_h^t = 1 \; t > 1$$

We note several features of the equilibrium. First, similar to the equilibrium discussed in the text, its nature depends on a threshold value of q (i.e., q^{**}). When λ=1, and thus negotiations do not last past one period, q^{**} corresponds to the q^* defined in the text. Second, the physician's strategy is similar in this infinite horizon model as in the take-it-or-leave-it model discussed in the text in that she basically chooses between two possible strategies to maximize her expected utility. Thus, the equilibrium of this model resembles that of the simple model in the text. However, this model also opens the possibility to screening. When the ratio of well-informed patients is above a critical value, the physician plans on making two offers. The first is less advantageous but is accepted by the less informed. If rejected, the physician is aware that the patient is more informed and offers a better (from the patient's perspective) treatment option. Whether such screening is occurring in practice is an empirical question that deserves of future research efforts.

The rest of this section develops several lemmas to prove the above proposition.

Lemma A.4.1. In a stationary equilibrium, a patient will accept within the first two periods.
Proof: Suppose $\{\pi^t(A \mid \alpha), \pi^t(B \mid b), Acc_i^t\}$ is an equilibrium and consider a period t>1 such that a patient of type i has rejected previous offers. If a patient rejects the physician's offers $\{\pi^t(A \mid \alpha), \pi^t(B \mid b)\}$ in period t, the physician earns 0, since the same offer will exist in all future periods (by definition of a stationary equilibrium). However, the physician can offer $\pi^{t^*}(A \mid \alpha) = \pi^{t^*}(B \mid \beta)$=1 which the patient will accept (since it yields maximal possible payoffs), and which results in positive payoffs for the physician. Thus a $\{\pi^t(A \mid \alpha), \pi^t(B \mid b)\}$, t>1 which is rejected cannot be part of an equilibrium. ■

Corollary A.4.1. In a stationary equilibrium, a type l patient will accept in the first period.
Proof: By contradiction. If both types were to reject in period 1 and (by Lemma A.4.1) accept in period 2, then letting $\pi^1(A \mid \alpha) = \pi^2(A \mid \alpha)$ and $\pi^1(B \mid \beta) = \pi^2(B \mid \beta)$, that is, changing the first period offer to be the same as the second period offer, will lead both types to accept in period 1, yielding higher payoffs for the physician. Lastly, by construction, if a low type rejects an offer then so will a high type, implying that the low type must accept in period 1.

Lemma A.4.2. In a stationary equilibrium, $\pi^t(B \mid \beta)$=1 for all t.

Proof: By construction, the patient's utility function is increasing in $\pi^t(B \mid \beta)$. Also, as long as one type of patient accepts, they physician's utility function is increasing in $\pi^t(B \mid \beta)$. Suppose

in equilibrium that for some period τ, $\pi^\tau(B\,|\,\beta)<1$. Consider an alternate physician strategy where $\hat{\pi}^t(B\,|\,b)=\pi^t(B\,|\,b)$ for all $t\neq\tau$, and $\hat{\pi}^\tau(B\,|\,b)=1$.
The patient is not less likely to accept and the physician earns a higher payoff. Thus, $\pi^\tau(B\,|\,\beta)<1$ cannot be part of an equilibrium. ■

Lemma A.4.3. In a stationary equilibrium, if both types do not accept in period 1, then $U_l[\pi^1(A\,|\,\alpha)]=(1-\lambda)U_l[\pi^2(A\,|\,\alpha)]$.
Proof: (i) Suppose $U_l[\pi^1(A\,|\,\alpha)]>(1-\lambda)U_l[\pi^2(A\,|\,\alpha)]$. Then there exists an ε such that $U_l[\pi^1(A\,|\,\alpha)-\varepsilon]>(1-\lambda)U_l[\pi^2(A\,|\,\alpha)]$; the physician can lower the offer a little bit and still have type l patients accept, but resulting in a higher payoff for the physician.
(ii) Suppose $U_l[\pi^1(A\,|\,\alpha)]<(1-\lambda)U_l[\pi^2(A\,|\,\alpha)]$. Then, a type l patient rejects $\pi^1(A\,|\,\alpha)$ in round 1 and accepts $\pi^2(A\,|\,\alpha)$ in round 2, contradicting Corollary A.4.1. ■

Next, denote by

$$\pi^h(A\,|\,\alpha) = 1+\frac{(1-p_h)}{p_h}\frac{u(B\,|\,\beta)}{u(B\,|\,\alpha)}, \text{ and}$$

$$\pi^l(A\,|\,\alpha) = 1+\frac{(1-p_l)}{p_l}\frac{u(B\,|\,\beta)}{u(B\,|\,\alpha)}$$

the offers that result in type h and type l patients earning a payoff of zero if accepted.

Lemma A.4.4. In a stationary equilibrium:
(i) $\pi^1(A\,|\,\alpha)\geq\pi^l(A\,|\,\alpha)$
(ii) $\pi^2(A\,|\,\alpha)=\pi^h(A\,|\,\alpha)$.
Proof: (i). Follows from Corollary A.4.1 since a low type must find the offer acceptable.
(ii). An offer of $\pi^2(A\,|\,\alpha)$ implies that a rejection occurred in period 1. By Corollary A.4.1, only the high type patient rejected the first offer. Thus, $\pi^h(A\,|\,\alpha)$ places a minimum bound on offers acceptable in period 2. Any higher offer would also be accepted but yield a lower payoff for the physician. ■

Thus, two possibilities exist. Either both types of patients accept in period 1, or only low types accept in period 1 and high types accept in period 2. The first period offer is $\pi^1(A\,|\,\alpha)=\pi^h(A\,|\,\alpha)$. In the latter case, Lemma A.4.3. implies a first period offer of

$$\pi^{1*}(A\,|\,\alpha)=(1-\lambda)\pi^h(A\,|\,\alpha)-\lambda\frac{u(B\,|\,\beta)-p_l[u(B\,|\,\beta)-u(B\,|\,\alpha)]}{p_l[u(A\,|\,\alpha)-u(B\,|\,\alpha)]} \qquad \text{(A.4-1)}$$

The physician effectively selects between these two strategies depending on which maximizes her payoffs.

Lemma A.4.5. In a stationary equilibrium, both types will accept in period 1 if and only if:

$$V[\pi^h(A \mid \alpha),1] \geq (1-q)V_l[\pi^{1*}(A \mid \alpha),1] + q(1-\lambda)V_h[\pi^h(A \mid \alpha),1]. \qquad \text{(A.4-2)}$$

Proof: Suppose $V[\pi^h(A \mid \alpha),1] < (1-q)V_l[\pi^{1*}(A \mid \alpha),1] + q(1-\lambda)V_h[\pi^h(A \mid \alpha),1]$ and both types accept in period 1. But then an offer of $\pi^{1*}(A \mid \alpha)$ in period 1 and $\pi^h(A \mid \alpha)$ in period 2 would result in a higher payoff. ■

Equation (A.4-2) may be rewritten in terms of q. The game will end in the first round if:

$$q > \frac{V_l[\pi^{1*}(A \mid \alpha),1] - V_l[\pi^h(A \mid \alpha),1]}{\lambda V_h[\pi^h(A \mid \alpha),1] + V_l[\pi^{1*}(A \mid \alpha),1] - V_l[\pi^h(A \mid \alpha),1]}$$

Proof of Proposition A.4.1: follows from Lemmas A.4.1 to A.4.5. ■

References

1. Drazen JM. The Consumer and the Learned Intermediary in Health Care. *N Engl J Med.* 2002; 346: 523-524.

2. Greenfield S, Kaplan S, Ware JE. Expanding patient involvement in care. *Ann Intern Med.* 1985; 102: 520-528.

3. Weissman JS, Blumenthal D, Silk AJ, Newman M, Zapert K, Leitman R, Feibelmann S. Physicians Report On Patient Encounters Involving Direct-To-Consumer Advertising. *Health Affairs Web Exclusive,* April 28, 2004.

4.Murray E, Lo B, Pollack L, *et al*. The Impact of Health Information on the Internet on Health Care and the Physician-Patient Relationship: National U.S. Survey among 1050 U.S. Physicians. *Journal of Medical Internet Research.* 2003; 5(3), e17.

5.Gallagher TH, Lo B, Chesney M and Christensen K 1997, How Do Physicians Respond to Patients' Requests for Costly, Unindicated Services? *J GEN Intern Med.* 12:663-668.

6. Evans RG. Supplier-Induced Demand: Some Empirical Evidence and Implications. In Perlan, M. (Ed.), The Economics of Health and Medical Care. London, UK, Macmillan, 1974: 162-173.

7. Farley PJ. Theories of the Price and Quantity of Physician Services: A Synthesis and Critique. *Journal of Health Economics.* 1986; 5(4): 315-333.

8. Dranove D. Demand Inducement and the Physician/Patient Relationship. *Economic Inquiry.* 1988; 26(2): 281-298.

9. De Jaegher K, Jegers M. The Physician-Patient Relationship as a Game of Strategic Information Transmission. *Health Economics.* 2001; 10: 651-668.

10. De Jaegher K. Microeconomic Aspects of SID in Healthcare. Dissertation, Vrije Universiteit Brussel, 2002.

11. Goldsmith J, Blumenthal D, Rishel W. Federal Health Information Policy: A Case Of Arrested Development. Health Affairs. 2003; 22(4): 44-55.

12. Fried BM et al. E-Health: Technologic Revolution Meets Regulatory Constraint. Health Affairs. 2000; 124–131.

13. Lumpkin JR. Perspective: E-Health, HIPAA, And Beyond. Health Affairs. 2000; 19(6): 149-151.

14. Towle A, Godolphin W. Framework for teaching and learning informed shared decision making. BMJ. 1999; 319: 766-71.

15. Wade JC. Perspective: The Patient/Physician Relationship: One Doctor's View. Health Affairs. 1995; 14(4): 209-212.

16. Cotton SR and Gupta SS. Characteristics of online and offline health information seekers and factors that discriminate between them. *Social Science & Medicine*. 2004; (59): 1795-1806.

17. McKinstry B. Do patients wish to be involved in decision making in the consultation? A cross sectional survey with video vignettes. *BMJ*. 2000; 321: 867 - 871.

18. Kakai H, Maskarinec G, Shumay DM, Tatsumura Y, Tasaki K. Ethnic Differences in choices of health information by cancer patients using complementary and alternative medicine: an exploratory study with correspondence analysis. Social Science & Medicine. 2003; 56: 851-862.

19. Mechanic D., McAlpine D. D., Rosenthal M.Are Patients' Office Visits with Physicians Getting Shorter? N Engl J Med. 2001; 344:198-204.

20. A second revolutionary period. In: Ludmerer KM. Time to heal: American medical education from the turn of the century to the era of managed care. New York: Oxford University Press, 1999: 370-99.

21. Burdi MD, Baker LC. Physicians' perceptions of autonomy and satisfaction in California. Health Affairs. 1999; 18(4): 134-145.

22. Ziebland S, Chapple A, Dumelow C, Evans J, Prinjha S, Rozmovits L. How the internet affects patients' experience of cancer: a qualitative study. BMJ. 2004; 328(7439): 564.

23. van Woerkum CM. The Internet and primary care physicians: coping with different expectations. Am J Clin Nutr. 2003; 77(4 Suppl):1016S-1018S.

24. Sciamanna CN, Clark MA, Diaz JA, Newton S. Filling the gaps in physician communication. The role of the Internet among primary care patients. Int J Med Inf. 2003; 72(1-3):1-8.

25. Peter G et al. The International Registry of Acute Aortic Dissection (IRAD): New Insights Into an Old Disease. JAMA. 2000; 283: 897 – 903.

26. Rashbass J. The Patient-Owned, Population-Based Electronic Medical Record: A Revolutionary Resource for Clinical Medicine. JAMA. 2001; 285: 1769.

27. Roger VL et al. Sex Differences in Evaluation and Outcome of Unstable Angina. JAMA. 2000; 283: 646 - 652.

28. Yancik R et al. Effect of Age and Comorbidity in Postmenopausal Breast Cancer Patients Aged 55 Years and Older. *JAMA*. 2001; 285: 885 - 892.

29. Labelle R, Stoddart G, Rice T. A Re-Examination Of The Meaning And Importance Of Supplier-Incuded Demand. *Journal of Health Economics*. 1994; 13(3): 347-368.

30. Crawford V, Sobel J. Strategic Information Transmission. *Econometrica.* 1982; 50: 1431-14518.

31. Pitchik C, Schotter A. Honesty in a Model of Strategic Information Transmission. *American Economic Review.* 1987; 77(5): 1032-1036.

32. Darby M, Karni E. Free Competition and the Optimal Amount of Fraud. *Journal of Law and Economics.* 1973; 16: 867-888.

33. Charles C, Gafnv A. Shared Decision-Making In The Medical Encounter: What Does It Mean? (Or It Takes At Least Two To Tango). *Soc. Sci. Med.* 1997; 44(5): 681-692.

34. Sacchetti P, Zvara P, Plante MK. The Internet and Patient Education - Resources and their Reliability: Focus on a Select Urologic Topic. *Urology.* 1999; 53(6): 1117-1120.

35. Harsanyi JC. Games with Incomplete Information Played by 'Bayesian' Players. Part I. The Basic Model. *Management Science.* 1967; 14(3): 159-182.

36. ___________ . Games with Incomplete Information Played by 'Bayesian' Players. Part II. Bayesian Equilibrium Points. *Management Science.* 1968; 14(5): 320-334.

37. ___________ . Games with Incomplete Information Played by 'Bayesian' Players. Part III. The Basic Probability Distribution of the Game. *Management Science.* 1968; 14(7): 486-502.

38. Selten R. Re-examination of the Perfectness Concept for Equilibrium Points in Extensive Games. *International Journal of Game Theory.* 1975; 41(1-2): 25-55.

39. Kreps DM, Wilson R. Sequential Equilibria. *Econometrica.* 1982; 50(4): 863-894.

40. Harsanyi JC, Selten R. *A General Theory of Equilibrium Selection in Games*. Cambridge, MA: MIT Press, 1988.

41. Katz ML, Shapiro C. Technology Adoption in the Presence of Network Externalities. *Journal of Political Economy.* 1986; 94(4): 822-841.

