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## Decision-making in General Practice:

The importance of laboratory analyses when choosing medical actions


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# Decision-making in General Practice:

## The importance of laboratory analyses when choosing medical actions

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**Abstract:**

The focus of this study is the effect of a laboratory analysis and socio-economic variables on choosing medical actions in a specific situation (a clinical vignette – a young woman, Mrs Hansen, with dyspepsia – presented to GPs). We assume that the GP's decision depends on what he or she thinks is best for the patients, based on the best clinical evidence available. Significant variables associated with the choice of medical actions are: the result of the Helicobacter pylori (HP) test, the GP's stated importance of HPRT, the location of the general practice, the GP recommending sick leave, the GP's stated probability that Mrs Hansen's symptoms are due to a H.pylori infection after the HP-result is known, and how the GP follows up the patient. Our results show that the HP-analysis has a significant and major influence on the GPs choice of medical actions. Therefore the quality of the analysis is likely to affect the patients' health and social costs. Hence institutions for quality monitoring and improvement are important elements of health care reforms. Such institutions should balance cost and benefits of quality improving measures, and will be the focus of closer studies in our future research.

## 1. Introduction

Laboratory tests have been analysed for many years in general practice (family medicine) in Norway. Laboratory tests are essential in diagnostic work-up and monitoring of patients.

Compared with other European countries like Denmark and England, vast amounts of laboratory analyses in general practice are carried out decentralised in Norway, due in part to geographical factors and economic incentives. In Norway about 1800 surgeries have laboratory facilities run by general practitioners (GPs), serving a population of 4.5 million.

Our study was designed to develop a method for economic evaluation of near patient tests, using data from a questionnaire designed in cooperation with NOKLUS (The Norwegian Quality Improvement of Laboratory Services in Primary Care). NOKLUS is an organization that was established in 1992, and is funded by the Norwegian Medical Association's Fund for Quality improvement of laboratory services in primary care. At present, 99% of general practices participate on a voluntary basis in NOKLUS in order to improve the analytical quality of laboratory tests. However it is not enough that these tests are analysed correctly, it is just as important that tests are requested appropriately and interpreted correctly.

In this paper, our main purpose is to study the effect of a test result with regard to medical actions taken. Previously (in an unpublished paper) we have studied the effect of certain characteristics on the two questions: whether to have or whether to use a specific laboratory analysis. Our next study will be a cost-benefit analysis

of good quality of a laboratory test, but this will only be relevant if the result of the test has a significant influence on the GP's choice.

A questionnaire including a clinical vignette, describing a 30-year old woman with dyspepsia, is used to assess the clinical reasoning and decisions made by GPs who had the Helicobacter pylori rapid test (HPRT) available in their surgery, and by a random sample of GPs who did not have HPRT in their surgery. By using a vignette we are able to focus on a relevant and standardized clinical situation familiar to the GP. In addition, we obtained information on the socio-economic characteristics of all the participants.

The bacterium Helicobacter Pylori (H.pylori) can induce peptic ulcers, and is the main cause of this disease. HPRT is a simple test kit for single use, on to which a drop of blood is applied to test for the presence of antibodies to this bacterium. The advantage of having the test is that the GP can get the result of the test immediately, during the consultation. In contrast, if the GP sends a blood sample for serological testing, it takes 3-4 days to get the result, and this usually demands more follow-up by the GP. The presence of antibodies is often associated with the presence of viable bacteria in the stomach, but not always, since antibodies persist for months after the bacteria have been eradicated e.g. by antibiotics.

There are many laboratory tests available, and the reasons for choosing the HP test were several: it is a fairly new test, it can be carried out both as a rapid test and as an ordinary "hospital laboratory" test, it may be a crucial test in that other laboratory tests are not needed, and there are more complex procedures or gold standards available to evaluate the benefit (predictive value) of the test. Information about H.pylori is from Atherton et al (1) and Friedman (2).

Upper endoscopy is the definitive examination if the GP suspects peptic ulcer, because one can detect whether the bacteria have done any damage to the stomach or duodenum, as well as detecting the presence of H.pylori bacteria. The presence of viable bacteria (but not an anatomical diagnosis) is also substantiated by the so-called breath test (a liquid swallowed by the patient is transformed by the bacteria, and this transformation is detected by measurements in the patient's expired air).

In this paper we use Discrete Choice Analysis with Multinomial logit models to analyse the choice of medical action among the GPs using this laboratory test to assess the patient, either by the rapid test or the serological ("hospital") test. We assume that the GP's decision depends on what he or she thinks is best for the patients, based on the best clinical evidence available to the GP. But the decision can also be influenced by the GP's workload, and this will be further discussed in section eight.

The GPs chose many different sets of medical actions and we grouped them by medical conclusions:

-wait and see strategy, i.e. relieving symptoms by issuing prescriptions (Balancid/Zantac which reduce acid production in the stomach), hoping that the dyspepsia would not return after treatment,

-further diagnostic measures i.e.referring for breath test or upper endoscopy, with or without symptomatic treatment,

-immediate treatment by the so-called triple therapy (two antibiotics combined with a drug which abolishes the acid production in the stomach) in order to eradicate the H.pylori bacteria if present, but without further diagnostic measures. Here we include every GP who had recommended triple therapy. If

they also had used referrals, we assume that many of these examinations will probably not be done if the triple therapy was successful.

For GPs who have the rapid test, variables with a positive significant effect on the probability of choosing referral vs. Balancid/Zantac are: a positive result on the rapid test, a high point (on a scale from 1 to 10) of the relative importance of HPRT, and whether the GP refrains from following up the patient either by making a new appointment or asking the patient to make a new appointment if she did not improve. Variables with a significant positive effect on the probability of choosing triple therapy vs. Balancid/Zantac are: a positive result of HPRT and whether the GP recommended sick leave. For GP's without HPRT, a positive result of the laboratory analysis had a significant positive effect on choosing referral or triple therapy vs. Balancid/Zantac, and location in an urban area had a significant positive effect for choosing referral vs. Balancid/Zantac.

To our knowledge, there are no other studies on the significance of how the H.pylori analysis and the characteristics of the general practitioner affect the choice of medical actions in primary health care.

Our results show that the H.Pylori - analysis has a significant and a major influence on the GP's choice of medical actions. We therefore conclude that the quality of the laboratory test is likely to have an effect on patients' health and social costs, and hence that institutions for quality monitoring and improvement are important elements of health care reforms. Such institutions should balance cost and benefits of quality improving measures, and will be the focus of closer studies in our future research.

## 2. The survey, the H.pylori bacterium, and the analysis

The focus of this study is the effect of the laboratory analyses and socio-economic variables on choosing medical actions in a specific situation. In this section we will focus on information about the survey and on the specific laboratory analysis in question.

The survey

The data used in this paper are based on a questionnaire (appendix A) mailed to GPs in April/May 1999. We had two sets of questionnaires, one set to all the GPs (n=739) who had HPRT in their surgery, and a different set to a random sample (n=717) of GPs who did not have HPRT in their surgery. The response rate was after one reminder 57% in both groups. To the GPs with HPRT, the questions depended on whether they chose to use the test or not in a given situation. In the questionnaire, a clinical vignette, describing a 30-year old woman with dyspepsia, was used to assess the clinical reasoning and decisions made by general practitioners. The clinical vignette describes a clinical situation fairly familiar to the GP, and in fact, with some modifications, this case history depicts a real patient. It was chosen from the medical record notes of consultations in which GPs had ordered the near patient test in real life. Minor modifications were made in collaboration with several clinicians (GPs and a gastroenterologist) and a microbiology specialist. It was an important element of the vignette that additional tests should not be necessary.

