Decision-making in General Practice: The Importance of a Near Patient Test When Choosing Medical Actions

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***Abstract*- There is a lack of studies on the impact of near patient test results in primary care, which should be an important prerequisite for reimbursing such tests. Our main purpose is therefore to develop a model to study what effect the results of a near patient test may have on medical actions in primary care. A clinical vignette, describing a young woman with dyspepsia was sent to GPs in Norway, who were asked to suggest actions in response to either a negative or a positive result of the Helicobacter pylori rapid test (HPRT). Discrete choice analysis with multinomial logit models was used to analyse the choice of medical actions. We find that the result of the rapid test has a major influence on actions suggested, and an important prerequisite for reimbursing such tests is fulfilled. Therefore the analytical quality of test results is likely to affect patients' health and social costs.**

Keywords- Discrete Choice models; Decision-making; Primary Health Care

I. INTRODUCTION

Laboratory analyses are widely used in diagnostic work-up and monitoring of patients in primary care. Getting the correct treatment at an early stage may decrease the patient's likelihood of developing a more severe form of illness that requires more complex and costly care. Thus, the economic consequences of laboratory analyses may amount to a substantial proportion of health service costs.

Interest in using laboratory analyses in the general practitioner (GP)'s office has been increasing in Europe [1-2]. In Norway (Source: The Norwegian Quality Improvement of Laboratory Services in Primary Care), Switzerland, and the Netherlands, almost all practices have their own laboratory facilities [3]. In Norway, about 25 % of all fees in general practices in 2006 were from the use of laboratory services [4].

In spite of the extensive use of near patient test results in primary care, there is a lack of studies on the impact of such results, economic consequences included [5]. Thus our main purpose is to develop a model to study this impact. Given that a laboratory analysis is performed, we are interested in that whether or not the test result changes the medical actions. We also study the effect of characteristics of the GP and the practice on the medical actions chosen. Such information may be important for implementing strategies to be able to secure rational use of laboratory tests.

Dyspepsia is a fairly common presenting symptom in general practice consultations [6-9]. Sometimes dyspepsia is due to peptic ulcer, and the bacterium Helicobacter Pylori (HP) has been identified as the main cause of this disease. The presence of this bacterium may be detected by the HP rapid test (HPRT), which is a simple test kit for single use, onto which a drop of blood is applied to test for the presence of specific antibodies. The result is read as negative or positive within a few minutes. The HPRT is a fairly new test and may be crucial when testing younger patients with dyspepsia in that other laboratory tests are generally not needed. Upper endoscopy will serve as a definitive test since endoscopy will detect peptic ulcer as well as the presence of viable bacteria with great certainty. Thus, dyspepsia and the HPRT were chosen for our impact-modelling study.

The data used in this paper are based on a case history based questionnaire mailed to Norwegian GPs with HPRT on their office laboratory repertoire. We have previously used the same clinical vignette and developed a model for economic evaluation of diagnostic accuracy in general practice [10]. But diagnostic accuracy will only be important if the test result has a significant influence on the choice of medical actions. Further, in Norway GPs are reimbursed for the use of several near patient tests, and the less impact of test results, the less motivation for the government to spend money on reimbursement.

We assume that the clinical practice of GPs for treating ulcer in Norway is representative of the clinical practice of GPs in other developed countries, since internationally acclaimed guidelines on dyspepsia were easily available to Norwegian GPs, e.g. in the Norwegian textbook of general practice and in an editorial in the Journal of the Norwegian Medical Association [11-12]. Thus, Norway seems well suited for a study on the impact of near patient test results.

It also seems reasonable to assume that the model may be applied generally for clinical situations in which other diagnostic tests are used as important sources of information e.g. some other laboratory analyses, x-ray and MRI. Hence, our method has interest beyond the setting used in this article.

To the best of our knowledge, there are no other studies on the significance of how a near patient test result and socio-economic characteristics of the GP affect the choice of medical actions in primary health care.

II. METHODS

The data used in this paper are based on a case history based questionnaire mailed in the spring of 99 to 739 GPs, who, according to information from NOKLUS, had the HPRT in their surgery. More details on the survey are published previously [13]. The present analysis focuses on the subgroup of GPs in the survey who decided to use a HPRT in the clinical situation described in the case history. Each GP responded first to when the test result was taken to be negative, and then to when it was positive.