42. Wynia MK *et al.* Do Physicians Not Offer Useful Services Because of Coverage Restrictions? *Health Affairs.* 2003; 22(4): 190-197.

43. Institute of Medicine. Crossing the quality chasm: a new health system for the 21st century. Washington: National Academy Press, 2001.

44. Roter D, Hall J. Physician interviewing style and medical information obtained from patients. *J Gen Intern Med.* 1987; 2: 326.

45. Stewart M, Brown JB, Weston WAS'. Patient-centred medicine. Thousand Oaks, CA: Sage, 1995.

46. Schulman KA, Berlin JA, Harless W, et al. The effect of race and sex on physicians' recommendations for cardiac catheterization. N Engl J Med. 1999; 340: 618-626.

47. Wenneker M, Epstein AM. Racial inequalities in the use of procedures for patients with ischemic heart disease in Massachusetts. JAMA. 1989; 261: 253-257.

48. Gornick ME, Eggers PW, Reilly TW, et al. Effects of race and income on mortality and use of services among Medicare beneficiaries. N Engl J Med. 1996; 335:791-799.

49. Whittle J, Conigliaro J, Good CB, Lofgren RP. Racial differences in the use of invasive cardiovascular procedures in the Department of Veterans Affairs medical system. N Engl J Med. 1993; 329: 621-627.

50. Peterson ED, Shaw LK, DeLong ER, Pryor DB, Califf RM, Mark DB. Racial variation in the use of coronary-revascularization procedures: are the differences real? Do they matter? N Engl J Med. 1997; 336: 480-486.

51. Rubinstein A. Perfect equilibrium in a bargaining model. Econometrica. 1982; 50: 97–110.

52. Binmore KG, Rubinstein A, Wolinsky A. The Nash bargaining solution in economic modeling. Rand Journal of Economics. 1986; 17: 176–188.

53. Ausubel LM, Cramton P, and Deneckere RJ. Bargaining with Incomplete Information. In Handbook of Game Theory, Aumann RJ and Hart S (eds.). Vol.3, Amsterdam: Elsevier Science B.V., chapter 50, 2002.

CHAPTER III

EMPIRICAL EVIDENCE

Introduction

Patients are increasingly seeking medical information from the Internet and other sources [1-3], and several studies show that such patient or consumer-obtained medical information (POMI) has impact on the amount of healthcare services used by the patients. For example, Kenkel found that more informed patients have more physician visits [4]. In a survey to physicians, Murray et al. found that when patients brought information to the physicians and wanted a change in medication, many physicians usually did what the patients wanted, either completely (23%) or partially (59%) [5].

This suggests that a patient with medical information from sources other than his[*] physician (i.e., with POMI) may use more healthcare services and more resources than patients without such information. But given the persistent disparities in healthcare utilization among patients of different socioeconomic groups [6-10] and the fact that patients with POMI have different socioeconomic status than those without POMI [11], there are important questions about the relationship between POMI and healthcare utilization that are not addressed by existing studies. For example, are the healthcare disparities among different socioeconomic groups caused by differences in information seeking behaviors of these groups (i.e., can we change utilization level of certain patients by changing their information level)? Or is it the other way around, that differences in utilization between more informed patients and lesser informed ones are just a reflection of their differences in socioeconomic characteristics (i.e., as long as a patient's socioeconomic characteristics do not change, changing his POMI level has no impact on his utilization)?

Answers to these questions have important implications to efforts to alleviate or even eliminate the persistent disparities in healthcare utilization among different socioeconomic groups [6-10] and the persistent variances in healthcare utilization among different regions [12-20]. For

[*] For convenience, we assume that a patient is a male and a physician a female in this paper.

example, if changing the disparities/variances in information levels can change the disparities/variances in healthcare utilization across population groups or geographic regions, then we may well achieve such goals as a result of our efforts to create a patient-centered healthcare system [21-25] with shared decision making between patients and their providers [26-28]. Then, our vision about the power of Internet [29-30] and the shared decision making model [26-28] does hold the key to a better healthcare system for the 21st century as IOM and others envisioned [29, 31].

In this study, we address these questions by investigating the relationship between POMI and healthcare utilization at both the individual level and the regional (county) level. We first confirmed that a patient with POMI receives higher usage of healthcare services than a patient without POMI, even if these patients are at the same level of health conditions. This imbalance seems to be consistent in different services, as we found it in all ten services analyzed. We then investigate the change in per capita healthcare services usage in counties when more patients are obtaining POMI. Interestingly, we found that although counties with higher portion of patients with POMI tend to have higher per capita usage levels, the trend is not monotonic; there seems to exist stepwise effects. Per capita usage seems to remain at the same level as the portion of patients with POMI increases, until the portion reaches a critical value at which point per capita usage increases suddenly.

Methods

Data Sources And Sample Selection

Individual patients' sources of information and healthcare utilization data were obtained from the 2000-2001 Community Tracking Study (CTS) Household Survey, a biannual nationally representative telephone survey of the civilian, non-institutionalized families and individuals (total sample size of 59,725 people in 1226 counties) in the U.S. conducted by the Center for Studying Health System Change. Individual patient's demographic, socioeconomic, general health condition and insurance coverage data were also obtained from this survey.

Individual data were then aggregated to the county level by FIPS (Federal Information Processing Standards, by US Census Bureau) code. In a total of 1226 counties, those counties with 15 or more samples were selected, yielding a total of 41,485 individuals in 306 counties. Per capita utilization data were obtained by averaging individual utilization in each county, a practice frequently used in the literature [32]. For example, if there are 300 patients in the individual data with the same FIPS code, these 300 patients are aggregated into one record in the aggregate file, and the per capita utilization in that record was calculated by averaging the utilization rates of these 300 patients.

Healthcare resource data for these 306 counties were obtained from The 2003 Area Resource File (ARF), a database containing 6,289 healthcare related variables for each county in the US. It also uses the FIPS code to specify county code. Number of hospital beds and number of active MDs per 1000 population in each county were used in our analysis as they were shown to be associated with utilization [43].

Healthcare Service Utilization

We used ten different services in four categories (physician or other specialist visits, surgery rates, hospital stays and emergency room visits) as indicators of healthcare usage. These services are among the most widely used in utilization studies [32-36]. Table 3-1 shows these ten variables. Note that to protect patients' privacy, extraordinary large numbers were top coded (i.e., any number larger than the top code was coded as the top code).

Table 3-1 Health service variables

Table 3-1: Health service variables (in the last 12 months)			
Variable	Note	Mean (SD)	Top code
DRVISNX	Number of times seen a doctor (exclude in ER)	3.979 (5.23)	30
MPVISNX	Number of times seen a nurse practitioner, physician assistant, or midwife (excluding doctor visits)	0.399 (1.44)	13
SURGNX	Number of times had surgery	0.212 (0.56)	5
SURGOPX	Total number of outpatient surgeries	0.151 (0.47)	5
HSPNITX	Number of nights spent in hospital	0.526 (2.10)	15
HSPNODX	Number of hospital stays excluding baby delivery	0.140 (1.44)	5
HSPSTYN	Number of times stay in hospital overnight or longer	0.161 (0.62)	5
TOTERX	Total number emergency room visits	0.369 (0.90)	7
ERUSENX	Number of times went to a hospital ER room	0.288 (0.79)	7
HSPERX	Number of times admitted to a hospital through ER	0.084 (0.38)	5

Statistic Analysis

For descriptive analyses, χ^2 tests were used to compare demographic, socioeconomic and insurance coverage characteristics between patients with POMI and those without. Consistent with common practice in the literature [37-38], continuous variables such as income and age were categorized into categorical variables. Considering large sample size as well as a high number of comparisons, statistical significance for these comparisons was set at .001, reducing the Meehl effect [39] and the likelihood of chance significance. All p-values were 2-sided.

For relationships between POMI and utilizations, various tests were performed in two levels (the individual level and the county level). In the individual level, t-tests were used to compare the mean utilizations of all ten services of patients with POMI and patients without POMI in each general health condition level since utilizations are continuous variables and the independent variable is a dichotomous variable [40]. The level of general health condition for a patient was obtained using the self-reported general health condition variable (excellent, very good, good, fair, poor) in the CTS survey. Since studies showed that patients with POMI have different demographic, socioeconomic and insurance coverage status with patients without POMI [11] and that there exist disparities in healthcare utilization among patients with different socioeconomic characteristics [6-10], partial correlation analysis was used to see if the relationship between utilization and POMI persists after controlling for these socioeconomic, demographic and insurance coverage variables. Statistical significance for individual level analysis was set at .01, with all p-value 2-sided.

In the county level, because utilizations and portion of patients with POMI (Q_RATIO) are continuous variables, partial correlation analysis were used to establish the relationship between per capita utilizations of the ten services and Q_RATIO in the 306 counties, controlling for demographic, socioeconomic and insurance coverage characteristics of a county population and number of hospital beds and number of active MDs per 1000 population in a county [40]. Given the sample size (306), statistical significance for the analyses was set at .05 (all p-values were 2-sided).

As theoretical studies predict nonlinearity in the aggregate level relationship between POMI and utilization [49], binary variables representing different levels of Q_RATIO were used in multiple regression analysis [41] for those services that achieved statistical significance in the partial correlation analysis to account for possible nonlinearity in the relationship between Q_RATIO and per capita utilizations in the county level [40].

To further investigate the nonlinearity in the relationship between Q_RATIO and per capita utilizations, the continuous independent variable Q_RATIO was transformed into an ordinal variable and one-way analysis of variance (ANOVA) was used to compare means of per capital utilizations of different Q_RATIO groups [42]. Criteria for the categorical definitions of Q_RATIO were chosen so that the categories would divide the study population into groups of approximately the same number of counties and that the intervals between cut-off values were roughly the same. Because of the small number of counties with very low or very high Q_RATIO, counties with Q_RATIO less than 0.30 were categorized in one group, as were counties with Q_RATIO larger than 0.50.

All analyses were performed with SPSS, Version 13 (SPSS Inc, Chicago, Ill).

Results

Patient's Sources Of Medical Information

Most studies on POMI tend to focus on the Internet [44-48]. But as shown in the 2000-2001 CTS Household Survey and Figure 3.1 below, most patients are still acquiring POMI from more traditional sources such as books/magazines and friends/relatives. The survey asked individuals if they had sought medical information during the last 12 months from seven sources other than their physicians (the Internet, friends or relatives, TV or radio, books or magazines, somewhere else other than their doctors, healthcare professionals other than their doctors, healthcare organizations). Of all the total 41485 individuals, 25189 (60.7%) never sought medical information from such sources, 16296 (39.3%) sought medical information from at least one of these sources. Of these 16296 individuals, 9992 (61%) used books/magazines, 8342 (51%) used friends/relatives, 7190 (44%) used the Internet, 4755 (29%) used TV/Radio, and few (less than 3%) used other sources for POMI. The survey shows that about 17% of the US population used the Internet for health related information in 2000, comparable with similar surveys [48].

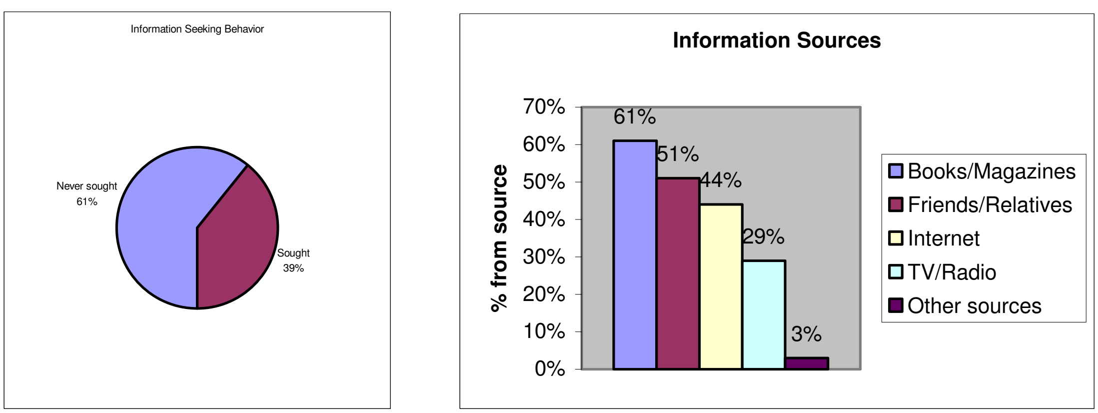

Figure 3.1 Information seeking behavior and information sources

Characteristics Of Patients With POMI

Table 3-2 shows the demographic, socioeconomic and insurance coverage characteristics of patients with POMI and those without POMI. It can be seen from this table that patients who actively seek POMI are on average younger, less healthy, have higher family income, spent more years in school, and are more likely to be female, insured and white than patients who rely solely on their physicians for medical information. Such characteristic differences are comparable with other studies [11].