In the questionnaire the GPs were asked to state:

- the pre-test probability that Mrs. Hansen's symptoms were caused by H.pylori
- whether or not they would order HPRT or the serological test
- what actions they would take based on the history, or on the history in addition to the test result.

In this study we focus on the effect of the H.pylori analysis, and therefore only include data from the GPs who ordered HPRT or the serological test.

The actions (more than one could be chosen, and in addition, there was some open space for comments)

1. - lifestyle advice
2. - recommend locally-acting antacids (Balancid etc.)
3. - try H2 antagonists (Zantac etc.) (more potent antacids)
4. - try triple therapy
5. - refer for breath test
6. - refer for upper endoscopy
7. - recommend sick leave
8. - set up a new appointment
9. - new appointment initiated by the patient

In addition to the medical actions mentioned above, GPs without HPRT could choose to send a blood sample to a medical lab for serological testing. We also obtained information on the characteristics of all the GPs.

The GPs later received feedback reports on their answers compared with the other GPs and with clinical guidelines about the use of the H.pylori analysis relevant to our patient.

The dependent variables

We reduced the alternative actions as follows:

- "lifestyle advice" was given by nearly everyone, and we therefore did not consider this alternative as a medical action
- "sick leave" (alt. 7) and "new appointment" (alts. 8 and 9) are coded as characteristics of the GP because whether or not a GP chose to give a patient sick leave or make a new appointment are somewhat related to the personality and practice style of the GP. Here we don't have any input from the patient. But we also believe that these variables are influenced by the alternatives chosen. This is further discussed in section five.

When grouping the different sets of medical actions we focuse on alternatives two to six.

The GP could choose conservative treatment, either antacids or histamine antagonists. To cure an H.pylori infection he could choose to try triple therapy. Two-week triple therapy reduces ulcer symptoms, kills the bacteria and prevents ulcer recurrence in more than 90% of patients.

An endoscopy is carried out as an ambulatory service in hospitals or by practicing gastroenterologists and is an examination that uses an endoscope, a thin, lighted tube with a tiny camera on the end. The patient is lightly sedated, and the doctor eases the endoscope into the mouth and down the throat to the stomach and

duodenum. This allows the doctor to see the lining of the oesophagus, stomach, and duodenum. The doctor can use the endoscope to take photos of ulcers and remove a tiny piece of tissue to view under a microscope to see if the bacteria have done any damage.

More about the H.pylori bacterium and the H.pylori analysis

H.pylori analysis detects antibodies to the H.pylori bacterium. The result of the laboratory test is read as negative or positive, and the cut-off point is similar for both for the rapid test and ordinary serology. If the result is positive it means that there are antibodies to H.pylori in the blood. The problem is that many of those who have antibodies do not have a peptic ulcer and do not need any treatment. Even in younger people the prevalence of the bacteria may be as high as 15%.

Serological testing is more accurate than HPRT because it has a higher sensitivity (95% versus 85%) and specificity (95% versus 80%) for detection of H pylori. The sensitivity of the test is here the probability of getting a positive result if the patient has viable bacteria in the stomach, and the specificity of the test is the probability of a negative result if the patient does not have H.pylori bacteria.

## 3. Hypotheses

We are interested in studying the impact of laboratory tests on clinical decision-making. Hence, in this section we concentrate on the characteristics of the information derived from laboratory testing and how this information is likely to be used in determining clinical actions. We also introduce some other variables

that are included as control variables in the empirical analyses. Hypotheses are derived under the assumption that decisions are motivated by serving patients' best interests. This motivation is further discussed in the concluding remarks.

The *pre-test probability* is the GP's assumption that the patient in our case history had an H.pylori infection as the cause of her dyspepsia before the HP-test was taken, and the *post-test probability* is the GP's assumption that the patient had an H.pylori infection taking the test result into account. The post-test probability depends on the GP's pre-test-probability and the result of the HP-test**.** If the test result is *positive* this means that a GP with a pre-test-probability of 30% should state a post-test-probability of H.pylori caused dyspepsia (i.e. ulcer) of 55% if HPRT is used, and 69% if a serological test is used, because the serological test is better than HPRT (from calculations in the feed-back report to the GPs on the questionnaire). According to clinical guidelines, the GP can choose between referral or prescription of triple therapy. If the test is negative there is a probability of over 90% that the patient does not have an H.pylori infection, and the symptoms are probably only temporary and the GP should prescribe Balancid/Zantac.
We assume that if the GP has a low pre-test and a low post-test-probability, the GP will choose only to give Balancid or Zantac. We also expect that the importance of the pre-test- and post-test-probability in the diagnostic decision-making is non-linear and that the importance of the probability increases with the pre-test and the post-test value. We assume that each GP generally has his own threshold value of a patient's probability of having an H.pylori infection, and above this threshold value the probability curve is steep. The exception is when the pre-test or post-test probability is very high; then the GP feels confident of the diagnosis. We test this

hypothesis by including a squared pre-test variable or a squared post-test variable that we assume is negative.

GPs with HPRT were asked to distribute 10 points between the case history, clinical findings, and the laboratoryresult, allotting a higher number of points with increasing importance. We assume that the GPs who allotted a relatively high *score to the importance of the HP-test* will tend to choose triple therapy if the test is positive, and Balancid or Zantac if the test is negative.

Referral to upper endoscopy will be more inconvenient for the patient if the *waiting time* or the *travelling time* is long, and thus we assume that the probability of referral to upper endoscopy decreases in step with the travelling time or waiting time.

The GPs who prefer to follow up the patient may choose medical actions that demand more follow-up. Only prescribing Balancid/Zantac demands more follow-up by the GP than referring the patient for a breath test or upper endoscopy. We assume therefore that the GPs who follow up their patient by making a *new appointment* or *asking the patient to make a new appointment* tend to give Balancid/Zantac versus referral or the triple therapy.

The probability of meeting a patient with symptoms indicating peptic ulcer increases with the number of patients, and hence with the number of *consultations* and *working hours*. And we want to study whether GPs with more experience (high number of consultations and working hours) would choose differently from GPs with less experience.

GPs in *group practices* have the same type of laboratory equipment. We assume that the GPs influence each other in discussions about what kind of lab-equipment

the practice should have, and as a consequence of more inter-collegiate exchange of information, they are more aware of its weaknesses and less apt to give triple therapy than GPs in solo practices.

General practices *in urban areas* face competition for patients, and one way of getting a competitive advantage is to give quicker service to the patients. We assume therefore that, compared to GPs located in urban and semi-urban areas, GPs in the cities have a higher probability of choosing referral or prescribing triple therapy versus Balancid/Zantac.

The GPs who only use *supplier's information* as the most important information source regarding the use of HPRT are those who have used information from visits by a supplier, exhibitions, mailed information, or other types of information from the suppliers. GPs with “other combinations” have used "The Journal of the Norwegian Medical Association", courses or other sources. We want to study whether the fact that GPs only use supplier’s information or not affects their choice of medical action.

A number of courses are required in order to maintain a *specialist certificate*, and we want to study whether the GP’s education affects his or her choice of medical action.