Responses were received from 425 GPs (57%), of whom 210 decided to use the HPRT. Of these, nine GPs who had

obviously misunderstood the questionnaire, or had very deviant characteristics were excluded: GPs on internship in general practice, those aged > 67 years, those with working hours > 60 or < 10 per week, number of consultations >160 or < 10 per week, and waiting time to obtain endoscopy for the case history patient > 26 weeks.

We compared age, sex, and type of payment in our sample of 201 GPs using HPRT with the total Norwegian population of GPs from a register kept by the Norwegian Medical Association. The sample had the same mean value regarding age, but had a slightly higher percentage of men (81% versus 74%), and fewer on fixed salary (8% versus 28%).

The GPs chose many different sets of actions, which were categorized into three main medical strategies: symptomatic treatment only, referral for upper endoscopy, or eradication of HP by the so called triple therapy. Table I shows that the medical actions strongly depend on the result of the HPRT. Table II gives an overview of our data for the 201 GPs as well as responses to either a positive or a negative HPRT result.

TABLE I MEDICAL STRATEGIES (DEPENDENT VARIABLE) IN RESPONSE TO A NEGATIVE OR A POSITIVE HPRT, AS SUGGESTED BY GPS (N=201)

Independent Variable Medical Strategies	**HPRT neg**	**HPRT pos**
1. Symptomatic Treatment	112 (56%)	8 (4%)
2. Referral	85 (42%)	100 (53%)
3. Triple Therapy	4 (2%)	83 (43%)

TABLE II OVERVIEW OF INDEPENDENT VARIABLES (N=201 GPS)

Variables	**Definition**	**Mean.**	**Std.dev**
Data on the Gps and Practice Characteristics			
Sex	Binary Variable:1 If Male, 0 If Female	0.806	
Age	Number of Years	46.200	7.299
Need of Info on HPRT	Need for Information about the Use of HPRT; Binary: 1 If Some Or A Lot, 0 If None or Only Modest	0.642	
Type of Info on HPRT	The Two Most Important Information Sources of HPRT. Binary Variable; 1 If Only Suppliers Info, 0 If Other	0.517	
Group Practice	Type of Practice. Binary Variable: 1 If Group Practice, 0 If Solo Practice	0.776	
Urban	Reference Category for Location of Practice: Binary Variable: 1 If Inhab.>15000, 0 If Other	0.632	
Semi-Urban	Category For Location of Practice. Binary Variable: 1 If 5000≤Inhab.≤15000, 0 If Other	0.209	
Rural	Category For Location of Practice Binary Variable: 1 If Inhab.<5000, 0 If Other	0.159	
Consultation s	Number of Consultations Per Week	89.139	27.316
Working Hours.	Number of Working Hours Per Week	35.129	8.088
Private Practice	Binary:0=Fixed Salary, 1=Are Reimbursed	0.92	
Specialist	The GP's Education. A Number of Courses are Required to Have A Specialist Certificate- Binary Variable: 1 If Specialist Certificate, 0 If Other	0.721	
Wait.Upper Endo.	Waiting Time in Weeks for Upper Endoscopy Assumed by the GP	4.900	3.700
Trav.Upper Endo.	Travelling Timein Hours for the Patient (One Way) for Upper Endoscopy Assumed by the GP	1.015	3.495
Gps' Suggestions in Response to the Case History			
Pre-test-Probability	The Pre-test Probability that Mrs Hansen's Symptoms are Due to A HP Infection	49.459	20.515
Post- test Prob of Negative Test*	The Post-test Probability that Mrs Hansen's Symptoms are Due to A HP Infection	15.652	16.312
Post -test Prob of Positive Test*	The Post-test Probability that Mrs Hansen's Symptoms are Due to A HP Infection	76.375	18.985
Importance of Negative Test**	The Relative Importance of The HPRT-Test Result on A Scale from 1 to 10	2.797	1.447
Importance of Positive Test**	The Relative Importance of the HPRT-Test Result on A Scale From 1 to 10	3.923	1.8
Sick Leave – Neg Test	Binary: 0= No Sick Leave, 1=Sick Leave Suggested	0.269	
Sick Leave – Pos Test	Binary: 0= No Sick Leave, 1=Sick Leave Suggested	0.318	
New Appointment Negative Test	Binary: 0= No Appointm.1=New Appointm Suggested By GP	0.438	
New Appointment Positive Test	Binary: 0= No Appointm.1=New Appointm.	0.477	
Patient Initiated Appointm. – Neg	Binary: 0= No Appointm.1=New Appointm. (Patient Makes A New Appointment as Needed)	0.468	
Patient Initiated Appointm. – Pos.	Binary: 0= No Appointm.1=New Appointm.	0.248	