Table 3-2 Characteristics of the whole CTS sample, patients who actively sought medical information and patients who did not sought medical information

	Patients who actively sought medical info	Patients who did not seek medical info	Whole CTS sample
	%	%	%
Gender			
Female	60.9	51.3	55.1
Chi-Square	369.7 (df=1, sig. <0.001)		
Ethnicity			
White	78.8	76.7	77.5
Black	11.3	12.6	12.1
Other	9.9	10.7	10.4
Chi-Square	31.0 (df=2, sig. <0.001)		
Age (years)			
<=21	3.7	4.3	4.0
21-34	23.0	23.0	23.0
35-49	34.6	32.5	33.3
50-64	23.7	22.0	22.7
65-74	9.2	10.5	10.0
>= 75	5.9	7.8	7.0
Chi-Square	103.8 (df=5, sig. <0.001)		
Mean (SD)	46.1 (16.2)	46.7 (17.3)	46.5 (16.9)
Household income ($)			
<25,000	27.9	33.0	31.0
25000-49999	27.0	29.1	28.2
50000-74999	24.0	21.9	22.7
>=75000	21.1	16.0	18.0
Chi-Square	259.6 (df=3, sig. <0.001)		
Mean	49524	43858	46083
Education (years)			
<=12	39.1	55.1	48.8
13-16	46.5	37.0	40.7
>16	14.5	7.9	10.5
Chi-Square	1138.3 (df=2, sig. <0.001)		
Health Status			
Excellent	17.3	21.8	20.0
Very good	36.4	37.2	36.9
Good	28.3	26.1	27.0
Fair	13.7	11.3	12.3
Poor	4.4	3.6	3.9
Chi-Square	180.8 (df=4, sig. <0.001)		
Residency			
Urban	70.0	68.9	69.3
Nonurban	30.0	31.1	30.7
Chi-Square	5.9 (df=1, sig. = 0.015)		
Insurance coverage			
Insured	89.7	87.1	88.1
Uninsured	10.3	12.9	11.9
Chi-Square	63.7 (df=1, sig. <0.001)		
Total respondents	16296	25189	41485

Differences In Healthcare Services Usage Of Patients With POMI And Without POMI

Comparison of means of ten services is presented in Table 3-3. Table 3-3 shows that there was a trend in the direction of those with POMI having higher utilization for all ten services than patients without POMI of the same general health condition level, although this trend was not universally statistically significant for all services and/or general health condition levels. For example, patients with POMI had statistically significantly higher number of surgeries than patients without POMI at all five general health condition levels, while there were statistically significant differences between patients with POMI and patients without POMI on number of nights spent at hospital only at the excellent health condition level.

Table 3-3 Usage by patients with POMI and patients without POMI

Table 3-3a Usage by patients with POMI and patients without POMI					
		# of Surgeries		# of Outpatient Surgeries	
	Number of observations	Mean (95% CI)	P Value	Mean (95% CI)	P Value
Excellent health					
w POMI	2812	0.18 (0.16-0.19)		0.14 (0.12-0.15)	
w/o POMI	5492	0.11 (0.10-0.12)	<0.001	0.09 (0.08-0.10)	<0.001
Very good health					
w POMI	5937	0.22 (0.21-0.23)		0.17 (0.16-0.18)	
w/o POMI	9632	0.16 (0.15-0.17)	<0.001	0.09 (0.08-0.10)	<0.001
Good health					
w POMI	4606	0.28 (0.26-0.30)		0.20 (0.19-0.22)	
w/o POMI	6578	0.21 (0.19-0.22)	<0.001	0.14 (0.13-0.15)	<0.001
Fair health					
w POMI	2227	0.35 (0.32-0.38)		0.23 (0.21-0.26)	
w/o POMI	2855	0.26 (0.24-0.29)	<0.001	0.17 (0.15-0.19)	<0.001
Poor health					
w POMI	714	0.48 (0.42-0.55)		0.27 (0.22-0.32)	
w/o POMI	902	0.39 (0.34-0.45)	0.04	0.23 (0.18-0.27)	0.21

Table 3-3b Usage by patients with POMI and patients without POMI					
		# of Hospital ER visits		# of ER visits	
	Number of observations	Mean (95% CI)	P Value	Mean (95% CI)	P Value
Excellent health					
w POMI	2812	0.16 (0.15-0.17)		0.22 (0.20-0.25)	
w/o POMI	5492	0.11 (0.10-0.12)	0.048	0.19 (0.17-0.20)	0.005
Very good health					
w POMI	5937	0.24 (0.22-0.25)		0.28 (0.26-0.30)	
w/o POMI	9632	0.20 (0.19-0.21)	<0.001	0.24 (0.23-0.26)	<0.001
Good health					
w POMI	4606	0.36 (0.34-0.39)		0.45 (0.42-0.47)	
w/o POMI	6578	0.29 (0.28-0.31)	<0.001	0.38 (0.35-0.40)	<0.001
Fair health					
w POMI	2227	0.54 (0.49-0.59)		0.72 (0.67-0.77)	
w/o POMI	2855	0.43 (0.40-0.47)	0.001	0.60 (0.56-0.64)	0.001
Poor health					
w POMI	714	0.90 (0.79-1.02)		1.32 (1.19-1.46)	
w/o POMI	902	0.68 (0.59-0.76)	0.002	1.05 (0.95-1.16)	0.002

Table 3-3c Usage by patients with POMI and patients without POMI					
		# of Hosp Adm. Through ER		# of Nights Spent in Hospital	
	Number of observations	Mean (95% CI)	P Value	Mean (95% CI)	P Value
Excellent health					
w POMI	2812	0.04 (0.03-0.05)		0.27 (0.22-0.32)	
w/o POMI	5492	0.03 (0.02-0.03)	0.01	0.17 (0.14-0.20)	<0.001
Very good health					
w POMI	5937	0.04 (0.04-0.05)		0.30 (0.26-0.33)	
w/o POMI	9632	0.04 (0.04-0.05)	0.862	0.27 (0.25-0.30)	0.277
Good health					
w POMI	4606	0.09 (0.08-0.10)		0.58 (0.52-0.64)	
w/o POMI	6578	0.08 (0.08-0.09)	0.657	0.56 (0.51-0.61)	0.639
Fair health					
w POMI	2227	0.18 (0.16-0.20)		1.05 (0.93-1.18)	
w/o POMI	2855	0.17 (0.15-0.19)	0.367	1.04 (0.93-1.16)	0.853
Poor health					
w POMI	714	0.46 (0.39-0.54)		2.74 (2.39-3.10)	
w/o POMI	902	0.41 (0.35-0.47)	0.254	2.39 (2.09-2.69)	0.137

Table 3-3d Usage by patients with POMI and patients without POMI					
		# of Hospital Stays		# of Hospital Stays Overnight	
	Number of observations	Mean (95% CI)	P Value	Mean (95% CI)	P Value
Excellent health					
w POMI	2812	0.07 (0.05-0.08)		0.10 (0.08-0.11)	
w/o POMI	5492	0.04 (0.04-0.05)	<0.001	0.06 (0.05-0.07)	<0.001
Very good health					
w POMI	5937	0.09 (0.08-0.10)		0.11 (0.10-0.12)	
w/o POMI	9632	0.07 (0.07-0.08)	0.01	0.09 (0.08-0.10)	0.035
Good health					
w POMI	4606	0.16 (0.15-0.18)		0.18 (0.16-0.19)	
w/o POMI	6578	0.14 (0.13-0.16)	0.043	0.16 (0.14-0.17)	0.043
Fair health					
w POMI	2227	0.30 (0.27-0.33)		0.33 (0.29-0.37)	
w/o POMI	2855	0.28 (0.25-0.30)	0.275	0.30 (0.27-0.33)	0.281
Poor health					
w POMI	714	0.70 (0.61-0.78)		0.79 (0.67-0.92)	
w/o POMI	902	0.62 (0.55-0.70)	0.201	0.68 (0.58-0.78)	0.147

Table 3-3e Usage by patients with POMI and patients without POMI					
		# of Nurse Practioner Visits		# of Physician Visits	
	Number of observations	Mean (95% CI)	P Value	Mean (95% CI)	P Value
Excellent health					
w POMI	2812	0.31 (0.27-0.35)		3.03 (2.88-3.18)	
w/o POMI	5492	0.19 (0.17-0.21)	<0.001	2.05 (1.97-2.13)	<0.001
Very good health					
w POMI	5937	0.44 (0.41-0.48)		3.88 (3.77-3.99)	
w/o POMI	9632	0.30 (0.27-0.32)	<0.001	2.91 (2.83-2.98)	<0.001
Good health					
w POMI	4606	0.31 (0.27-0.35)		5.18 (5.01-5.34)	
w/o POMI	6578	0.19 (0.17-0.21)	<0.001	3.83 (3.71-3.94)	<0.001
Fair health					
w POMI	2227	0.71 (0.63-0.80)		7.07 (6.77-7.37)	
w/o POMI	2855	0.49 (0.43-0.56)	<0.001	5.28 (5.05-5.52)	<0.001
Poor health					
w POMI	714	1.24 (1.01-1.46)		11.25 (10.54-11.96)	
w/o POMI	902	0.91 (0.73-1.08)	0.02	7.95 (7.44-8.47)	<0.001

The results shown in Table 3-3 should be interpreted with caution because they are unadjusted. Partial correlation analyses (Table 3-4) showed that these differences in utilization between patients with and without POMI were partially explained by demographic and socioeconomic factors, although a statistically significant linear association between utilizations and POMI persisted even after adjustment for these demographic and socioeconomic factors.

Table 3-4 Correlation between utilization and POMI before and after controlling for demographic and socioeconomic factors

Service	Unadjusted correlation	Partial Correlation
# of Physician Visits	0.135 (p<0.001)	0.099 (p<0.001)
# of Nurse Practioner Visits	0.064 (p<0.001)	0.049 (p<0.001)
# of Surgeries	0.066 (p<0.001)	0.051 (p<0.001)
# of Outpatient Surgeries	0.060 (p<0.001)	0.047 (p<0.001)
# of Nights Spent in Hospital	0.022 (p<0.001)	0.013 (p=0.008)
# of Hospital Stays	0.032 (p<0.001)	0.024 (p<0.001)
# of Overnight Hospital Stays	0.031 (p<0.001)	0.021 (p<0.001)
# of ER visits	0.048 (p<0.001)	0.042 (p<0.001)
# of Hospital ER visits	0.046 (p<0.001)	0.041 (p<0.001)
# of Hospital Admission through ER	0.019 (p<0.001)	0.014 (p=0.003)
Sample Size		41485

Portion Of Patients With POMI In A County And Per Capita Utilization In That County

Tables 3-3 and 3-4 show that there exists statistically significant relationship between utilization and POMI at the individual level. Our interest is to find out if such individual level relationship still exists at the county level, and if so, if there exists some non-linearity at the county level relationship [49].

To see what happens to the amount of healthcare services usage in a county when more patients are seeking medical information from sources other than their physicians, we aggregated the individual data to the county level. We define Q_RATIO as the portion of individuals in a county who actively seek medical information from sources other than their physicians (for example, if there are 300 samples in a county, and 100 has POMI, then Q_RATIO of this county would be 33.3.3%), and it ranges from 9% to 71%, with a mean of 37.5% and a median of 37.5% after aggregation. Per capita utilization data were calculated as the average utilization of every county for all ten services [32].

Table 3.5 presents the results of ten partial correlation analysis between per capita utilization and Q_RATIO after controlling for demographic, socioeconomic, and number of hospital beds and number of active MDs per 1000 population in each county. Results show that among the ten services, five (DRVISNX—Number of doctor visits; MPVISNX—Number of nurse practitioner, physician assistant, or midwife visits; SURGNX—Number of times had surgery; SURGOPX—Number of outpatient surgery; and HSPNITX—Number of nights spend in hospital) are correlated with Q_RATIO at the .05 level. The other five (ERUSENX—Number of times went to a hospital ER room; HSPERX—Number of times admitted to a hospital through ER; TOTERX—Number of ER visits; HSPSTYN—Number of times stay in a hospital overnight or longer; and HSPNODX—Number of hospital stays excluding baby delivery) are not correlated to Q_RATIO in the county level.

Table 3-5 Partial correlation between utilization and Q_RATIO

Service	Partial Correlation	Significance
# of Physician Visits	**0.149**	**0.010**
# of Nurse Practioner Visits	**0.248**	**<0.001**
# of Surgeries	**0.164**	**0.004**
# of Nights Spent in Hospital	**0.114**	**0.048**
# of Outpatient Surgeries	**0.113**	**0.049**
# of Hospital Stays	0.069	0.235
# of Overnight Hospital Stays	0.094	0.104
# of ER visits	0.061	0.291
# of Hospital ER visits	0.065	0.265
# of Hospital Admission through ER	0.03	0.600
Sample Size		306

The reasons for such differences among different variables need further investigation, and we offer one possible reason: some services are more subject to the choices of patients and/or their physicians, and therefore more subject to the impacts of POMI than others. For example, physician or nurse practitioner visits and surgery are more subject to impact of POMI than ER visits or hospital stays. Patients with POMI may initiate physician visits or request for surgery based on the their own information, but ER visits or hospital stays are less influenced by such POMI.

For the five services that are correlated with Q_RATIO, while the correlation coefficients are all positive, suggesting that per capita utilization of these services tend to increase as Q_RATIO increases, the relationship is not obviously linear, as shown in Figure 3.2.