Primary health care is the responsibility of the municipalities. We collected our data in April/May 1999 and our description is based on the type of payment system we had then. About 2/3 of the doctors in general practices were self-employed, and their income derived from three sources: a fixed grant from the municipality, patient co-payment, and reimbursement from the National health Insurance according to a negotiated tariff (about 1/3 each). Some of the doctors did

not have an agreement with the municipality, but could use the same National health Insurance Reimbursement tariff and usually charge a higher patient co-payment. We had three types of payment in private practice: GPs with fee-for-service combined with a practice allowance from the municipalities, GPs with only fee-for-service, and list-doctors. A new doctor organisation in general practice based on a list system had been tried out in 4 municipalities since 1993. These doctors get an annual fee for each patient on their list (per capita fee) from the municipality. In addition they got fee-for-service based on a special tariff. From June 2001 the list system is enacted as the system by which primary health care is organised in Norway, but it is still possible to be on a fixed salary rather than per capita and fee-for-service.

The last group is GPs who receive a fixed salary from the municipality. The municipality also pays the salaries for other personnel in the practice and other costs of running the practice. This is the only group that does not receive fee-for-service financing. For GPs on fixed salary the doctor's salary is independent of the income and expenses in the practice. We include whether the GP is in private practice as a control variable in the empirical analysis, without having any particular hypothesis regarding the effect of private practice on clinical decision-making in this particular case.

## 4. Data

In this section we will first give an overview of the available choices the GP had in according to our questionnaire (figure 1), or had made before we sent out the

questionnaire (i.e. the decision to have HPRT available). Afterwards we will give an overview of what the GPs chose as medical actions (the dependent variables), and an overview of the independent variables.

For GPs with HPRT we study the choice made in the first consultation in those who used HPRT. For GPs without HPRT it is in the second consultation that they chose medical actions, depending on the result of the serological test. In the first consultation they chose to use a serological test in addition to the medical actions. In the second consultation the patient returns after two weeks and is not feeling better.

We cannot compare GPs with and without HPRT directly, because for GPs with HPRT we study the medical actions chosen in the first consultation, while for GPs without HPRT, we study the medical actions chosen in the second consultation. In the second consultation GPs have

received more information than GPs with HPRT since they know that the medical action chosen in the first consultation did not have any effect.

FIGURE 1

The dependent variables

The GPs chose many different sets of medical actions and we grouped them by medical decisions into three categories as described in the introduction:

- Balancid/Zantac
- Referrals
- Triple therapy.

Table 1 shows an overview over the number of GPs who had chosen the different medical strategies, depending on the result of the HP-test. If a GP without HPRT in the first consultation referred the patient for a breath test or an upper endoscopy, we anticipate that it has not yet been done by the second consultation. We grouped the medical actions in both consultations concerning GPs without HPRT, because we wanted to study if the medical actions in the first consultation would influence their choices in the second.

TABLE 1

Table 1 shows that the GPs' choices of medical actions depend on the result of the HP-test, and follow clinical guidelines, given that the lab.result is correct. When the lab result is negative the GPs seldom choose triple therapy, and if the result of the HP-test is positive they seldom choose only to prescribe Balancid/Zantac. If the test is positive, approximately the same percentage of GPs choose the different alternatives regardless of whether or not they have the rapid test, showing that neither the time aspect nor the fact that the GPs without the rapid test have more information in the second consultation influence the GPs' choice. If the test is negative, the table shows that fewer GPs without the test than those with the test choose to prescribe Balancid/Zantac, and a much higher number of these choose referral. In the second consultation, the GP knows that the patient is not feeling better, indicating that the medical actions chosen in the first consultation (often only Balancid/Zantac) have not been very successful. Therefore the GPs change their strategy, and 81% chose to do further investigations such as a breath test or

upper endoscopy. The high number of referrals is consistent with Healy and Ryan's (3) findings that 70% of the GPs will refer a patient to obtain reassurance.

210 of 425 GPs with HPRT decided to use HPRT but only 100 GPs of 410 GPs without HPRT decided to use a serological test. We excluded observations when the GP seemed to have misunderstood the question or groups of GPs with deviant characteristics. GPs on internship in general practice, age > 67 years, working hours > 60 or <10 per week, number of consultations > 160 or < 10 per week, waiting time > 26 weeks (concerning referral). Further details on the exclusion of the observations are described in appendix B.

The independent variables

Table 2 gives an overview of our data for the 201 GPs with HPRT and 84 GPs without HPRT. These had in common that, in this specific situation, they used a HP-test, for example HPRT, or sent a blood test to a "hospital" laboratory

Table 2 shows that 80.6% of the GPs with HPRT and 76.2% without HPRT are male, 77.6% of the GPs with HPRT and 77.4% without HPRT are in group practice. 63.2% of the GPs with HPRT and 50% without HPRT are located in an urban area, and most of the GPs with HPRT are in private practice. On average, the GP with HPRT has 35 working hours and 89 consultations per week and the GP without HPRT has 33 working hours and 75 consultations per week. On average, the pre-test-probability is 49.5% for GPs with the test and 48% for GPs without the test. Questions about the importance of HPRT, compared with case history and clinical findings, were only asked to GPs with the test. Questions about

the importance of HPRT, sick leave, new appointment and post-test-probability were related to whether the result of the HP-test was positive or negative.

For GPs without HPRT we have used information from the questions asked regarding the second consultation, and, because of the wording of the questionnaire, we believe that the GPs in the second consultation chose fewer medical actions, in particular they seldom or never chose “recommend sick leave” or “patient initiated new appointment”. In the first consultation the GPs were asked to ‘mark’ the chosen medical actions, but in the second consultation the GPs had to go back in the questionnaire to find the numbers for each of the chosen medical actions.

We compared the characteristics age, sex, and type of payment in our total sample of GPs (both using and not using lab) with the total population of GPs (from a register kept by the Norwegian Medical Association). We found that our sample had the same mean values regarding age, had a higher percentage of men (77% versus 73.6%), and only half the share of the GPs were on fixed salary (14.4% versus 28%).

TABLE 2

We calculated the probability of having an H.pylori-induced ulcer (predictive value) by taking into account that a fraction of 15% of the population under 45 year are healthy carriers of the H.pylori bacterium, and also the sensitivity and specificity of both the rapid test and the serological test. We tested whether the mean predictive value of the test result was significantly different from the mean post-test probability assumed by the GPs, and found that it was only in GPs

without the test and with a positive result that the predictive value of the test result was *not* significantly different from the post-test probability assumed by the GPs. For GPs with the test, the post-test probability with a positive result was significantly higher than the positive predictive value, and significantly lower with a negative result than the negative predictive value. For GPs without the test, the post-test probability was significantly higher with a negative result than the predictive value. The details of the calculations are put in Appendix C. The significance of these results will be discussed in section eight.

## 5. Empirical models

The theoretical framework is based on discrete choice analyses, see Greene (4).

We want to study variables influencing the GPs' choice of medical actions in GPs using a lab in a specific situation. We want to establish models to predict the probability of a GP choosing different alternatives. We have three alternatives (Balancid/Zantac, referral and triple therapy) that are mutually exclusive, and we will use multinomial models. The reference alternative in the model was Balancid/Zantac.

We suppose that the GPs have preferences for different choices, and that these preferences can be represented in a utility function. All the GPs have the same patient – so the focus here is on the GP's own objectives and preferences, knowledge, experience and uncertainty. The patient here is a paper-patient and the patient's preferences are not known by the GPs.

The usefulness of using a laboratory analysis to detect an H.pylori infection will depend on the GP's pre-test probability stated by the GP. The test must also be analysed and interpreted correctly. Because some patients are carriers of H-pylori without being ill, the use of the test will depend on the GP's knowledge of H.pylori, and on the use of the HP-test.