*The post-test probability measure changes in pre-test probability when the HPRT result is known.** GPs were asked to distribute ten points between the case history, clinical findings described, and the laboratory result (negative or positive), by giving most points to the factor he/she considered most important.

In modelling the GPs' choice of medical actions, we use discrete choice analysis [14 – 15]. We have data on GPs' hypothetical choices among three alternatives (symptomatic treatment, referral, and triple therapy) that are mutually exclusive, and use the framework of multinomial logit models to analyse these data. We have two observations per GP, one set of medical actions when the HPRT is negative and one set of medical actions when the HPRT is positive. Encounters by the same GP may be correlated and then standard regression techniques may not be suitable. To take this into account, we use a multinomial logit model with random effects or a so-called mixed multinomial logit model with normal mixing distribution, which is a method used for panel data [16]. The model is estimated in NLOGIT 4.0 [17]. This is further described in a working paper [18].

III. RESULTS

We examine the effect of the variables included in Table II on the probability for choosing different medical actions by estimating a mixed multinomial logit model. The number of observations was reduced from 402 to 350, due to missing values.

Table III shows the results from the mixed multinomial logit model for variables that were significant as well as all laboratory-related variables. The full table for both the standard multinomial logit model and mixed multinomial logit model is in Appendix A.

TABLE III RESULTS OF ESTIMATIONS FROM THE MIXED MULTINOMIAL LOGIT MODELS. REFERENCE: SYMPTOMATIC TREATMENT

Independent Variables	**Medical Action**	**Mixed Model**	
		Parameter	**T-ratio**
Constant	Referral	2.059	0.847
	Triple Therapy	- 13.477	-1.453
HPRT: Positive Vs. Negative	Referral	**3.895**	**4.247**
	Triple Therapy	**11.178**	**2.506**
Relative Importance of HPRT, Result vs. History/Findings	Referral	-0.122	-0.784
	Triple Therapy	1.027	1.522
Pre-test-Probability	Referral	0.011	0.895
	Triple Therapy	0.030	1.136
Travelling Time	**Referral**	**-1.291**	**-2.004**
	Triple Therapy	-	-
New Appointment vs. Not A New Appointment	Referral	**-2.456**	**-3.207**
	Triple Therapy	-0.361	-0.287
New Appointment Initiated by Patient vs. Not A New Appointment by Patient	Referral	**-3.049**	**-3.651**
	Triple Therapy	-0.994	-0.729
Sick Leave Vs. No Sick Leave	Referral	1.129*	1.941
	Triple Therapy	3.471*	1.868
Variance of the Random Effect	Referral	**1.587**	**2.385**
	Triple Therapy	3.786	1.590
Log-L		-338.4920	
Restricted Log-L		-485.2030	
Mcfadden'S R^2		0.302	
Mcfadden'S Adjusted R^2		0.275	

Bold figures indicate that the effect is significant at the 5% level, *close to significant i.e. p=0.053 and p=0.061).

Table III shows that if the HPRT-result is positive versus negative, the GP is more likely to choose referral or triple therapy versus symptomatic treatment. This seems reasonable because if the HPRT-test is positive, there are reasons for further investigations to find out whether this patient has an HP-infection, or to adapt a test-and-treat strategy with no further investigations. The result is consistent with Table I. If the travelling time to get endoscopy increases, the GP is more likely to prefer symptomatic treatment than referral. GPs that make a new appointment or ask the patient to make a new appointment if he/she does not recover will tend to prefer symptomatic treatment compared to the GPs who do not arrange for a follow up. This makes sense, since only prescribing symptomatic treatment demands more follow-up from the GP in case a referral should be necessary later. GPs who recommend sick leave are more likely to choose referral than symptomatic treatment, compared with the GPs who do not recommend sick leave. This is probably because GPs choosing referral versus symptomatic treatment assume that the patient has more serious dyspepsia.