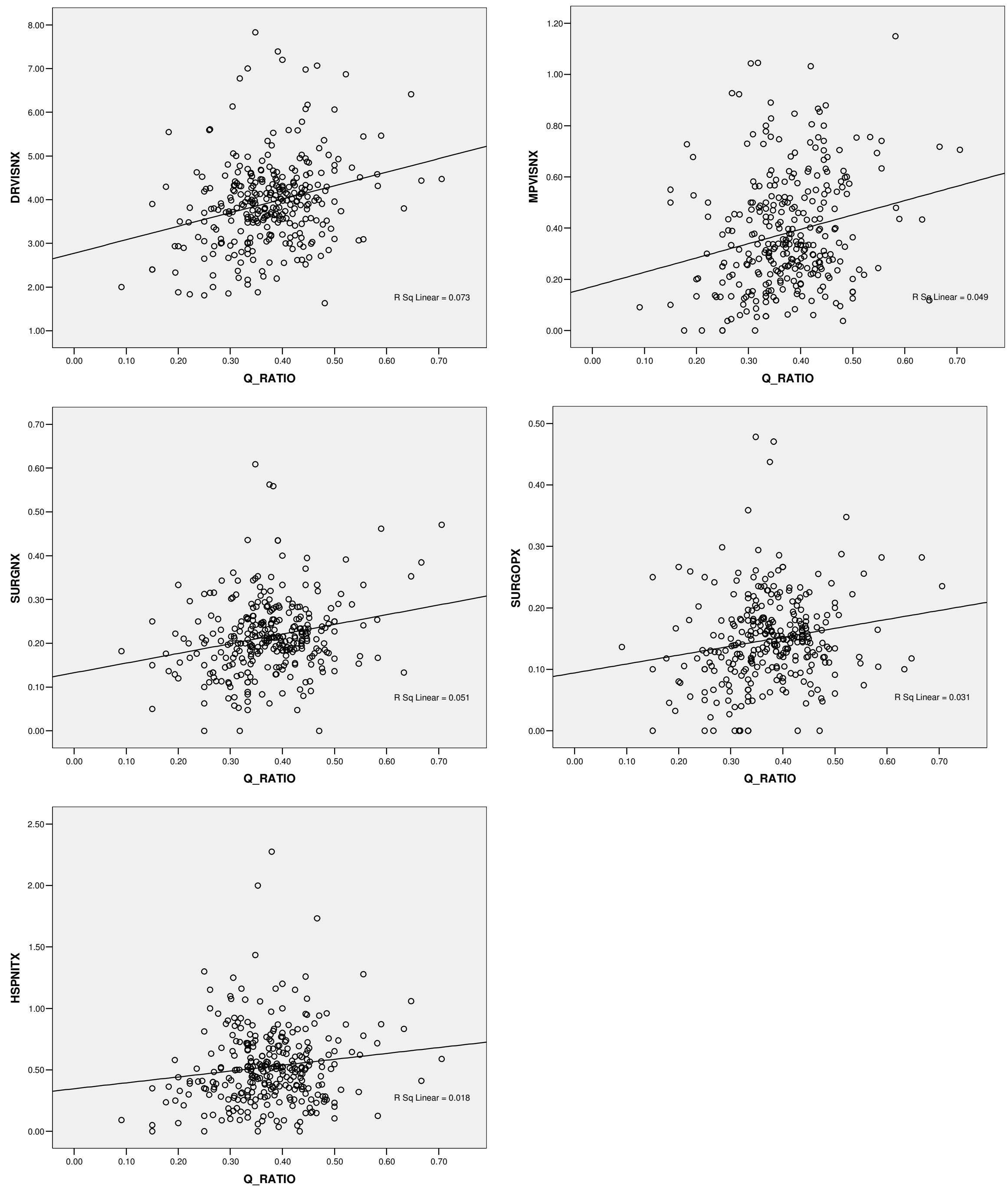

Figure 3.2 Scatter charts between Q_RATIO and Utilization

To assess possible nonlinearity in the relationship, two binary variables representing different levels of Q_RATIO (less than 30% or higher than 50%) were used in multiple regression analysis [41] for those five services that achieved statistical significance in the partial correlation analysis. Table 3-7 presents the results of such multiple regression models. Please note that as Q_RATIO is highly correlated to these binary variables representing different levels of Q_RATIO (Table 3-6), it is not appropriate to include Q_RATIO and any of these binary variables in the same regression model [40]. So two regression models were developed for every service, one contain Q_RATIO as independent (along with other control variables), the other contain the binary variables as independents (along with other control variables).

Table 3-6 Correlation Coefficients (Significance)

	Q_RATIO	Binary Variable Representing Q<30%
Q_RATIO		
Binary Variable Representing Q<30%	-0.642 (p<0.001)	
Binary Variable Representing Q>50%	0.560 (p<0.001)	-0.107 (p=0.062)
Sample Size:		306

Table 3-7 suggests that two binary variables, Q_LESSTHAN30 and Q_LARGERTHAN50, contain almost all of the information Q_RATIO has in predicting utilization of these five services (only variables that achieved statistic significance at the .05 level were included in the models). This strongly indicates that there exist stepwise effects on the impact of Q_RATIO on utilization in the county level.

Table 3-7 Multiple Regression Results

	DRVISNX			MPVISNX			SURGNX			HSPNITX			SURGOPX		
	Beta	t	p	Beta	t	p	Beta	t	p	Beta	t	p	Beta	t	p
Constant		-4.62	<0.001								-4.91	<0.001		-5.07	<0.001
General Health	0.44	7.28	<0.001							0.32	5.95	<0.001	0.35	6.50	<0.001
Income	0.22	3.50	0.001												
Education															
Q_RATIO	0.20	3.68	<0.001	0.22	3.95	<0.001	0.23	4.29	<0.001	0.14	2.59	0.010			
Age	0.15	2.87	0.004				0.21	3.85	<0.001	0.14	2.61	0.010	0.17	3.21	0.001
Adjusted R2			0.242			0.046			0.089			0.152			0.170
Constant		-4.00	<0.001					-2.40	0.017		-4.23	<0.001		-5.07	
General Health	0.50	7.93	<0.001							0.32	5.87	<0.001	0.35	6.50	<0.001
Income	0.20	2.76	0.006												
Education							0.17	2.87	0.004						
Q_LARGER_50							0.12	2.31	0.043						
Q_LESS_30	-0.11	-2.11	0.036	-0.16	-2.88	0.004				-0.14	-2.58	0.010			
Age	0.14	2.64	0.009				0.21	3.80	<0.001	0.14	2.57	0.011	0.17	3.21	0.001
Adjusted R2			0.235			0.023			0.084			0.152			0.170
Sample Size														306	

To further shed light on possible nonlinearity of the relationship between per capita utilization and Q_RATIO, we divided these 306 counties into eight groups according to their Q_RATIO values, and used ANOVA to analyze the resulting trends. We divided the counties into groups so that each group has roughly the same number of counties (about 40 counties per group, except for the last group, since there were not enough counties with high portion of patients with POMI). To test the robustness of the analysis, we tried different ways to form these groups, both by forming different numbers of groups and by forming the groups in different ways (i.e., using different cut-off values between groups). The results are similar, indicating that the analysis is robust. Table 3-8 and figure 3.2 show the results of one particular way of breaking the counties into eight groups.

Table 3-8 ANOVA: Q_RATIO group membership and utilization in the county level

	No. of observations	SURGNX	SURGOPX	DRVISNX	MPVISNX	HSPNITX
Counties with Q_RATIO between:						
9%-29%	43	0.18	0.12	3.41	0.29	0.41
29%-33%	37	0.18	0.12	3.90	0.38	0.57
33%-36%	46	0.22	0.16	3.83	0.37	0.54
36%-39%	40	0.24	0.17	3.87	0.37	0.54
39%-42%	41	0.23	0.16	4.10	0.34	0.57
42%-45%	51	0.22	0.16	4.12	0.45	0.52
45%-50%	32	0.20	0.13	4.02	0.38	0.47
50%-71%	15	0.29	0.19	4.66	0.55	0.68
p Value		<0.001	<0.001	0.001	0.001	0.087

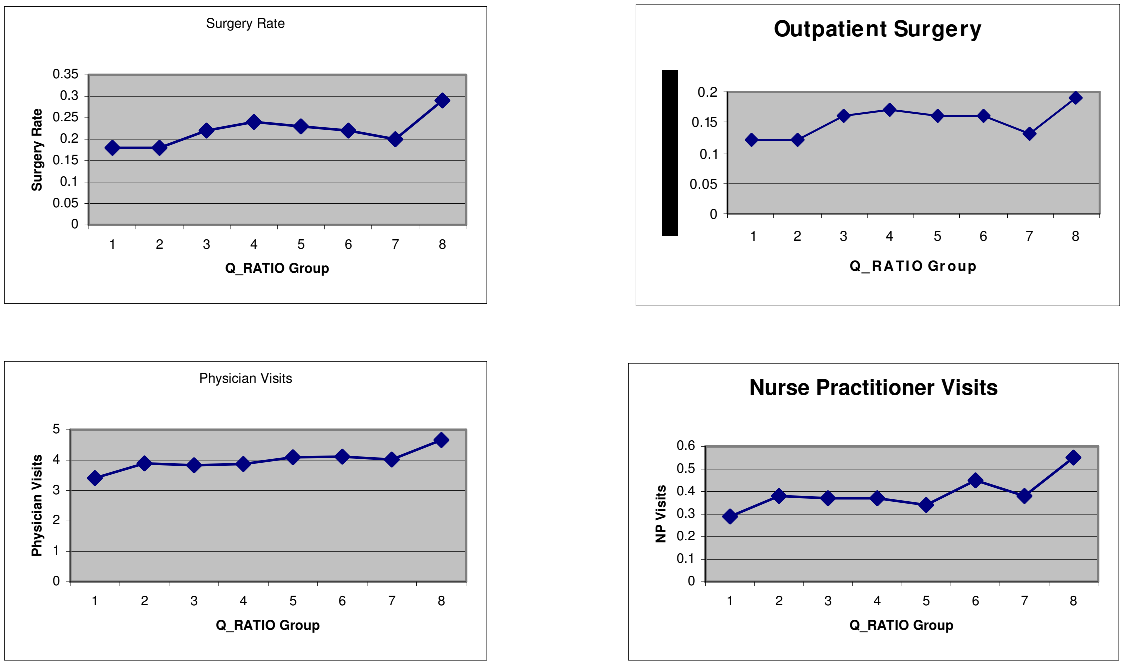

Figure 3.3 The nonlinear, non-monotonic relationship between per capita utilization and the portion of informed patients in US counties

Table 3-8 shows that the differences in utilization between counties of different Q_RATIO are statistically significant for four variables (DRVISNX—Number of doctor visits; MPVISNX—Number of nurse practitioner, physician assistant, or midwife visits; SURGNX—Number of times had surgery; SURGOPX—Number of outpatient surgery), while such difference is not statistically significant for HSPNITX (Number of nights spent in hospital), further confirming our reasoning that physician or nurse practitioner visits and surgery are more likely to be subject to the influence of POMI than hospital stays.

Table 3-8 and Figure 3.2 show that when the portion of patients in a county who seek POMI increases, per capita healthcare services usage for those four services in that county tends to increase as well, although the trend is not monotonic. When the portion is low (below 30%), healthcare services usage tends to be low; when the portion is high (above 50%), usage tends to be high; when the portion is medium (between 30% and 50%), usage tends to remain the same level with little change when the portion changes. Figure 3.2 illustrates the nonlinear, non-monotonic relationship between per capita utilization and the portion of informed patients in US counties.

One possible reason for such non-monotonic relationship might be that as more patients obtain POMI, they may demand new investments in equipment in their county, and new investments bring an increase in capacity. With the newly available capacity, patients in a county may get sudden increase in usage. There would not be such increase if the increase in the portion of patients with POMI were not enough to push for new investments in the county.

Another possible reason might be that physicians tend to react to the characteristics of the patient population, so when more patients use POMI, physicians may shrift their practice style to become more responsive to patients' request. Such sudden shrift in practice style brings the non-monotonic relationship, as we showed in another paper [49]. Although existing studies on variations of physicians practice did not specifically link such variances with POMI, such variances do widely exist [32-36].

Discussion

Our study found that of patients with POMI, most actually relied on more traditional sources such as friends/relatives and books/magazines for information. So while the Internet is playing an important role in providing medical information to patients, more traditional sources should not be ignored. Our study also suggested that of patients with the same level of general health condition, patients with POMI have higher healthcare services utilization than patients without POMI.

Such results have important implications for equality of care. It suggests that we may alleviate the persistent disparities in healthcare utilization among different socioeconomic groups [6-10] if we can alleviate the disparities in access to medical information among these groups. Given that most patients actually gain medical information from more traditional sources, we may be able to circumvent the persistent digital divide [50-53] to reach those patients of lower socioeconomic status who are less likely to have Internet access [11, 50] and who are usually in a disadvantaged position in terms of access to and utilization of healthcare services [6-10].

We also found that, when the portion of patients with POMI increases in a county, per capita utilization of healthcare services that are more likely to be subject to the influence of POMI tend to increase, while utilization of other services show no consistent pattern. This may be one of the factors that contributes to the wide spread regional variances in healthcare utilization [12-20], as regions with more informed patients may see more utilization initiated by informed patients. Further studies to link the portion of informed patients in a region with utilization and health outcome can shed more light to the welfare implications of such phenomenon, as studies show that large regional variances in utilization have little (if any) impact on outcome [54-56]. As studies show that more informed patients and more active participation in decision making are positively linked to better outcome [57-61], it would be very interesting to see if regional variances caused by differences in patient information have any impact on outcome.

Our study also found that of those services that see increase in utilization as the portion of informed patients increases, there seem to exist stepwise effects, in that utilization increase suddenly when the portion of informed patients crosses some critical values and remain stable otherwise. This suggests that utilization would not increase linearly as more patients seek POMI; utilization would increase only after enough patients seek POMI. In other words, providers would respond to informed patients' request only when there exist enough such informed patients. For a patient with POMI who would like to have a particular treatment, it may be desirable to seek such services in a region where there exist enough informed patients.

References

1. Gagliardi A, Jadad AR. Examination of instruments used to rate quality of health information on the internet: chronicle of a voyage with an unclear destination. *BMJ.* 2002; 324: 569-573.

2. Silberg WM, Lundberg GD, Musacchio RA. Assessing, Controlling, and Assuring the Quality of Medical Information on the Internet. *JAMA*. 1997; 277: 1244-1245.

3. Purcell GP, Wilson P, Delamothe T. The Quality of Health Information on the Internet. *BMJ*. 2002; 324: 557-558.

4. Kenkel D. Consumer Information and the Demand for Medical Care. *Review of Economics and Statistics*. 1990; 72(4): 587-595.

5. Murray E, Lo B et al. The Impact of Health Information on the Internet on Health Care and the Physician-Patient Relationship: National US Survey among 1050 US physicians. *Journal of Medical Internet Research.* 2003; 5(3): e17.

6. Schulman KA, Berlin JA, Harless W, et al. The effect of race and sex on physicians' recommendations for cardiac catheterization. *N Engl J Med*. 1999; 340: 618-626.

7. Wenneker M, Epstein AM. Racial inequalities in the use of procedures for patients with ischemic heart disease in Massachusetts. *JAMA*. 1989; 261: 253-257.

8. Gornick ME, Eggers PW, Reilly TW, et al. Effects of race and income on mortality and use of services among Medicare beneficiaries. *N Engl J Med.* 1996; 335:791-799.

9. Whittle J, Conigliaro J, Good CB, Lofgren RP. Racial differences in the use of invasive cardiovascular procedures in the Department of Veterans Affairs medical system. *N Engl J Med.* 1993; 329: 621-627.