The GPs' choice setting can be compared with choices between lotteries, because of the uncertainty of the initial health status of the patient and of the laboratory analysis. The uncertainty of the laboratory analysis occurs because the HP-test measures antibodies to the H.pylori bacteria, and not the disease as such, and because healthy carriers of the H.pylori bacteria exist. When the GP is uncertain about the initial health status, there is also uncertainty about the effect of a treatment for a given condition (here an H.pylori infection). The GP may refer the patient for a breath test or upper endoscopy to be more certain about the initial health status.

Problems with evaluating the expected utility of the different alternatives are that the GP may also have unstable preferences. This means that he may make different choices in replications of the same choice setting (bounded rationality). The degree of bounded rationality may vary in apparently identical situations because the GP is continually being influenced by colleagues, medical journals and experience from treating other patients. Further, there will be variation in the choices that will not be explained by the variables available to us. Unobservable variables for the researcher are the signals from the patient to the GP about choosing different medical actions. We have a "paper-patient" and there will

therefore be no signals from the patient, except the notion that she was no better in the second consultation with GPs without the rapid test.

Let $U_{ij}$ be the expected utility for $GP_i$, as evaluated by the $GP_i$, with respect to the uncertain events mentioned above, given alternatives j = 0,1,2. According to the discussion above we assume that the utility $U_{ij}$ is stochastic.

(1a) $$U_{ijt}= \alpha_{ij} + X_i\beta_j + \varepsilon_{ij}$$

where $\varepsilon_{ij}$ is a stochastic term and $X_i$ is a vector of; the characteristics of the GPs, the result of the test, the pre-test-probability and the squared pre-test-probability for GPs with HPRT. For GPs without HPRT, $X_i$ is a vector of the characteristics of the GPs and the post-test-probability and the squared post-test-probability. $\varepsilon_{ijt}$ is supposed to account for unobserved variables of the GP that affect his preferences, and the fact that the GP may have unstable preferences.

When t = 1 we study the GPs choice when the test result is negative and when t = 2 we study the GP's choice when the test result is positive. Recall that we have two observations per GP, one set of medical actions when the HP-test is negative and one set of medical actions when the HP-test is positive. There may be unobservable heterogeneity of the GPs and correlation between the stochastic terms. To take this into account, we use a multinomial logit model with random effects, which is a method used for panel data.

This implies that we can rewrite the model as

(1b) $U_{ijt} = \alpha_j + X_i\beta_j + \varepsilon^*_{ijt}$

where $\alpha_j$ is the mean of $\alpha_{ij}$ across the population and

$$\varepsilon^*_{ijt} = \varepsilon_{ijt} + \alpha_{ij} - \alpha_j$$

which implies that the error term $\varepsilon^*$ becomes correlated over two periods. We assume that the alfas are random effects, thus constant over periods, while the epsilons are independent over periods and also independent of the alfas.

We have included whether the GP recommends sick leave, or how the GP follows up the patient as independent variables. But these variables may also depend on the medical choice, the endogenous variable, because the GP may anticipate that the patient will get strong side effects from triple therapy, which may influence the GP to recommend sick leave. This is not a problem as long as we are aware of that our model predicts the conditional choice probabilities. Thus the probability of choosing triple therapy versus Balancid/Zantac depends on whether the GP recommends sick leave, or makes a new appointment, etc. (Ben-Akiva, Lerman (5)).

We assume that the GP will choose the alternative with the highest utility

(2) $P_j(X_i,\alpha_i) = P(U_{ij} > U_{ik}, \text{ for all } k \neq j) = P(\alpha_{ik} + X_i\beta_k - \alpha_{ij} - X_i\beta_j \leq \varepsilon_{ij} - \varepsilon_{ik}, \text{ for all } k \neq j)$

where $P_j(X_{i,}\alpha_i)$ is the probability that the GP will choose the j alternative among the three alternatives, conditional on $\alpha_i$, where $\alpha_i = (\alpha_{i0}, \alpha_{i1}, \alpha_{i2})$

Let $Y_{ij}$ be a random variable that indicates the choice made. $Y_{ij}$=1 if the alternative j is chosen by the $GP_i$, and 0 if not.

McFadden (6) has shown that if (and only if) the three disturbances are independent and identically distributed with the extreme value distribution.

(3) $$F(\varepsilon_{ij}) = \exp(-\exp(-\varepsilon_{ij}))$$

Then

(4) $$P(Y_{ij} = 1 \mid X_i,\alpha_i) = P(X_i,\alpha_i) = \exp(\alpha_{ij} + X_i\beta_j)/[\sum_{k=0}^{2}\exp(\alpha_{ij} + X_i\beta_k)], \quad j = 0,1,2$$

which is to a multinomial logit model. After normalizing such that $\beta_0 = 0$ where alternative zero is the reference, the probabilities are

(5) $$P(Y_{ij} = 1) = \exp(\alpha_{ij} + X_i\beta_j)/[1 + \sum_{k=1}^{2}\exp(\alpha_{ij} + X_i\beta_k)] \text{ for } j = 1,2$$

(6) $$P(Y_{i0} = 1) = 1/[1 + \sum_{k=1}^{2}\exp(\alpha_{ij} + X_i\beta_k)],$$

The log likelihood for random effect is described in NLOGIT versjon 3.0 (7).

## 6. Estimation results

To estimate the coefficients (the β-vector) in logistic regression we use the Maximum Likelihood Method.

In the tables 3 and 4 we have included the variables that were significant, the laboratory related variables and the remuneration variable (private practice). The full tables are in appendix D. These tables show the values and the t-ratios on the parameters in the models.

The GP's choice of medical action - GPs with HPRT.

Here we examine the importance of the characteristics of the GP for the probability for choosing different medical actions by estimating a multinomial logit model.

We had 393 observations but these were reduced to 369 observations for the standard model, because LIMDEP skip all observations with missing values when estimating multinomial logit model. But for the model with random effect we needed balanced data and had to exclude GPs who had only chosen one set of medical action, and thus had 354 observations.

We have included results from both the standard multinomial logit, and the model with random effect in table 3. By using the LR-test we found that the model with random effect is significantly the best model, and we will focus on this model when interpreting the table. We see that the parameters in the model with the

random effect are a bit less significant and that the significant variables have a bigger effect on the probability of the choice.

TABLE 3

From table 3 we see that the variables having a significant effect on the probability of choosing referral versus Balancid/Zantac are:

- whether the GP gets a positive or a negative result of HPRT
- whether the GP makes a new appointment,
- whether the GP asks the patient to make a new appointment if she does not recover.

Table 4 shows that if the HPRT-result is positive the GP chooses referral versus Balancid/Zantac 23 times as often as if the HPRT-result is negative. This seems reasonable because if the HPRT-test is positive there are reasons for further investigations to find out whether this patient has a HP-infection.

GPs who make a new appointment or/and ask the patient to make a new appointment if she does not recover, choose referral vs. Balancid/Zantac 0.12 and 0.07 times as often as GPs who do not arrange for a follow up of the patients. This may be because only prescribing symptomatic treatment demands more follow up from the GP (ref. section three).

From table 3 we see that the variables with a significant effect on the probability of choosing the triple therapy versus Balancid/Zantac are:

- whether the GP gets a positive or a negative result of HPRT,
- whether the GP gives the importance of HPRT a high point
- whether the GP recommends sick leave.

The results show that the lab result in particular has a major influence on the probability of the GP choosing triple therapy versus Balancid/Zantac. If the HPRT-result is positive, the GP chooses triple therapy versus Balancid/Zantac 966 times as often as if the HPRT-result was negative. If the GP increase the importance of the HPRT-test by one point, the GP will choose triple therapy versus Balancid/Zantac 1.62 times more often as before.