We have conditional choice probabilities, and the probability of choosing referral or triple therapy versus symptomatic treatment depends on whether the GPs have recommended sick leave or not. This aspect is mentioned in the discussion.

Using NLOGIT 4.0, the model allows for calculating detailed strategy probabilities for a particular GP including the effect of changes in significant attribute or characteristics [17]. All the results are presented in a working paper [18]. If the HPRT is taken to be negative, the probability of choosing symptomatic treatment will increase by 42 percentage points to 44.5% and the probability of using triple therapy will decrease by 22.4 percentage points to 0.4%.

IV. DISCUSSION

The main purpose of our study was to construct a model for the impact of a near patient test. We are not aware of other studies on the significance of how near patient test results and the socio-economic characteristics of the GP affect the choice of medical actions in primary health care. The main finding in our study is that the result of the HPRT has a significant and major influence on the GP's choice of medical actions. This underlines the need for strategies to secure rational use of laboratory tests. There are several limitations regarding our findings, for example, the use of a case history based approach and the method chosen.

First, the results are conditional since the GP has already chosen whether or not to carry out the test in private practice, and whether or not to recommend sick leave. Previously we found that there was a selection effect because the variable "private practice" depended on characteristics of the GP [13]. We also assume that whether or not the GP recommends sick leave depends on the characteristics of the GP. If so, the variables "sick leave" and "private practice" become endogenous variables and will correlate with the error term. Hence, our estimates may be biased due to the selection effect, and this aspect needs further investigation in another study.

Second, we do not have any information about the sensitivity and the specificity of the HPRT actually used in the GP's office. Several studies show that test results are perceived to be accurate in various clinical settings [19-21] implying that the GPs usually do not consider sources of error involved in laboratory work when interpreting results, i.e. a single result is taken at "face value" and acted upon. We, therefore assume that the GP considers the test-result to be correct without considering diagnostic accuracy. The difference between the post-test and pre-test probability (ref. Table II) somewhat supports this assumption.

Third, we wanted to measure the effect of the test result, and there were several options including: focusing on both the pre-test probability and the test result, focusing on post-test probability, and focusing on the difference between the post-test probability and the pre-test probability. We chose to include the pre-test probability and the test result variables because this improved the model, and because we are particularly interested in identifying the effect of the test result in the impact model.

Fourth, we have revealed preference data, as our data is based on a questionnaire where the GP is assumed to have enough information to establish a preliminary diagnosis and conduct reasonable medical actions. Thus, when we composed the clinical vignette, it was important to describe a realistic situation. In the literature, there have been discussions about the validity of written case scenarios in medical decision-making. This aspect is further discussed in a working paper [13]. Bias is more likely if the respondents feel obliged to display some kind of expected behaviour or if the written scenario differs from a typical situation. However, our case history depicts a real patient with some minor modifications, in order to make the situation as realistic as possible, and Norwegian GPs are used to responding to clinical scenarios like these, thus making a less biased response plausible.

Finally, the response rate was 57% which may imply selection bias in results. Still, the participants were similar to the total population of Norwegian GPs regarding age and sex, but fewer were on a fixed salary (8% (see Table II) vs. 28%) since the H. pylori test was commoner among GPs on fee-for-service. If selection bias is present, we believe it would be sensible to assume that participants are more knowledgeable of dyspepsia than non-responders, and therefore, more likely to adhere to medical guidelines in this field.

V. CONCLUSION

We have developed a model that can be used to evaluate the effect of a specific laboratory analysis, or other "crucial" diagnostic measures, on choosing medical actions. By using discrete choice analysis, we have seen that the result of the HPRT has a very important influence on GPs' choice of medical actions, thereby fulfilling an important prerequisite for reimbursing near patient tests. Still, further studies of different types of laboratory analyses and other "crucial" diagnostic measures, e.g., MRI or x-ray, are needed before we can draw general conclusions.