10. Peterson ED, Shaw LK, DeLong ER, Pryor DB, Califf RM, Mark DB. Racial variation in the use of coronary-revascularization procedures: are the differences real? Do they matter? *N Engl J Med.* 1997; 336: 480-486.

11. Cotton SR and Gupta SS. Characteristics of online and offline health information seekers and factors that discriminate between them. *Social Science & Medicine.* 2004; 59: 1795-1806.

12. Coulter A, Seagroatt V, McPherson K. Relation between general practices' outpatient referral rates and rates of elective admission to hospital. *BMJ*. 1990; 301(6746): 273-276.

13. Baicker K, Chandra A, Skinner JS, and Wennberg JE. Who You Are And Where You Live: How Race And Geography Affect The Treatment Of Medicare Beneficiaries. *Health Affairs Web Exclusive.* October 7, 2004.

14. Dimick JB, Finlayson SRG, and Birkmeyer JD. Regional Availability Of High-Volume Hospitals For Major Surgery. *Health Affairs Web Exclusive.* October 7, 2004.

15. O'Connor AM, Llewellyn-Thomas HA, and Flood AB. Modifying Unwarranted Variations In Health Care: Shared Decision Making Using Patient Decision Aids. *Health Affairs Web Exclusive.* October 7, 2004.

16. Wennberg JE. Perspective: Practice Variations And Health Care Reform: Connecting The Dots. *Health Affairs Web Exclusive.* October 7, 2004.

17. Weinstein JN, Bronner KK, Morgan TS, and Wennberg JE. Trends: Trends And Geographic Variations In Major Surgery For Degenerative Diseases Of The Hip, Knee, And Spine. *Health Affairs Web Exclusive.* October 7, 2004.

18. Goodman DC. Trends: Twenty-Year Trends In Regional Variations In The U.S. Physician Workforce. *Health Affairs Web Exclusive.* October 7, 2004.

19. Berenson RA. Perspective: Lumpers And Splitters: Different Approaches To Understanding Variations Research. *Health Affairs Web Exclusive.* October 7, 2004.

20. Fuchs VR. Perspective: More Variation In Use Of Care, More Flat-Of-The-Curve Medicine. *Health Affairs Web Exclusive.* October 7, 2004.

21. Say RE, Thomson R. The importance of patient preferences in treatment decisions—challenges for doctors. *BMJ.* 2003; 327: 542 - 545.

22. Hibbard JH. Perspective: Moving Toward A More Patient-Centered Health Care Delivery System. *Health Affairs Web Exclusive.* October 7, 2004.

23. Skelton J, Coleman T, et al. Patient centred care of diabetes in general practice. *BMJ.* 1999; 318: 1621.

24. National Cancer Alliance. Patient-centered cancer services? What patients say? Oxford: National Cancer Alliance, 1996.

25. Berry LL, Seiders K, Wilder SS. Innovations in Access to Care: A Patient-Centered Approach. *Ann Intern Med.* 2003; 139: 568 - 574.

26. Ferriman A. Patients need to be more involved in care decisions. *BMJ.* 2001; 323: 10.

27. Charles C, Whelan T, Gafni A. What do we mean by partnership in making decisions about treatment? *BMJ.* 1999; 319: 780 - 782.

28. Charles C, Gafnv A. Shared Decision-Making In The Medical Encounter: What Does It Mean? (Or It Takes At Least Two To Tango). *Soc. Sci. Med*. 1997; 44(5): 681-692.

29. Kassirer JP. Patients, physicians, and the Internet. *Health Affairs.* 2000; 19(6): 115-123.

30. Kassirer JP. The Next Transformation in the Delivery of Health Care. *New England Journal of Medicine*. 1995; 332(1): 52–54.

31. Institute of Medicine. Crossing the quality chasm: a new health system for the 21st century. Washington: National Academy Press, 2001.

32. Landon BE, Reschovsky J, Blumenthal D. Changes in Career Satisfaction Among Primary Care and Specialist Physicians, 1997-2001. *JAMA*. 2003; 289: 442-449.

33. Wennberg JE, Cooper MM, eds. The quality of medical care in the United States: a report on the Medicare program. The Dartmouth atlas of health care 1999. Chicago, IL: American Hospital Association Press, 1999.

34. Wennberg JE, Freeman JL, Culp WJ. Are hospital services rationed in New Haven or over-utilized in Boston? *Lancet.* 1987; i: 1185-1188.

35. Wennberg JE, Freeman JL, Shelton RM, Bubolz TA. Hospital use and mortality among Medicare beneficiaries in Boston and New Haven. *N Engl J Med.* 1989; 321:1168-1173.

36. Fisher ES, Wennberg JE, Stukel TA, Sharp SM. Hospital readmission rates for cohorts of Medicare beneficiaries in Boston and New Haven. *N Engl J Med.* 1994; 331: 989-995.

37. Newhouse JP and The Insurance Experiment Group. Free for all? Lessons from the RAND Health Insurance Experiment. Harvard University Press, Cambridge, Massachusetts, 1993.

38. Jain T, Harlow BL, Hornstein MD. Insurance Coverage and Outcomes of in Vitro Fertilization. *N Engl J Med.* 2002; 347: 661-666.

39. Meehl P. Clinical Versus Statistical Prediction: A Theoretical Analysis and a Review of the Evidence. University of Minnesota Press, Minneapolis, 1954.

40. Keppel G, Wickens TD. Design and Analysis : A Researcher's Handbook (4th Edition). Prentice Hall, 2004.

41. Cunningham PJ, Grossman JM, Peter RFS, Lesser CS. Managed Care and Physicians' Provision of Charity Care. *JAMA.* 1999; 281:1087-1092.

42. Berger MS. Perspectives in nonlinearity: An introduction to nonlinear analysis. W. A. Benjamin, 1968.

43. Fuchus VR. The Supply of Surgeons and The Demand for Operations. *The Journal of Human Resources.* 1978; XIII Supplement: 35-56.

44. Sciamanna CN, Clark MA, Diaz JA, Newton S. Filling the gaps in physician communication. The role of the Internet among primary care patients. *Int J Med Inf.* 2003; 72(1-3): 1-8.

45. van Woerkum CM. The Internet and primary care physicians: coping with different expectations. *Am J Clin Nutr.* 2003; 77(4 Suppl): 1016S-1018S.

46. Sciamanna CN, Clark MA, Diaz JA, Newton S. Filling the gaps in physician communication. The role of the Internet among primary care patients. *Int J Med Inf.* 2003; 72(1-3): 1-8.

47. Ziebland S, Chapple A, Dumelow C, Evans J, Prinjha S, Rozmovits L. How the internet affects patients' experience of cancer: a qualitative study. *BMJ.* 2004; 328(7439): 564.

48. Baker L, Wagner TH, Singer S and Bundorf MK. Use of Internet and E-mail for Health Care Information, Results From a National Survey. *JAMA*. 2003(289): 2400-2406.

49. Xie B, Dilts DM and Shor M 2004. The Physician-Patient Relationship: The Impact of Patient Obtained Medical Information. Under review at *Health Economics*.

50. Brodie M, Flournoy RE, Altman DE, Blendon RJ, Benson JM, Rosenbaum MD. Health information, the Internet, and the digital divide. *Health Affairs*. 2000; 19(6): 255-265.

51. Bikson TK Panis CWA. Citizens, Computers, and Connectivity: A Review of Trends. Santa Monica, Calif. *RAND*, 1999.

52. Birdsell D et al. Web Users Are Looking More Like America. *Public Perspective*. 1998; 33–35.

53. National Science Board, Science and Engineering Indicators—2000. Arlington, Va.: National Science Foundation, 2000.

54. Fisher ES, Wennberg DE, Stukel TA, Gottlieb D, Lucas FL, Pinder E. The implication of regional variances in medicare spending. Part 1: the content, quality and accessibility of care. *Annals of Internal Medicine*. 2003; 138: 273-287.

55. Fisher ES, Wennberg DE, Stukel TA, Gottlieb D, Lucas FL, Pinder E. The implication of regional variances in medicare spending. Part 2: health outcomes and satisfaction with car. *Annals of Internal Medicine*. 2003; 138: 288-298.

56. Wennberg JE, Fisher ES, Skinner J. Geography and the debate over Medicare reform. *Health Affairs Web Exclusive*. 13 February, 2002.

57. Krakauer H, Jacoby I, Millman M. Lukomnik JE. Physician Impact on hospital admission and on mortality rates in the medicare population. *Health Service Research*. 1996; 31: 191-211.

58. Fallowfield LJ, Hall A, Maguire GP, Baum M. Psychological outcomes of different treatment policies in women with early breast cancer outside a clinical trial. *BMJ*. 1990; 301: 575-580.

59. Gattellari M, Butow PN, Tattersall MH. Sharing decisions in cancer care. *Soc Sci Med*. 2001; 52(12): 1865-78.

60. Kinmonth AL, Woodcock A, Griffin S, Spiegal N, Campbell MJ. Randomised controlled trial of patient centred care of diabetes in general practice: impact on current wellbeing and future disease risk. *BMJ*. 1998; 317: 1202 – 1208.

61. Bodenheimer T et al. Patient Self-Management of Chronic Disease in Primary Care. *JAMA*. 2002; 288 (19): 2469–2475.

CHAPTER IV

IMPACT OF POMI ON PHYSICIAN'S ATTITUDE

Introduction

With the increasing availability and accessibility of medical information through the Internet and other sources, there is hope that the Internet may help create a patient-centered healthcare system utilizing a shared decision making model between patients and their physicians [1-8]. While it is widely documented that increasingly more patients are obtaining medical information from the Internet and other sources [9-11] and that such patient obtained medical information (POMI) impacts on the physician-patient relationship [12-15] and on patient outcome [16-20], the potential for POMI to create a patient-centered healthcare system and a shared decision making model depends largely on the actions of physicians, as the physician is the gatekeeper of the healthcare system [21].

Existing evidence shows that physicians have mixed feelings about POMI and shared decision-making [22-26]. Some see it as positive, while others cite time constraint, questionable quality of POMI and patients' questionable ability to understand information as reasons for reservations [22-26]. Given the important role physicians play in the physician-patient interaction, different reactions on the physician side towards POMI will certainly have major implications on efforts to promote patient-centered healthcare and shared decision making. But little is known about how physicians factors, such as race, gender, practice type and other demographic and socioeconomic characteristics, impact physicians' reaction to POMI. For example, while Murray et al listed physicians' overall attitude towards POMI, they did not study if and how physicians with different characteristics differ on such attitude [23].

Evidence shows that black patients or patients of color are more likely to see black physicians or physicians of color [27-31]. Given the disadvantages minority patients have on access to medical information [32] and utilization of healthcare [33-37], it would be helpful to know if minority physicians are more or less positive towards POMI than white physicians. Another example is the impact of physicians' financial incentives on their attitude towards POMI, as studies show that physicians' financial incentive has significant impacts on physicians' behavior and patients' utilization [38-39]. It would be interesting to know if such financial incentives also impact physicians' attitude towards POMI.

In this paper, we investigate the differences in reaction to POMI among physicians of different demographic and socioeconomic groups. We found that physicians' attitudes towards POMI and their willingness to order tests, procedures or prescriptions upon patients' requests that they would not otherwise order are influenced by physicians' demographic, socioeconomic and practice characteristics. Physicians of male gender, older age, international training, race other than white, and overall personal financial incentive favoring expanding services are more likely to have positive attitudes towards POMI and more willing to order tests, procedures or prescriptions upon patients' requests.

Study Data And Methods

Data Source

The data for our analysis were drawn from the 2000-2001 Community Tracking Study (CTS) Physician Survey. The CTS Physician Survey is a biannual nationally representative survey of physicians in the U.S. conducted by the Center for Studying Health System Change. The survey has been conducted three times (1996-97, 1998-99 and 2000-01), and approximately 12,000 physicians were interviewed for each survey. The 2000-2001 CTS Physician Survey has a sample of 12406 physicians, and it includes each physician's demographic, socioeconomic and professional characteristics, and his/her reactions to POMI. After excluding those with missing values, a total of 10706 physicians were included in our analysis.

Physician's Reaction to POMI

Physician's reaction to POMI is a multi-dimensional variable, as various studies have viewed it from different aspects [22-26]. In our study, we include the physician's opinion about the impacts of POMI on physician's efficiency, on her[2] ability to provide high quality care, and on her willingness to recommend treatments upon requests from patients with POMI that she would otherwise not recommend as indicators of physician's reaction to POMI.

Specifically, we used three variables from the 2000-2001 CTS Physician Survey to measure a physician's reaction to POMI. The first one is PATACT, the percentage of patients she ordered tests, procedures, or prescriptions (refer to as services hereafter) suggested by patients that she would not otherwise have ordered during the last month. It ranges from 0 to 100. After controlling the percentage of patients discussing medical conditions, tests, treatments or drugs they (patients) learned from POMI, this variable (PATACT) measures the physician's willingness to order treatments per the requests of patients. The second metric is EFEFF, the physician's opinion (negative, neutral, positive) on the effect of medical information obtained by her patients from non physician sources on her efficiency. It has three possible values (1-negative, 2-netural, 3-positive). The third variable is EFINFO, the physician's opinion (1-negative, 2-neutral, 3-positive) on the effect of POMI on her ability to provide high quality care.

Correlation results in Table 4-1 show that PATACT is not correlated to the other two variables (treating EFEFF and EFINFO as interval variables), so PATACT measures a different construct with the other two variables. The correlation coefficients between EFEFF and EFINFO (as interval variables or as ordinal variables) are low, suggesting that while there exists overlap on what these two variables measure, one variable still provides significant new information about the physician's attitude towards POMI even when we know the value of the other.

[2] For convenience, we assume that the physician is a female and the patient male.