GPs who recommend sick leave choose triple therapy 6.38 times more often than Balancid/Zantac, compared with GPs who do not recommend sick leave. Recall here from section five that we have conditional choice probabilities, the probability of a GP choosing triple therapy vs. Balancid/Zantac is given whether they have recommend sick leave or not.

The GP's choice of medical actions - GPs without HPRT.

Here we examine the importance of variables on the probability of choosing different medical actions in the second consultation (when the test result was available) by estimating a multinomial logit model.

In this section we use the post-test-probability instead of the pre-test-probability and the result of the HP-analysis, because, as table 3 showed, all the GPs choosing triple therapy had a positive lab result and we had too little variation in the data to be able to use this variable.

We had 162 observations but these were reduced to 156 in the standard model, because LIMDEP skips all observations with missing values when estimating multinomial logit model. But in the model with random effect we had to have

balanced data and had to exclude GPs who had only chosen one set of medical action, leaving us with 139 observations.

TABLE 4

In table 4 we have included results from both the standard multinomial logit, and the model with random effect. By using the LR-test we found that the model with random effect was not a significantly better model than the standard model.

Table 4 shows that the post-test-probability and the location of the practice (semi-urban vs. uban) are the only variables that have a significant effect. We also see that the post-test probability is non-linear. From the table we see that the odds ratio for choosing referral vs. Balancid/Zantac is ca.1.33, and that the odds ratio for choosing triple therapy vs. Balancid/Zantac is ca.1.48. Thus if the GP has a post-test-probability of 50%, the GP will choose referral 66.5 times as often as Balancid/Zantac, and triple therapy 74 times as often as Balancid/Zantac.
If the general practice is located in the urban area vs. a semi-urban area it is 8.33 times as often that the GP choose referral vs. general practice located in the semi-urban area.

It may seem strange that the choice of medical actions in the second consultation does not depend on the first consultation, but this may be because the 24 GPs who chose referral in the first consultation also chose referral in the second consultation, because neither upper endoscopy nor the breath test had been carried out when the patient came to the second consultation.

## 7. The effect of changes in significant variables

In this section we only use the results from the standard multinomial model for GPs with HPRT.

Calculations in Appendix E show that the probability that “our” GP with HPRT chooses referral vs. Balancid/Zantac is 95%, and the probability of choosing triple therapy vs. Balancid/Zantac is 85.9%. The marginal effects on the probability are listed in table 5.

TABLE 5

Table 5 shows that the HP-test has the greatest effect on the GP’s decision of choosing medical action. Our GP has a probability of 90.5% of choosing referral, and if the HP-test is negative for an identical GP, the probability will decrease by 54.5%.

Our GP does not ask the patient to make a new appointment. In the third line in table 5 it is shown that an identical GP who asks the patient to make a new appointment will decrease the probability by 37.9% compared with our GP, thus the probability that this GP chooses referral versus Balancid/Zantac is 53.3%.

Our GP has a probability of 85.9% of choosing triple therapy versus Balancid/Zantac, and if the HP-test is negative for an identical GP, the probability will decrease by 84.3%. Thus the probability that this GP will choose triple therapy versus Balancid/Zantac is 0.04%. Our GP does not recommend sick leave. Table 5 shows that an identical GP who recommends sick leave will have a probability of 96.3 of choosing triple therapy versus Balancid/Zantac.

## 8. Concluding remarks

We have developed a method for studying the effect of a specific laboratory analysis on choosing medical actions. By using discrete choice analysis and multinomial logit models, we have seen that the result of the HP-analysis has a significant influence on a GP's choice of medical actions. We plan similar future studies of different types of laboratory analyses before we can draw general conclusions. However, it is reasonable to assume that we will find similar results in clinical situations where other tests are rarely needed. It is also reasonable to assume that the GPs in Norway are representative for the practice in other western countries

We will now discuss some objections to the methods we have used.

Our data is based on a questionnaire where the GP is given enough information to establish a preliminary diagnosis. In writing the clinical vignette it was important to describe a realistic situation to get valid results. But in a questionnaire we loose the interaction between the patient and the GP. The patient could have wanted to have the laboratory test taken, but the Helicobacter Pylori analysis is not very well known in Norway, so this is not very likely.

In the literature there have been discussions about the validity of written case scenarios in medical decision-making. One might say that by using a clinical vignette we measure competence (what a physician is capable of doing), and not performance (what a physician actually does in his day-to-day practice). Kuyvenhoven and co-workers (8) conclude that written simulations give a realistic impression of a GP's diagnostic and therapeutic approach to patients with vague

symptoms like those in our clinical vignette. By use of clinical scenarios, Redelmeier and Tversky (9) noted that physicians are more likely to request ineffective care when presented with a named patient than when a general question about the strategy is asked. In a review of 74 published studies using written simulations, the validity issue was addressed in only 11 studies, and the conclusions were conflicting (Jones TV et al (10)). Sandvik H (11) studied the validity of responses to patient vignettes in a situation based on the management of female urinary incontinence, and found that when cueing items were provided the physician claimed more actions with vignettes than were actually performed. In our situation this means that waiting and travelling time for an upper endoscopy will probably have a significant effect in a real consultation compared with our findings, because the GP considers the patients convenience more in actual encounters with the patient, and this will make it easier to start treatment versus referral.

Peabody et al (12) have validated clinical vignettes as a method for measuring the competence of physicians and the quality of their actual practice, and conclude that the quality of care can be measured by using clinical vignettes.

Bias is more likely if the respondents feel obliged to display some kind of expected behaviour or/and if the written scenario differs from a typical situation. Our case history depicts a real patient with some minor modifications, in order to make the situation as realistic as possible.

NOKLUS mails questionnaires 2-3 times a year. The GPs receive feedback reports with their answers compared with the results of other GPs, and with clinical guidelines about the use of the laboratory analysis in question. It is

possible that the GPs who respond make an extra effort to study H-pylori in order to try to score better than most of their colleagues. If so, their answers to the questionnaire will reflect their level of competence at the 'later consultations' and not the consultations they had before receiving the questionnaire. We also believe that we have a selection problem because the GPs responding on the questionnaire are probably more eager than those not responding.

Recall that we assumed that the GPs were motivated by the patients' interests guided by the best clinical evidence available. This is not an uncontroversial assumption. In the literature, various models of GP behaviour are suggested, as described by Scott (13). A basic income-leisure framework is common to many models. In these, the GPs are modelled as self-employed individuals who supply their own labour and have their own objectives regarding leisure and the consumption of other goods. Other models have included "inducement" in the utility function to represent the disutility from physician-induced demand (PID). PID exists when the GP influences a patient's demand for care against the GP's interpretation of the best interest of the patient (McGuire 14). The majority of models have examined treatment decisions as the main decision variable, as our model does.

The only way a GP can increase his income from private practice in our setting is to influence the number of consultations by influencing the number of follow-up visits. The motivation for influencing the number of consultations in GPs with private practice depends on whether the GP feels that he has enough patients. Figure 2 shows how the GP can influence the number of consultations.