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APPENDIX A. ESTIMATIONS RESULTS – FULL MODELS

By using the LR-test, we found that the standard multinomial model tested against the mixed multinomial logit model is rejected (LR-stat 9.805, 5% significance level). The estimated parameters in the mixed model are slightly less significant, but have a larger effect on the probability of choice of medical strategy.

TABLE A RESULTS OF THE ESTIMATION OF THE MODEL FOR GPS WITH HPRT- REFERENCE: BALANCID/ZANTAC

Independent Variables	**Medical Action**	**Standard Model**		**Mixed Model**	
		Parameter	**T-ratio**	**Parameter**	**T-ratio**
Constant	Referral	1.212	0.724	2.059	0.847
	Triple Therapy	**-4.743**	**-1.921**	- 13.477	-1.453
Result of HPRT: Positive Vs. Negative Result	Referral	**3.000**	**6.188**	**3.895**	**4.247**
	Triple Therapy	**6.069**	**7.957**	**11.178**	**2.506**
Relative Importance of HPRT Result vs. History/Findings	Referral	-0.075	-0.684	-0.122	-0.784
	Triple Therapy	**0.311**	**2.194**	1.027	1.522
Pre-test-Probability	Referral	0.007	0.877	0.011	0.895
	Triple Therapy	0.016	1.374	0.030	1.136
Age	Referral	0.005	0.206	0.008	0.223
	Triple Therapy	-0.001	-0.025	-0.025	-0.340
Sex	Referral	0.010	0.022	0.165	0.253
	Triple Therapy	0.086	0.140	0.338	0.278
Need of Information	Referral	-0.325	-0.907	-0.364	-0.699
	Triple Therapy	-0.271	-0.553	-0.447	-0.443
Type of Information*	*Referral*	*0.614*	*1.850*	*0.825*	*1.642*
	Triple Therapy	*0.741*	*1.638*	1.292	1.271
Group Practice:Group vs. Solo	Referral	-0.337	-0.816	-0.436	-0.719
	Triple Therapy	-0.636	-1.133	-1.175	-0.993
Semi-Urban vs. Urban	Referral	-0.365	-0.875	-0.517	-0.852
	Triple Therapy	-0.215	-0.383	0.177	0.144
Rural vs. Urban	Referral	0.286	0.562	0.547	0.747
	Triple Therapy	-0.368	-0.533	-0.761	-0.523
Private Practice vs. Fixed Salary	Referral	-0.888	-1.315	-1.098	-1.105
	Triple Therapy	0.283	0.305	1.808	0.777
Travelling Time	**Referral**	**-0.655**	**-2.072**	**-1.291**	**-2.004**
	Triple Therapy	-	-	-	-
Waiting Time	Referral	0.013	0.377	0.008	0.131
	Triple Therapy	-	-	-	-
Working Hours	Referral	0.001	0.042	-0.001	-0.030
	Triple Therapy	0.005	0.151	0.010	0.140
Consultations	Referral	0.003	0.357	0.003	0.243
	Triple Therapy	-0.001	-0.108	-0.005	-0.228
Specialist Vs. Not A Specialist	Referral	0.064	0.157	0.077	0.129
	Triple Therapy	-0.300	-0.546	-0.912	-0.768
New Appointment Vs. Not A New Appointment	Referral	**-1.791**	**-3.837**	**-2.456**	**-3.207**
	Triple Therapy	-0.957	-1.669	-0.361	-0.287
New Appointment Initiated By Patient vs. Not A New Appointment. Initiated by Patient	Referral	**-2.236**	**-4.724**	**-3.049**	**-3.651**
	Triple Therapy	-1.203	-1.937	-0.994	-0.729
Sick Leave vs. Not A Sick Leave	Referral	**0.853**	**2.225**	1.129*	1.941
	Triple Therapy	**1.670**	**3.355**	3.471*	1.868
Variance of yhe Random Effect	Referral	-	-	**1.587**	**2.385**
	Triple Therapy	-	-	3.786	1.590
Log-L		-344.2526		-338.4920	
Restricted Log-L		**-481.2643**		-485.2030	
Mcfadden'S R^2		0.285		0.302	
Mcfadden'S Adjusted R^2		0.256		0.275	

Bold figures indicate that the effect is significant at 5% level, *close to significant at 5% level (p=0.053 and p=0.061).