Table 4-1 Correlation Coefficients (Significance)

	EFEFF	EFINFO
EFINFO	Person's R 0.419 (p<0.001) Gamma: 0.579 (p<0.001) Kendall's tau-b: 0.385 (p<0.001)	
PATACT	0.006 (p=0.536)	-0.002 (p=0.831)
Sample Size:		10706

Physician's Demographic, Socioeconomic And Practice Characteristics

We included information about the age, gender, ethnicity, income, years in practice, country of training, specialty, geographic setting and overall personal financial incentive of each physician in our analysis. Most of these variables are widely used in the literature [40-42]. Please refer to Table 4-2 for detailed description for these variables.

Table 4-2 Variable description

Variable	Description	Value
AGE	Age	Range: 28-100; Mean: 46.6; Median: 45
GENDER	Gender	1 Male 2 Female
YRS_PRCT	Years in practice	Range: 0-58; Mean: 14.3; Median: 13
RACE_GRP	Race	1 White 2 Black 3 Asian or Pacific Islander 4 Other
MSACAT	Geographic Setting	1 Large metro over 200k 2 Small metro under 200k 3 Rural
AMAPRIM	Specialty	1 Primary care 2 Non-primary care
IMGUSPR	Country of training	1 US 2 Foreign
INCENT	Financial incentive	1 Favor reducing services 2 Favor expanding services 3 Favor neither
INCOMET	1999 income from practice	Range: 0-400,000; Mean: 157,307; Median: 140,000
EFEFF	Opinion on the impact of POMI on efficiency	1 Negative 2 Netural 3 Positive
EFINFO	Opinion on the impact of POMI on ability to provide high quality care	1 Negative 2 Netural 3 Positive
PATACT	Percentage of patients ordered tests, procedures, or prescriptions SUGGESTED BY PATIENTS that would not otherwise have ordered during last month	Range: 0-100; Mean: 4.36; Median: 2
PATINFO	Percentage of patients talked about medical conditions, tests, treatments, or drugs they had read or heard about from other sources during last month	Range: 0-100; Mean: 18.2; Median: 10

Analysis

In the three variables measuring physician's reaction to POMI, two are ordinal (EFEFF and EFINFO), one is interval (PATACT). Since PATACT has a highly skewed distribution (Figure 4-1), it was transformed into an ordinal variable in descriptive and regression analysis, although ordinary least square regression was also performed to see if such OLS regression yields different results. PATACT was categorized into three groups (0%, 1-4%, 5-100%) so that each group has roughly the same number of physicians to avoid difficulties in χ^2 tests and logistic regression analysis [43]. While such categorization facilitates χ^2 tests and logistic regression analysis, it ignores information on the high end (since 5-100% was categorized into one group, information on the differences within this group was not used), so results of χ^2 tests and logistic regression analysis should be interpreted with caution.

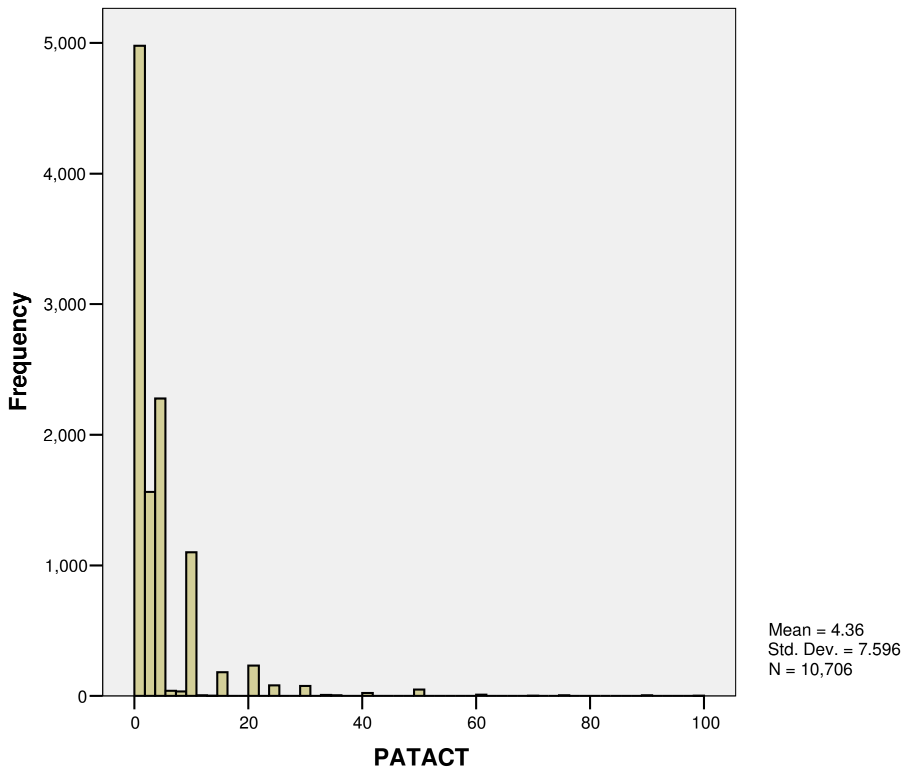

Figure4.1 Highly skewed distribution of PATACT

For descriptive analysis, χ^2 tests were used to compare differences in demographic, socioeconomic and practice characteristics among physician groups with different attitudes towards POMI. Consistent with common practice in the literature [44-45], continuous variables such as income and age were categorized into categorical variables to facilitate χ^2 tests. Considering large sample sizes as well as a high number of comparisons, statistical significance for these comparisons was set at .01, reducing the Meehl effect [46] and the likelihood of chance significance. All p-values were 2-sided.

To further assess the adjusted predictive powers of various demographic, socioeconomic and practice characteristics on physician's attitudes towards POMI, ordinal logistic regression analysis for all three dependant variables and multivariate ordinary least square regression (for PATACT as an interval variable) were performed. In the ordinal logistic regression analysis, continuous variables such as age and income were categorized into categorical variables to avoid the creation of a very large cell probabilities table [47]. Because the dependant variables are ordinal variables with three categories, ordinal logistic regression was preferable over multinomial logistic regression or ordinary least square regression [43].

All analyses were performed with SPSS, Version 13 (SPSS Inc, Chicago, Ill).

Results

Overall Characteristics Of The Sample

Table 4-3 presents the overall characteristics of the sample. These characteristics are comparable to the American Medical Association (AMA) Physician Masterfile in the same time period and other national representative physician surveys [23] with the exception of a slight under representation of older (60+ years old), high income ($250k+ annual income), and US trained physicians.

Table 4-3 Overall characteristics of the sample

	No. (%)
Gender	
Female	2792 (26.1)
Male	7914 (73.9)
Ethnicity	
White	8573 (80.1)
Black	434 (4.1)
Asian or Pacific Islander	1307 (12.2)
Other	392 (3.6)
Age (years)	
<=39	2876 (26.9)
40-49	4141 (38.7)
50-59	2486 (23.2)
60+	1203 (11.2)
Years in practice	
0-14	6013 (56.2)
15-29	3806 (35.6)
30-44	783 (7.3)
45 +	104 (1.0)
1999 income from practice($)	
<100,000	2740 (25.6)
100,001-150,000	3724 (34.8)
150,001-200,000	2068 (19.3)
200,001-250,000	940 (8.8)
250,001 +	1234 (11.5)
Geographic setting	
Large metro over 200k	9220 (86.1)
Small metro under 200k	369 (3.4)
Rural	1117 (10.4)
Type of medical specity	
Prime care	6986 (65.3)
Non-prime care	3720 (34.7)
Country of training	
US	8562 (80.0)
Foreign	2144 (20.0)
Overall Personal Financial Incentive	
Favor Reducing Serv	854 (8.0)
Favor Neither	7331 (68.5)
Favor Expanding Serv	2521 (23.5)
Total respondents	10706

Physicians' Reaction To POMI

Table 4-4 presents physicians' encounter with and reactions towards POMI.

Table 4-4 Physicians' encounter with and reaction to POMI

	No. (%)
During the last month, what percentage of your patients talked about medical conditions, tests, treatments, or drugs they had read or heard about from various sources other than you?	
0%	100 (1.0)
1-25%	8451 (78.9)
26%-50%	1603 (15.0)
51%-75%	354 (3.3)
76%-100%	198 (1.8)
During the last month, for what percentage of your patients did you order tests, procedures, or prescriptions SUGGESTED BY PATIENTS that you would not otherwise have ordered?	
0%	3617 (33.7)
1-25%	6884 (64.3)
26%-50%	170 (1.6)
51%-75%	23 (0.2)
76%-100%	12 (0.1)
On balance, what do you think is the effect of medical information obtained by your patients from sources other than you on your EFFICIENCY?	
Positive	2811 (26.3)
Neutral	4475 (41.8)
Negative	3420 (31.9)
On balance, what do you think is the effect of medical information obtained by your patients from sources other than you on your ability to provide HIGH QUALITY CARE?	
Positive	5134 (48.0)
Neutral	3834 (35.8)
Negative	1738 (16.2)
Total Respondents	10706

It can be seen from Table 4-4 that most physicians have some patients talking about information they obtained from other sources, and quite large percentage (66.3%) ordered tests, procedures or prescriptions suggested by patients that their would not otherwise have ordered (referred to as order upon request hereafter). It can also be seen that significant number of physicians (31.9%) believe that POMI have a negative impact on efficiency and on their ability to provide high quality care (16.2%). Such results are consistent with existing studies [23].

Differences In Physicians' Attitudes Towards POMI

Table 4-5 presents results of χ^2 tests comparing the differences in attitudes towards POMI among physicians of different characteristics. As discussed earlier, because of the way PATACT was categorized, results of PATACT should be interpreted with caution.

It can be seen from table 4-5 that overall, physicians are more likely to have negative opinion about the impacts of POMI on efficiency than on their ability to provide high quality of care, indicating that time constraints are an important factor in how physicians react to POMI, a conclusion shared by other studies [48-50].

It can also be seen that physicians' income and geographic setting do not have statistically significant impact on physicians' opinions about the impacts POMI on efficiency, indicating that the issue of time constraint exists across board, and the practice environment does not seem to make a large difference in this front. On the other hand, physicians' age, gender, ethnicity, years in practice, country of training and overall personal financial incentive are statistically significant on physicians' opinion on the impacts of POMI on efficiency. For example, younger physicians (in terms of both age and years in practice) are more likely to have negative opinion on the impacts of POMI on efficiency. Another finding is that female physicians are more likely to have negative opinion about the impacts of POMI on efficiency. This is surprising, given our culture of females being assumed to be more gentle and patient. As to country of training and overall personal financial incentive, physicians trained in the US and physicians with overall personal financial incentive favor reducing services are more likely to have negative opinion about the impacts of POMI on efficiency.

On physicians' opinion of the impacts of POMI on their ability to provide high quality care, only type of medical specialty and overall personal financial incentive are statistically significant (although ethnicity was statistically significant, it did not show a consistent pattern of impacts), Primary care physicians and physicians with overall personal financial incentive favor reducing services are more likely to have negative opinion about the impacts of POMI on their ability to provide high quality care.

Table 4-5 Different reactions to POMI among physicians of different characteristics

	EFEFF				EFINFO				PATACT			
	Negative	Neutral	Positive	Chi-Squ	Negative	Neutral	Positive	Chi-Squ	0%	1-4%	5-100%	Chi-Squ
Gender												
Female	36.0	39.8	24.3	28.4 (df=2	16.3	36.7	47.0	1.6 (df=2	31.8	29.2	39.0	7.3 (df=2
Male	30.5	42.5	27.0	p<0.001)	16.2	35.5	48.3	p=0.451)	34.5	27.5	28.0	p=0.027)
Ethnicity												
White	34.6	42.8	22.6	323.5 (df=	16.7	35.6	47.7	17.0 (df=6	33.7	29.1	37.2	62.9 (df=6
Black	22.1	38.7	39.2	6, p<0.001)	14.1	35.9	50.0	p=0.009)	40.8	24.7	34.6	p<0.001)
Asian or Pacific Islander	19.7	38.6	41.6		13.1	38.2	48.7		30.4	23.7	45.9	
Other	26.3	33.9	39.8		19.1	31.9	49.0		39.3	19.9	40.8	
Age (years)												
<=39	35.1	40.5	24.4	119.9 (df=	16.50	37.4	46.1	12.3 (df=6	27.7	29.2	43.2	96.2 (df=6
40-49	34.4	41.0	24.6	6, p<0.001)	16.90	34.3	48.9	p=0.056)	33.7	28.0	38.3	p<0.001)
50-59	30.0	43.0	27.1		15.8	35.8	48.4		37.7	27.4	34.9	
60+	20.0	45.4	34.6		14.5	37.3	48.2		40.6	26.3	33.2	
Years in practice												
0-14	33.9	41.3	24.8	76.8 (df=6	16.5	36.6	46.8	10.2 (df=6	31.5	27.9	40.6	55.1 (df=6
15-29	31.5	41.7	26.7	p<0.001)	16	34.2	49.8	p=0.118)	35.8	28.5	35.7	p<0.001)
30-44	21.1	46.0	33.0		14.9	36.7	48.4		40.1	27.5	32.4	
45 +	15.4	43.3	41.3		16.3	39.4	44.2		46.2	17.3	36.5	
1999 income from practice($)												
<100,000	31.7	39.9	28.4	15.5 (df=	16.8	35.4	47.7	10.5 (df=8	32.2	28.2	39.6	90.6 (df=8
100,001-150,000	32.4	41.5	26.1	8, p=0.051)	16.2	37.3	46.5	p=0.234)	30.6	28.3	41.1	p<0.001)
150,001-200,000	32.2	42.2	25.6		16.7	34.9	48.5		33.3	29.2	37.5	
200,001-250,000	30.3	45.9	23.8		15.1	34.3	50.6		39.7	26.7	33.6	
250,001 +	31.9	43.0	25.0		15.1	35.0	49.9		43.3	25.3	31.4	
Geographic setting												
Large metro over 200k	32.1	41.6	26.2	7.6 (df=4	16.2	36.2	47.6	8.4 (df=4	34.2	27.9	37.9	12.3 (df=4
Small metro under 200k	27.9	48.5	23.6	p=0.106)	14.4	30.9	54.7	p=0.079)	34.4	23.6	42.0	p=0.015)
Rural	32.0	40.8	27.2		16.8	34.5	48.7		33.0	30.3	39.7	
Type of medical specity												
Prime care	33.8	39.7	26.5	41.9 (df=2	17.8	36.0	46.2	43.6 (df=2	27.2	30.0	42.8	393.6 (df=2
Non-prime care	28.5	45.7	25.8	p<0.001)	13.3	35.5	51.2	p<0.001)	46.1	24.2	29.7	p<0.001)
Country of training												
US	35.5	42.2	22.4	415.2 (df=2	16.2	36.0	47.8	1.0 (df=2	33.6	29.2	37.2	36.0 (df=2
Foreign	17.8	40.4	41.8	p<0.001)	16.4	34.9	48.7	p=0.602)	34.4	23.1	42.5	p<0.001)
Overall Personal Fina Incent												
Favor Reducing Serv	39.5	36.8	23.8	51.2 (df=2	22.8	33.8	43.3	61.5 (df=4	28.6	27.5	43.9	24.8 (df=4
Favor Neither	31.5	43.3	25.2	p<0.001)	15.9	37.3	46.7	p<0.001)	35.0	27.9	37.0	p<0.001)
Favor Expanding Serv	30.6	39.1	30.3		15	32.0	53.0		31.9	28.2	39.9	

Adjusted Predictive Powers Of Various Characteristics

Table 4-6 presents results of ordinal logistic regression models for all three dependant variables. Again, because of the way PATACT was categorized, results of PATACT should be interpreted with caution.