If the GP feels he has too few patients, there is an economic incentive to initiate follow-up visits. If the GP feels he has enough patients he may be concerned about the availability of services to the other patients, for ethical reasons and independently of the remuneration system. He may therefore ration his services or induce negatively, as explained in McGuire (14). In our case, the GP can influence utilization in different ways. If the GP feels that he has enough patients, the GP may ask the hospital to start treatment if the test result is positive and examination at the hospital indicates that the patient has an H.pylori infection. If the GP chooses to give the triple therapy, the patient will only return if she does not improve. Thus both relevant alternatives enable the GP to avoid a new consultation if the patient has an H.pylori infection. If the patient does not have the infection and does not recover, she will return to the GP with both alternatives
FIGURE 2

If the GP lacks patients he may tend to choose to refer the patient to the hospital and ask the hospital not to start treatment after the examination, and make a new appointment, independently of the alternative chosen. But the decision whether or not to start treatment is usually done at the hospital. This was taken care of by including follow-up as an independent variable.
If the test is negative and the GP lacks patients, he may only prescribe Balancid/Zantac and make a new appointment. If the GP has enough patients he may prescribe Balancid/Zantac without making a new appointment and/or inform the patient that the symptoms are temporary and not dangerous, or refer the patient without a follow-up to reassure the patient.

However, we do not know the actual number of patients compared with the preferred number of patients for each GP and are not able to test for physician-induced demand.

The answer to the question "Need for information about the use of the test" is the GP's own evaluation. Regarding the question about the "most important information sources for HPRT", it is possible that the GPs answer what they believe would be accepted by their colleagues.

Recall that by estimating the predictive value and comparing with the post-test-probability assumed by the GPs, we found that it was only GPs without the H.pylori test and with a positive result that had managed to estimate the post-test-probability correctly, based on the pre-test-probability and the result of the test. We also found that GPs with HPRT overestimated the value of the test and this agrees with results from Steurer et al. (15), who found that doctors tend to overestimate information derived from diagnostic tests and underestimate information from a patient's clinical history. Steurer et al. have studied the extent to which different forms of summarising diagnostic test information influence general practitioners' ability to estimate disease probabilities. They found that many doctors confuse the sensitivity of clinical tests and their positive predictive value. The consequence of overestimating results of the H.pylori analysis is that if the test result is positive, more patients will be given the triple therapy than necessary, which may increase resistance to antibiotics.

We conclude that, since the result of laboratory tests in our study affect the choice of medical action, the quality of the laboratory test is likely to have an effect on patients' health and social costs. Hence, institutions for quality

monitoring and improvement are important ingredients of health care reform. Such institutions should balance cost and the benefits of quality improving measures, and will be the focus of closer study in our future research. We want to develop a method that can be used to evaluate the economical consequences of good quality of a laboratory analysis through a cost-benefit analysis.

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Appendix A

**THE NORWEGIAN QUALITY IMPROVEMENT OF LABORATORY SERVICES IN PRIMARY CARE**

*NOKLUS is financed by Quality Assurance Fund III, which was established by The Norwegian Medical Association, The Norwegian Association of Local and Regional Authorities, and The Ministry of Health and Social Affairs.*

NOKLUS

## *Dear General practitioner*

Many so-called rapid tests have been developed for use in the doctor's surgery. One of the most recent on the market is the **Helicobacter pylori test**. However, we know little about how much importance is attached to this test in clinical practice and the consequences of the result.

We have therefore constructed a short case history, which is presented below. The case history is modelled on a real patient, and all the relevant information is included. However, as in most case records, it is not possible to present all the details. We ask you to read the case history carefully, and to cross off the proposed measure(s) that you would initiate if *you* were treating this patient in *your* surgery today.

The results will be used in the preparation of guidelines for using this test. The objective of this questionnaire is slightly different from the casuistic material that you otherwise receive from NOKLUS, and control material is therefore not enclosed.

We hope that you will set aside a few minutes to fill in this form. It is only labelled with a practice number and will be treated confidentially. You will be sent a feedback showing the distribution of answers and including professional information before the end of June.

***Please return the questionnaire before May 9th***

Yours sincerely,

| Atle Klovning | Sverre Sandberg | Geir Thue | Siri Fauli |
|---|---|---|---|
| Research Fellow | Leader, NOKLUS | GP/Specialist NOKLUS | Master degree student |

### *Anette Hansen*

is 31 years old and works for 5 hours a day in the afternoon/evening as a cleaner. Married, usually happy at home, two children aged 11 and 6 years.

During the past month she has had epigastric pain with a feeling of hunger, and some relief on eating. Experiences that the pain increases when she under stress. Slightly loose and irregular defecation at times.

She had a similar episode just under a year ago, and then recovered rapidly with Zantac 150 mg x 2, which she took for just over a week during her summer holidays. No other measures were taken at this consultation. She smokes 10 cigarettes a day, 2-3 cups of coffee, consumes little alcohol. No medication.

When you examine her this Tuesday she is slightly tender over her epigastrium, no other findings.

She should be at work later today.

- How likely do you think it is that Mrs Hansen's symptoms are caused by an H. pylori infection: _____ %

  (0% - absolutely certain that H. pylori is not the cause, 100% - absolutely certain that H. pylori is the cause)

- Would you have used the H. pylori rapid test here? $\theta_1$ **no (answer sections A and C)**

  (put a cross to show your choice) $\theta_2$ **yes (answer sections B1, B2 and C)**

## *A You choose **not** to carry out the Helicobacter pylori rapid test*

- Draw a circle round the number indicating the measure(s) that you will initiate at today's consultation:

  1 -advice on life-style

  2 - advise to take Balancid or similar

  3 - trial treatment with Zantac or similar

  4 - trial treatment with one of the triple regimens against H. pylori

  5 - referral for a breath test to demonstrate H. pylori

  6 - referral to gastroscopy

  7 - suggest sick leave for the patient this Tuesday

  *For how long*? …… days

  8 - make a follow-up appointment for the patient

  9 - ask the patient to renew contact if she does not recover

  *Other measures if relevant (please specify):*

- Mrs Hansen returns after 2 weeks.

  She is no better.
  Neither gastroscopy nor a breath test (if relevant) has been carried out.

  *Please answer **one** of the two alternatives below,*
  *and specify the measures you will initiate using the numbers given above, e.g.* 6 if you now refer to gastroscopy , 7 for (extended) sick leave, etc.

  If relevant, you can enter other measures at the bottom of this page

I. You do *not* carry out an H. pylori rapid test, but initiate the following measure(s) (specify using numbers as above):
_____

II. You choose to carry out an H. pylori rapid test and receive the result during the consultation **(please answer both a and b)**

a. the result is *negative*.
How likely do you now think it is that Mrs Hansen's symptoms are caused by an H. pylori infection? ____%

You initiate the following measures (specify using numbers as above): _____

b. the result is *positive*
How likely do you now think it is that Mrs Hansen's symptoms are caused by an H. pylori-infection? ____%

You initiate the following measures (specify using numbers as above): _____

*Other measures if relevant (please specify):*

**Proceed to section C**

## *B You choose to carry out an H. pylori rapid test (please answer both B1 and B2)*

### B1 The result of the H. pylori rapid test is negative

- How likely do you now think it is that Mrs Hansen's symptoms are caused by an H. pylori infection? _____ %

- How much importance do you attach to the case history and clinical examination of Mrs Hansen and the result of the H. pylori rapid test in relation to each other?
  You have 10 points to allot (give most points to the factor that you consider most important):

  case history _____ examination _____ test _____ (in total: 10 points)

- Draw a circle round the number specifying the measure(s) that you will initiate at today's consultation:

  1 - advice on life-style

  2 - advise to take Balancid or similar

  3 - trial treatment with Zantac or similar

  4 - trial treatment with one of the triple regimens against H. pylori

  5 - referral for a breath test to demonstrate H. pylori

  6 - referral to gastroscopy

  7 - suggest sick leave for the patient this Tuesday

  *For how long*? …… days

  8 - make a follow-up appointment for the patient

  9 - ask the patient to renew contact if she does not recover

  *Other measures if relevant (please specify):*

- Mrs Hansen returns after 2 weeks.

  She is no better.
  Neither gastroscopy nor a breath test (if relevant) has been carried out.

  Specify the measures that you will now initiate using numbers, e.g. 6 if you now refer for gastroscopy, 7 for (extended) sick leave etc. _____

  *Other measures if relevant (please specify):*

**Proceed to section B2**

## B2 The result of the H. pylori rapid test is positive

- How likely do you now think it is that Mrs Hansen's symptoms are caused by an H. pylori infection? _____ %

- How much importance do you attach to the case history and clinical examination of Mrs Hansen and the result of the H. pylori rapid test in relation to each other?
  You have 10 points to allot (give most points to the factor that you consider most important):

  case history _____ examination _____ test _____ (in total: 10 points)

- Draw a circle round the number specifying the measure(s) that you will initiate at today's consultation:

  1 -advice on life-style

  2 - advise to take Balancid or similar

  3 - trial treatment with Zantac or similar

  4 - trial treatment with one of the triple regimens against H. pylori

  5 - referral for a breath test to demonstrate H. pylori

  6 - referral to gastroscopy

  7 - suggest sick leave for the patient this Tuesday

  *For how long*? …… days

  8 - make a follow-up appointment for the patient

  9 - ask the patient to renew contact if she does not recover

  *Other measures if relevant (please specify):*

- Mrs Hansen returns after 2 weeks.

  She is no better.
  Neither gastroscopy nor a breath test (if relevant) has been carried out.

  Specify the measures that you will now initiate using numbers, e.g. 6 if you now refer for gastroscopy, 7 for (extended) sick leave etc. _____

  *Other measures if relevant (please specify):*

**Proceed to section C**

## *C Background information*

- The travelling time (one way) for a patient to carry out gastroscopy is generally _____hours
- The waiting period for a gastroscopy where you usually refer patients is generally _____weeks
- The travelling time (one way) for a patient to carry out a breath test is generally _____hours
- The waiting period for a breath test is generally _____weeks

  θ do not have this possibility

- Do you sometimes refer patients to a private clinic where they have to pay more in order to be able to carry out gastroscopy?

  $\theta_1$ yes

  $\theta_2$ no

  $\theta_3$ do not have this possibility

- To what extent do you feel that you need information on the use of the H. pylori rapid test?

  $\theta_1$ no need

  $\theta_2$ slight need of information

  $\theta_3$ some need

  $\theta_4$ a great need of information

- Which have been your two most important sources of information on the use of the H. pylori rapid test?

  $\theta_1$ information from the dealer (visit by representative, displays at courses, material sent by post)

  $\theta_2$ The Journal of The Norwegian Medical Association

  $\theta_3$ course

  $\theta_4$ journals published by the pharmaceutical industry, e.g. Legemidler og Samfunn, Therapia Medica

  $\theta_5$ other, specify_____

- Your year of birth: _____
- Gender: _____ (M/F)
- Your initials: _____ (in capital letters and clear, to facilitate the feedback)

**(continued on next page)**

- You work in $\theta_1$ a group practice

  $\theta_2$ a single doctor practice

- The practice is located in $\theta_1$ a town/densely populated area with more than 15 000 inhabitants

  $\theta_2$ a densely populated area with between 5000 and 15 000 inhabitants

  $\theta_3$ a rural district – less than 5000 inhabitants in the largest densely populated area in the area covered by the practice

- Working hours in curative practice per week are about _____hours

- Number of consultations in the course of a normal working week is about _____ (number)

- In your practice do you have $\theta_1$ refund from the National Health Insurance, and an operating subsidy

  $\theta_2$ a fixed salary

  $\theta_3$ fastlegeordning (system providing each citizen with permanent doctor)

  $\theta_4$ only refund from National Health Insurance, no operating subsidy

  $\theta_5$ a practice with no refund or operating subsidy

- Are you a specialist in general medicine?

  $\theta_1$ no

  $\theta_2$ yes

  $\theta_3$ no, I am doing my pre-registration service (internship in GP)

*Thank you for your participation!*
*A prepaid envelope for your reply is enclosed*

Appendix A

**THE NORWEGIAN QUALITY IMPROVEMENT OF LABORATORY SERVICES IN PRIMARY CARE**

*NOKLUS is financed by Quality Assurance Fund III, which was established by The Norwegian Medical Association, The Norwegian Association of Local and Regional Authorities, and The Ministry of Health and Social Affairs.*

NOKLUS

## *Dear General practitioner*

The guidelines for the use of **Helicobacter pylori serology** in the investigation of dyspepsia are not clear, both as regards submitted blood samples and use of rapid tests. We know little about how much importance is attached to the serology results in clinical practice and the consequences of the result.

We have therefore constructed a short case history, which is presented below. The case history is modelled on a real patient, and all the relevant information is included. However, as in most case records, it is not possible to present all the details. We ask you to read the case history carefully, and to cross off the proposed measure(s) that you would initiate if *you* were treating this patient in *your* surgery today.

The results will be used in the preparation of guidelines for using H. pylori serology. The objective of this questionnaire is slightly different from the casuistic material that you otherwise receive from NOKLUS, and it is therefore also sent to practices that do not have this rapid test.

We hope that you will set aside a few minutes to fill in this form. It is only labelled with a practice number and will be treated confidentially. You will be sent a feedback showing the distribution of answers and including professional information before the end of June.

***Please return the questionnaire before May 9th***

Yours sincerely,

Atle Klovning, Research Fellow
Sverre Sandberg, Leader, NOKLUS
Geir Thue, GP/Specialist NOKLUS
Siri Fauli, Master degree student

### *Anette Hansen*

is 31 years old and works for 5 hours a day in the afternoon/evening as a cleaner. Married, usually happy at home, two children aged 11 and 6 years.

During the past month she has had epigastric pain with a feeling of hunger, and some relief on eating. Experiences that the pain increases when she under stress. Slightly loose and irregular defecation at times.

She had a similar episode just under a year ago, and then recovered rapidly with Zantac 150 mg x 2, which she took for just over a week during her summer holidays. No other measures were taken at this consultation. She smokes 10 cigarettes a day, 2-3 cups of coffee, consumes little alcohol. No medication.

When you examine her this Tuesday she is slightly tender over her epigastrium, no other findings.

She should be at work later today.

- How likely do you think it is that Mrs Hansen's symptoms are caused by an H. pylori infection: _____ %

(0% - absolutely certain that H. pylori is not the cause, 100% - absolutely certain that H. pylori is the cause)

- Draw a circle round the number indicating the measure(s) that you will initiate at today's consultation:

1 advice on life-style

2 advise to take Balancid or similar

3 trial treatment with Zantac or similar

4 trial treatment with one of the triple regimens against H. pylori

5 send a blood sample for serological demonstration of H. pylori

6 referral for a breath test to demonstrate H. pylori

7 referral to gastroscopy

8 suggest sick leave for the patient this Tuesday

*For how long*? …… days

9 make a follow-up appointment for the patient

10 ask the patient to renew contact if she does not recover

*Other measures if relevant (please specify):*

- Mrs Hansen returns after 2 weeks.

She is no better.
Neither gastroscopy nor a breath test (if relevant) has been carried out.