Please note that as age and years in practice were highly correlated (Person Correlation: 0.901), years in practice was not included in the regression models. Only variables with statistical significance were included in the table. It can be seen from Table 4-6 that income and geographic setting did not achieve statistical significance for all three variables, indicating that they have no predictive power on physician's attitude towards POMI. On the other hand, overall personal financial incentive and type of medical specialty achieve statistical significance for all three variables, suggesting that these two factors impact all three aspects of physician's attitude towards POMI.

On physician's opinion on the impact of POMI on efficiency, Table 4-6 shows that male physicians are more likely to have positive opinion (odds ratio: 1.18, 95% CI: 1.08-1.28) than females. It also shows that physicians of non-white ethnicity, older age, engaged in non-prime care, trained outside the US, and with overall personal financial incentive favoring expanding services are more likely to have a positive opinion on the impact of POMI on efficiency. The influences of ethnicity, age and country of training are especially large, as physicians of ethnicity other than white are much more likely to have positive opinion than white physicians (Black: odds ratio: 2.14, 95% CI: 1.79-2.57; Asian: odds ratio: 1.67, 95% CI: 1.42-1.83; Other: odds ratio: 1.66, 95% CI: 1.37-2.01), physicians 60 years or older are almost two times as likely to have positive opinion than physicians 39 years or younger (odds ratio: 1.75, 95% CI: 1.54-2.00), and foreign trained physicians are more than two times likely to have positive opinion than US trained ones (odds ratio: 2.05, 95% CI: 1.85-2.27).

Table 4-6 Ordinal Logistic Regression Results

	EFEFF		EFINFO		PATACT	
	OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)	p
Gender						
Female	1.00					
Male	1.18 (1.08-1.28)	<0.001				
Ethnicity						
White	1.00				1.00	
Black	2.14 (1.79-2.57)	<0.001			0.73 (0.61-0.87)	<0.001
Asian or Pacific Islander	1.61 (1.42-1.83)	<0.001			1.21 (1.09-1.36)	0.001
Other	1.66 (1.37-2.01)	<0.001			0.91 (0.75-1.10)	0.319
Age (years)						
<=39	1.00				1.00	
40-49	1.02 (0.93-1.11)	0.744			0.85 (0.77-0.93)	<0.001
50-59	1.15 (1.04-1.28)	<0.001			0.73 (0.66-0.81)	<0.001
60+	1.75 (1.54-2.00)	<0.001			0.66 (0.58-0.75)	<0.001
Type of medical specity						
Prime care	1.00		1.00		1.00	
Non-prime care	1.15 (1.07-1.24)	<0.001	1.25 (1.16-1.35)	<0.001	0.51 (0.47-0.55)	<0.001
Country of training						
US	1.00					
Foreign	2.05 (1.85-2.27)	<0.001				
Overall Personal Fina Incent						
Favor Reducing Serv	0.80 (0.70-0.91)	<0.001	0.80 (0.70-0.91)	0.001	1.33 (1.16-1.52)	
Favor Neither	1.00		1.00		1.00	
Favor Expanding Serv	1.17 (1.07-1.27)	<0.001	1.23 (1.12-1.34)	<0.001	1.16 (1.06-1.26)	0.001
Total Sample Size:						10706

On physician's opinion on the impact of POMI on her ability to perform high quality care, Table 4-6 shows that only type of medical specialty and overall personal financial incentive have significant influences. In these two factors, the influences on physician's opinion on the impact of POMI on her ability to perform high quality care are similar to the influences on her opinion on the impact of POMI on efficiency.

On physician's likelihood to order upon patient's requests, physician's ethnicity, age, type of medical specialty and overall personal financial incentive are significant. Table 4-6 shows that compare to white physicians, Asian physicians are more likely to order upon patient's requests (odds ratio: 1.21, 95% CI: 1.09-1.36), while physicians of other ethnicity are less likely to do so. Age is still a significant predictor on physician's likelihood of ordering upon requests, although Table 4-6 shows that older physicians are less likely to do so than younger ones. This is very interesting as we previously discussed that older physicians are more likely to have positive opinion on the impacts of POMI on efficiency. It appears that while older physicians are more likely to listen to their patients' POMI, they are less likely to agree with their patients requests based on such POMI.

Table 4-6 also shows that non-primary care physicians are half as likely as primary care physicians to order upon requests (odds ratio: 0.51, 95% CI: 0.47-0.55), although previous discussion showed that they are more likely to have positive opinion on the impacts of POMI on both efficiency and their ability to perform high quality care. The reason maybe that the information asymmetry between a non-primary care physician and her patients is likely to be more significant than that between a primary care physician and her patients. On one hand, patients' POMI are likely to be general, as information about a particular specialty is difficult to obtain and to understand; on the other hand, non-primary care physicians are more informed about their specialties due to their training. Given such information asymmetry, non-primary care physicians are less likely to order upon requests.

Since PATACT is an interval variable with a highly skewed distribution, ordinary least square regression may produce questionable results [51], but we still used it to compare the results of the ordinal logistic regression analysis. Table 4-7 shows the results of multiple OLS regression. Only variables with statistic significance are included in the model.

Table 4-7 Results of OLS regression analysis (dependant variable: PATACT *)

	Standardized Coefficients	t Statistics	p value
Constant		12.798	<.001
Gender	-0.044	-4.625	<.001
Ethnicity			
Asian or Pacific Islander	0.057	5.395	<0.001
Type of medical specity	-0.134	-14.361	<.001
Country of training	0.060	5.686	<.001
Overall Personal Financial Incentive			
Favor Reducing Serv	0.032	3.425	<.001
Favor Expanding Serv	0.025	2.630	0.009
Sample Size			10706
Adjusted R Square			0.101
Std. Error of Estimate			7.204

* Control for PATINFO

It can be seen from Table 4-7 that a physician's age, gender, type of medical specialty, country of training, Asian or pacific islands ethnicity and overall personal financial incentive are statistically significant in predicting likelihood of ordering upon requests. Together, these factors account for about 10% of the variance in physicians' likelihood to order upon requests. Comparing to the results of ordinal logistic regression, OLS regression includes more factors as predictive over physicians' likelihood to order upon requests, as gender and country of training are not significant in ordinal logistic regression but are significant in OLS regression.

Discussion

Our study suggests that physicians attitudes towards POMI and their likelihood to order tests, procedures or prescriptions upon patients' requests that they would not otherwise order may be influenced by their demographic, socioeconomic and practice characteristics. Such findings have two major implications.

Firstly, in our efforts to build a patient-centered healthcare system in which physicians and patients share decision-making power, it may be helpful to target physicians of certain demographic, socioeconomic and/or practice groups or to design payment schemes of particular style in order to change their opinions about POMI and their willingness to listen to their patients. For example, our study suggests that physicians whose overall personal financial incentive favors expanding services are more likely to react favorably toward POMI. So we should carefully design physicians financial incentive schemes to induce our desired behavior. While using financial incentive favoring reducing services may achieve cost saving goals in the short run, we should not neglect the negative impacts of such incentive scheme on physicians' attitude towards POMI and their willingness to listen to their patients.

Secondly, individual patients armed with medical information could seek physicians more likely to have positive attitudes towards POMI for a more favorable relationship. For example, our study suggests that older physicians are more likely to have positive opinion about the impacts of POMI on efficiency, indicating that they would be more willing to spend time listening to their patients. Since young patients are more likely to search medical information before visiting their physicians and to desire more active role in medical decision making [32], they can probably get a more favorable attitude towards their information if they visit older physicians. Another example is that physicians trained outside the US are more likely to have more favorable opinion about POMI and more willing to listen to their patients. As patients of international background or patients of color are more likely to have difficulties in the communication with physicians, such patients may be better off to visits physicians trained outside the US or physicians of color to get a better communication.

References

1. Say RE, Thomson R. The importance of patient preferences in treatment decisions—challenges for doctors. *BMJ*. 2003; 327: 542 - 545.

2. Hibbard JH. Perspective: Moving Toward A More Patient-Centered Health Care Delivery System. *Health Affairs Web Exclusive*. October 7, 2004.

3. Skelton J, Coleman T, et al. Patient centred care of diabetes in general practice. *BMJ*. 1999; 318: 1621.

4. National Cancer Alliance. Patient-centered cancer services? What patients say? Oxford: National Cancer Alliance, 1996.

5. Berry LL, Seiders K, Wilder SS. Innovations in Access to Care: A Patient-Centered Approach. *Ann Intern Med*. 2003; 139: 568 - 574.

6. Ferriman A. Patients need to be more involved in care decisions. *BMJ*. 2001; 323: 10.

7. Charles C, Whelan T, Gafni A. What do we mean by partnership in making decisions about treatment? *BMJ*. 1999; 319: 780 - 782.

8. Charles C, Gafnv A. Shared Decision-Making In The Medical Encounter: What Does It Mean? (Or It Takes At Least Two To Tango) *Soc. Sci. Med.* 1997; 44(5): 681-692.

9. Gagliardi A, Jadad AR. Examination of instruments used to rate quality of health information on the internet: chronicle of a voyage with an unclear destination. *BMJ.* 2002; 324: 569-573.

10. Silberg WM, Lundberg GD, Musacchio RA. Assessing, Controlling, and Assuring the Quality of Medical Information on the Internet. *JAMA*. 1997; 277: 1244-1245.

11. Purcell GP, Wilson P, Delamothe T. The Quality of Health Information on the Internet. *BMJ*. 2002; 324: 557-558.

12. Kassirer JP. Patients, physicians, and the Internet. *Health Affairs.* 2000; 19(6): 115-123.

13. Kassirer JP. The Next Transformation in the Delivery of Health Care. *New England Journal of Medicine*. 1995; 332(1): 52–54.

14. Institute of Medicine. Crossing the quality chasm: a new health system for the 21st century. Washington: National Academy Press, 2001

15. Murray E, Lo B et al. The Impact of Health Information on the Internet on the Physician-Patient Relationship. *Arch Intern Med.* 2003; 163: 1727-1734.

16. Stiles WB, Putman SM, Wolf MH, James SA. Interaction exchange structure and patient satisfaction with medical interviews. *Med Care.* 1979; 17: 667-81.

17. Roter D, Hall J. Physician interviewing style and medical information obtained from patients. *J Gen Intern Med.* 1987; 2: 326.

18. Heaton PB. Negotiation as an integral part of the physician's clinical reasoning. *Fam Prac*. 1981; 13: 845-848.

19. Sackett DL, Haynes RB, Gibson ES, Hackett BC, Taylor DW, Roberts RS, et al. Randomised clinical trial of strategies for improving medication compliance in primary hypertension. *Lancet*. 1975; 1: 1205-1207.

20. Stewart M, Brown JB, Weston WW. Patient-centred medicine. Thousand Oaks, CA: Sage, 1995.

21. Pauly MV. Doctors and Their Workshops: Economic Models of Physician Behavior. The University of Chicago Press, Chicago, 1980.

22. Mechanic D, McAlpine DD, Rosenthal M. Are Patients' Office Visits with Physicians Getting Shorter? *N Engl J Med.* 2001; 344:198-204.

23. Murray E, Lo B et al. The Impact of Health Information on the Internet on Health Care and the Physician-Patient Relationship: National US Survey among 1050 US physicians. *Journal of Medical Internet Research.* 2003; 5(3): e17.

24. Gallagher TH, Lo B, Chesney M, Christensen K. How do physicians respond to patient's requests for costly, unindicated services. *J Gen Intern Med*. 1997; 12(11): 663-668.

25. Bell RA, Wilkes MS, Kravitz RL. Advertisement-induced prescription drug requests: patients' anticipated reactions to a physician who refuses. *J Fam Pract*. 1999; 48(6): 446-452.

26. Hardey M. Doctor in the house: the Internet as a source of lay health knowledge and the challenge to expertise. *Sociology of Health and Illness*. 1999; 21: 820-835.

27. Bach PB, Hoangmai H. Schrag D, Tate RC, Hargraves JL. Primary Care Physicians Who Treat Blacks and Whites. *N Engl J Med*. 2004; 351: 575-584.

28. Ashford A, Gemson D, Sheinfeld Gorin SN, et al. Cancer screening and prevention practices of inner-city physicians. *Am J Prev Med*. 2000; 19: 59-62.

29. Gemson DH, Elinson J, Messeri P. Differences in physician prevention practice patterns for white and minority patients. *J Community Health*. 1988; 13: 53-64.

30. Schneider EC, Zaslavsky AM, Epstein AM. Racial disparities in the quality of care for enrollees in Medicare managed care. *JAMA*. 2002; 287: 1288-1294.

31. Mukamel DB, Murthy AS, Weimer DL. Racial differences in access to high-quality cardiac surgeons. *Am J Public Health*. 2000; 90:1774-1777.

32. Cotton SR and Gupta SS. Characteristics of online and offline health information seekers and factors that discriminate between them. *Social Science & Medicine*. 2004; 59: 1795-1806.

33. Schulman KA, Berlin JA, Harless W, et al. The effect of race and sex on physicians' recommendations for cardiac catheterization. *N Engl J Med*. 1999; 340: 618-626.

34. Wenneker M, Epstein AM. Racial inequalities in the use of procedures for patients with ischemic heart disease in Massachusetts. *JAMA*. 1989; 261: 253-257.

35. Gornick ME, Eggers PW, Reilly TW, et al. Effects of race and income on mortality and use of services among Medicare beneficiaries. *N Engl J Med.* 1996; 335: 791-799.

36. Whittle J, Conigliaro J, Good CB, Lofgren RP. Racial differences in the use of invasive cardiovascular procedures in the Department of Veterans Affairs medical system. *N Engl J Med*. 1993; 329: 621-627.

37. Peterson ED, Shaw LK, DeLong ER, Pryor DB, Califf RM, Mark DB. Racial variation in the use of coronary-revascularization procedures: are the differences real? Do they matter? *N Engl J Med*. 1997; 336: 480-486.

38. Hickson GB et al. Physician reimbursement by salary or fee-for-service: effect on a physician's practice behavior in a randomized prospective study. *Pediatrics*. 1987; 80:744-750.

39. McGuire TG Physician Agency in: Culyer AJ and Newhouse JP (Eds.), Handbook of Health Economics, Vol. 1a, Ch9. Elsevier New York: 2000.

40. Gallagher TH, Waterman AD, Ebers AG, Fraser VJ, Levinson W. Patients' and Physicians' Attitudes Regarding the Disclosure of Medical Errors. *JAMA*. 2003; 289: 1001 - 1007.

41. Kuo D, Gifford DR, Stein MD.vCurbside Consultation Practices and Attitudes Among Primary Care Physicians and Medical Subspecialists. *JAMA*. 1998; 280: 905 - 909.

42. Olatunbosun OA, Edouard L, Pierson RA. Physicians' attitudes toward evidence based obstetric practice: A questionnaire survey. *BMJ*. 1998; 316 (7128): 365-366.

43. Agresti A. Categorical Data Analysis, 2nd Edition. John Wiley & Sons, Inc. New Jersy, 2002.

44. Srivastava R et al. Community and Hospital-Based Physicians' Attitudes Regarding Pediatric Hospitalist Systems. *Pediatrics*; 2005; 115 (1): 34-38.

45. Ehresmann KR, Mills WA, Loewenson PR, Moore KA. Attitudes and practices regarding varicella vaccination among physicians in Minnesota: Implications for public health and provider education. *American Journal of Public Health.* 2000; 90 (12): 1917-1920.

46. Meehl P. Clinical Versus Statistical Prediction: A Theoretical Analysis and a Review of the Evidence. University of Minnesota Press, Minneapolis, 1954.

47. Norusis M. SPSS 12.0 Guide to Data Analysis. Prentice Hall, 2004.

48. Stapleton H, Kirkham M, Thomas G. Qualitative study of evidence based leaflets in maternity care. *BMJ*. 2002; 324: 639-643.

49. Mechanic D., McAlpine D. D., Rosenthal M.Are Patients' Office Visits with Physicians Getting Shorter? *N Engl J Med*. 2001; 344:198-204.

50. Hadley J, Mitchell JM, Sulmasy DP, Bloche MG. Perceived financial incentives, HMO market penetration, and physicians' practice styles and satisfaction. *Health Service Research.* 1999; 34: 307-321.

51. Montgomery DC, Peck EA, Vining GG. Introduction to Linear Regression Analysis, 3rd Edition. Wiley-Interscience, 2001.

CHAPTER V

CONCLUSION

In this dissertation, I investigated the impact of patient-obtained medical information (POMI) on the physician-patient relationship when the physician does not observe perfectly a patient's information level. It was found that the physician-patient relationship has some important characteristics that are not captured by existing studies when we take this into consideration. In such a situation, the relationship is shaped not only by the individual patient's information level, but also by the overall information of the population (e.g., certain socioeconomic and/or health condition group) that the patient comes from. The physician's socioeconomic, demographic and practice characteristics also impact the relationship.

Such findings have significant policy and practical implications. On the policy level, my dissertation computed that providing medical information to patients would change physician behavior and the physician-patient relationship only when such changes in information are significant enough at the population level to induce behavior changes from the physician. Otherwise, changes in individual patient's information level will have no impact on the physician-patient relationship. So, in our efforts to build a patient-centered healthcare system [1-5] with physicians and patients sharing medical decision making process [6-12], we should target population groups that are not well informed so as to help induce behavior changes from the physician. Efforts to provide information to these population groups will not only benefit those to whom we provide information, but should also benefit the whole population groups. Since evidence shows that patients of certain socioeconomic characteristics and/or diseases [13-14] are likely to be less informed, we should focus our attention on these population groups.

As these patients are likely to have limited ability to understand medical information and information not understood have no benefits [15-20], we should aim to improve the health literacy [21-25] rate of such population groups. Since these patient groups are also in a disadvantaged position in access and utilization of healthcare [26-32], such efforts may also help alleviate or eliminate the wide-spread and persistent disparities in access and utilization of healthcare among patients of different socioeconomic groups [33-37] or among different geographic regions [38-46].

On the practical level, although individual patient's information level does not change a particular physician's behavior, patients armed with medical information can still seek physicians more likely to have positive attitudes towards POMI to get the most desirable results. For example, our study suggests that older physicians may be more likely to have positive opinion about the impacts of POMI on efficiency, indicating that they would be more willing to spend time listening to their patients. Since young patients are more likely to search medical information before visiting their physicians and to desire more active role in medical decision making [13-14], they can probably get a more favorable attitude towards their information if they visit older physicians.

References

1. Say RE, Thomson R. The importance of patient preferences in treatment decisions—challenges for doctors. *BMJ.* 2003; 327: 542 - 545.

2. Hibbard JH. Perspective: Moving Toward A More Patient-Centered Health Care Delivery System. *Health Affairs Web Exclusive.* October 7, 2004.

3. Skelton J, Coleman T, et al. Patient centred care of diabetes in general practice. *BMJ.* 1999; 318: 1621.

4. National Cancer Alliance. Patient-centered cancer services? What patients say? Oxford: National Cancer Alliance, 1996.

5. Berry LL, Seiders K, Wilder SS. Innovations in Access to Care: A Patient-Centered Approach. *Ann Intern Med*. 2003; 139: 568 - 574.

6. Ferriman A. Patients need to be more involved in care decisions. *BMJ.* 2001; 323: 10.

7. Charles C, Whelan T, Gafni A. What do we mean by partnership in making decisions about treatment? *BMJ.* 1999; 319: 780 - 782.

8. Charles C, Gafnv A. Shared Decision-Making In The Medical Encounter: What Does It Mean? (Or It Takes At Least Two To Tango). *Social Science Medicine.* 1997; 44(5): 681-692.

9. Gattellari M, Butow PN, Tattersall MH. Sharing decisions in cancer care. *Social Science Medicine*. 2001; 52(12):1865-1878.

10. Leydon GM, Boulton M, Moynihan C, Jones A, Mossman J, Boudioni M, McPherson K. Cancer patients' information needs and information seeking behaviour: in depth interview study. *BMJ.* 2000; 320: 909 – 913.

11. McKinstry B. Do patients wish to be involved in decision making in the consultation? A cross sectional survey with video vignettes. *BMJ.* 2000; 321: 867 - 871.

12. Coulter A, Entwistle V, Gilbert D. Sharing decisions with patients: is the information good enough? *BMJ.* 1999; 318: 318 - 322.

13. McKinstry B. Do patients wish to be involved in decision making in the consultation? A cross sectional survey with video vignettes. *BMJ.* 2000; 321: 867 - 871.

14. Cotton SR and Gupta SS. Characteristics of online and offline health information seekers and factors that discriminate between them. *Social Science & Medicine.* 2004; 59: 1795-1806.

15. Silberg WM, Lundberg GD, Musacchio RA. Assessing, Controlling, and Assuring the Quality of Medical Information on the Internet: Caveat Lector et Viewer—Let the Reader and Viewer Beware. *JAMA.* 1997; 277 (15): 1244–1245.

16. Hibbard JH, Jewett JJ. Will quality report cards help consumers? *Health Affairs.* 1997; 16(3): 218-228.

17. Hibbard JH, Jewett JJ, Legnini MW, Tusler M. Choosing a health plan: do large employers use the data? *Health Affairs*. 1997; 16(6): 172-180.

18. Chernew M, Scanlon DP. Health Plan Report Cards and Insurance Choice. *Inquiry*. 1998; 35 (1): 9–22.

19. National Committee for Quality Assurance, Do Consumers Use Health Plan Report Cards? Findings from Two Evaluations. Washington: NCQA, 1998.

20. Ghali WA et al. Statewide Quality Improvement Initiatives and Mortality after Cardiac Surgery. *JAMA.* 1997; 379–382.

21. Parker RM, Ratzan SC, Lurie N. Health Literacy: A Policy Challenge For Advancing High-Quality Health Care. *Health Affairs*. 2003; 22(4): 147-153.

22. Gazmararian J et al. Health Literacy among Medicare Enrollees in a Managed Care Organization. *JAMA*. 1999; 281(6): 545–551.

23. Williams M et al. Inadequate Functional Health Literacy among Patients at Two Public Hospitals. *JAMA*. 1995; 274(21): 1677–1682.

24. Vass A. Health literacy and patients' understanding. *BMJ*. 2003; 326(7402): 1339.

25. Schillinger D et al. Association of Health Literacy with Diabetes Outcomes. *JAMA*. 2002; 288(4): 475–482.

26. Lantz PM et al. Socioeconomic Factors, Health Behaviors, and Mortality: Results from a Nationally Representative Prospective Study of U.S. Adults. *JAMA*. 1998; 279(21): 1703–1708.

27. Pappas G et al. The Increasing Disparity in Mortality between Socioeconomic Groups in the United States, 1960 and 1986. *New England Journal of Medicine.* 1993; 329(2): 103–109.

28. Adler NE, Newman K. Socioeconomic Disparities In Health: Pathways And Policies**.** *Health Affairs.* 2002; 21(2): 60-76.

29. Alter DA, Naylor CD, Austin P, Tu JV. Effects of Socioeconomic Status on Access to Invasive Cardiac Procedures and on Mortality after Acute Myocardial Infarction. *N Engl J Med.* 1999; 341:1359-1367.

30. Pell JP, Pell ACH, Norrie J, Ford I, Cobbe SM, Hart JT. Effect of socioeconomic deprivation on waiting time for cardiac surgery: retrospective cohort study *BMJ.* 2000; 320: 15-19.

31. Anderson P. Study demonstrates link between cancer survival and wealth**.** *BMJ.* 1999; 318: 1163.

32. Colhoun HM, Rubens MB, Underwood SR, Fuller JH. Cross sectional study of differences in coronary artery calcification by socioeconomic status. *BMJ.* 2000; 321: 1262 - 1263.

33. Schulman KA, Berlin JA, Harless W, et al. The effect of race and sex on physicians' recommendations for cardiac catheterization. *N Engl J Med.* 1999; 340: 618-626.

34. Wenneker M, Epstein AM. Racial inequalities in the use of procedures for patients with ischemic heart disease in Massachusetts. *JAMA.* 1989; 261: 253-257.

35. Gornick ME, Eggers PW, Reilly TW, et al. Effects of race and income on mortality and use of services among Medicare beneficiaries. *N Engl J Med.* 1996; 335: 791-799.

36. Whittle J, Conigliaro J, Good CB, Lofgren RP. Racial differences in the use of invasive cardiovascular procedures in the Department of Veterans Affairs medical system. *N Engl J Med.* 1993; 329: 621-627.

37. Peterson ED, Shaw LK, DeLong ER, Pryor DB, Califf RM, Mark DB. Racial variation in the use of coronary-revascularization procedures: are the differences real? Do they matter? *N Engl J Med.* 1997; 336: 480-486.

38. Coulter A, Seagroatt V, McPherson K. Relation between general practices' outpatient referral rates and rates of elective admission to hospital. *BMJ*. 1990; 301(6746): 273-276.

39. Baicker K, Chandra A, Skinner JS, and Wennberg JE. Who You Are And Where You Live: How Race And Geography Affect The Treatment Of Medicare Beneficiaries. *Health Affairs Web Exclusive.* October 7, 2004.

40. Dimick JB, Finlayson SRG, and Birkmeyer JD. Regional Availability Of High-Volume Hospitals For Major Surgery. *Health Affairs Web Exclusive.* October 7, 2004.

41. O'Connor AM, Llewellyn-Thomas HA, and Flood AB. Modifying Unwarranted Variations In Health Care: Shared Decision Making Using Patient Decision Aids. *Health Affairs Web Exclusive.* October 7, 2004.

42. Wennberg JE. Perspective: Practice Variations And Health Care Reform: Connecting The Dots. *Health Affairs Web Exclusive.* October 7, 2004.

43. Weinstein JN, Bronner KK, Morgan TS, and Wennberg JE. Trends: Trends And Geographic Variations In Major Surgery For Degenerative Diseases Of The Hip, Knee, And Spine. *Health Affairs Web Exclusive.* October 7, 2004.

44. Goodman DC. Trends: Twenty-Year Trends In Regional Variations In The U.S. Physician Workforce. *Health Affairs Web Exclusive.* October 7, 2004.

45. Berenson RA. Perspective: Lumpers And Splitters: Different Approaches To Understanding Variations Research. *Health Affairs Web Exclusive.* October 7, 2004.

46. Fuchs VR. Perspective: More Variation In Use Of Care, More Flat-Of-The-Curve Medicine. *Health Affairs Web Exclusive.* October 7, 2004.