*Please answer **one** of the two alternatives below,*
*and specify the measures you will initiate using the numbers given above, e.g. 7* if you now refer to gastroscopy , 8 for (extended) sick leave, etc.
If relevant, you can enter other measures at the bottom of this page

II. You did *not* order H. pylori serology at the previous consultation.
You now initiate the following measures (specify using numbers as above): _____

II. You *ordered* H. pylori serology at the previous consultation **(please answer both a and b)**

c. the H. pylori serology result is *negative*.
How likely do you now think it is that Mrs Hansen's symptoms are caused by an H. pylori infection? ____%

You initiate the following measures (specify using numbers as above): _____

d. the H. pylori serology result is *positive*
How likely do you now think it is that Mrs Hansen's symptoms are caused by an H. pylori-infection? ____%

You initiate the following measures (specify using numbers as above): _____

*Other measures if relevant (please specify):*

## *C Background information*

- The travelling time (one way) for a patient to carry out gastroscopy is generally _____hours
- The waiting period for a gastroscopy where you usually refer patients is generally _____weeks
- The travelling time (one way) for a patient to carry out a breath test is generally _____hours
- The waiting period for a breath test is generally _____weeks

  θ do not have this possibility

- Do you sometimes refer patients to a private clinic where they have to pay more in order to be able to carry out gastroscopy?

  $\theta_1$ yes

  $\theta_2$ no

  $\theta_3$ do not have this possibility

- To what extent do you feel that you need information on the use of the H. pylori rapid test?

  $\theta_1$ no need

  $\theta_2$ slight need of information

  $\theta_3$ some need

  $\theta_4$ a great need of information

- Which have been your two most important sources of information on the use of the H. pylori rapid test?

  $\theta_1$ information from the dealer (visit by representative, displays at courses, material sent by post)

  $\theta_2$ The Journal of The Norwegian Medical Association

  $\theta_3$ course

  $\theta_4$ journals published by the pharmaceutical industry, e.g. Legemidler og Samfunn, Therapia Medica

  $\theta_5$ other, specify_____

- Your year of birth: _____
- Gender: _____ (M/F)
- Your initials: _____ (in capital letters and clear, to facilitate the feedback)

**(continued on next page)**

- You work in $\theta_1$ a group practice

  $\theta_2$ a single doctor practice

- The practice is located in $\theta_1$ a town/densely populated area with more than 15 000 inhabitants

  $\theta_2$ a densely populated area with between 5000 and 15 000 inhabitants

  $\theta_3$ a rural district – less than 5000 inhabitants in the largest densely populated area in the area covered by the practice

- Working hours in curative practice per week are about _____hours

- Number of consultations in the course of a normal working week is about _____ (number)

- In your practice do you have $\theta_1$ refund from the National Health Insurance, and an operating subsidy

  $\theta_2$ a fixed salary

  $\theta_3$ fastlegeordning (system providing each citizen with permanent doctor)

  $\theta_4$ only refund from National Health Insurance, no operating subsidy

  $\theta_5$ a practice with no refund or operating subsidy

- Are you a specialist in general medicine?

  $\theta_1$ no

  $\theta_2$ yes

  $\theta_3$ no, I am doing my pre-registration service (internship in GP)

*Thank you for your participation!*
*A prepaid envelope for your reply is enclosed*

## Appendix B Exclusion and grouping of the observations

After exclusion we had 201 GPs with HPRT and 84 GPs without HPRT who requested this analysis (9 and 16 doctors excluded respectively). We had two sets of observations per GP (depending on whether the test result was positive or negative); 402 observations with HPRT and 168 observations without HPRT. Because of missing observations and 4 GPs who chose no medical action (regarded as an incomplete answer), we had 393 observations for GPs with HPRT. For GPs without the test there were 13 observations where the GPs who had chosen no medical action in the second consultation, had chosen Balancid/Zantac (6) and referral (7) in the first consultation. The six observations where no medical actions were chosen in the second consultation, and only Balancid/Zantac in the first consultation were regarded as missing observations and excluded. We coded the 7 observations with referral in the second consultation in the same way as in the first consultation. Hence we had 162 observations.

## Appendix C Testing of the predictive value versus the post-test-probability

By using Bayes law we calculated in LIMDEP the probability of having an H.pylori-infection (predictive value) by taking into account that 15% of the population under 45 years are healthy carriers of the H.pylori bacterium and the sensitivity and the specificity of the rapid test or the serological test.
We tested whether the predictive value of the test result was significantly different from the post-test probability assumed by the GPs. The details are shown below.

**Calculation of the predictive value vs. the post-test-probability**

We are going to calculate the effect of the lab result when 15% of the population is healthy carriers of the H pylori bacteria. Table C.1 shows the results of the calculations. The pre-test-value in our example is 0.2, thus the GP assume that 200 among 1000 similar patients are infected and 800 are not infected.

We show here the calculations for the predictive value of the HPRT. Similar calculations are done for the serological test. From ch.2 we know that the serological testing is more accurate than HPRT because it has higher sensitivity (95% versus 85%) and specificity (95% versus 80%) for detection of H pylori.

The number of persons having the bacteria without being infected is 120 (800*15%) persons, and 680 persons (800-120) don't have the bacteria. It is not possible to be infected without having the bacteria.

Table C.1

***Possible outcomes where the HPRT is positive***

1. Number of persons having the bacteria and being infected.

Total number of persons giving the bacteria and being infected* sensitivity

=Pre-test-probability*1000* sensitivity= 200*0.85=170 persons

2. Number of persons having the bacteria and not being infected.

Total number of persons having the bacteria and not being infected *sensitivity

=120*0.85 = 102 persons

3. Number of persons without the bacteria and not being infected.

Total number of persons without the bacteria and not being infected*(1-specificity)

= 680*0.2 = 136 persons

*Calculation of the positive predictive value;*

Number with the bacteria being infected/ all possible outcomes=

170/(170+102+136) = 0.4167

***Possible outcomes when the HPRT is negative***

1. Number of persons having the bacteria and being infected

Total number of persons having the bacteria and being infected

= Pre-test-probability*1000*15 (1- sensitivity) =200*15

= 30 persons

2. Number of persons having the bacteria and not being infected

= Total number of persons having the bacteria and not being infected

= 120*15% (1-sensitivity) = 18 persons

3. Number of persons without the bacteria and not being infected

= Total number of persons without the bacteria and not being infected * specificity

=680*0.8=544 persons

*Calculation of the negative predictive value;*

Number with the bacteria not being infected/ all possible outcomes

= 18+544/(30+18+544)=0.949

**For GPs having HPRT**

We study the mean from the two samples where

$\mu_1$ = “pospred” in tables below = mean of the calculated positive? predictive value

$\mu_2$ ="postsan" in tables below = mean of the post-test-probability given by the GPs

We find the T-value by using the formula

$T= \mu_1 - \mu_2 / \sqrt{(\sigma_1^2/n_1 + \sigma_2^2/n_2)}$

Where $\sigma_i$ = the standard deviation of sample i, i = 1,2

We compare the T-value with the critical t-value, to study if the means are significantly different

Our zero hypothesis is $H_0 = \mu_1 - \mu_2 = 0$. If $|T|| \geq t_{0.05}=1.96$, we reject $H_0$ , i.e. we reject that the means are equal.

The tables C.2 and C.3 shows the mean, std.deviation, minimum, maximum and number of rows (3 lines per observation because each GP choose between three alternatives).

<u>When the HPRT is positive:</u>

$T=68.04-76.31/\sqrt{(0.62 + 0.47)} = - 8.27/1.04= - 7.95$

*The t-value is above the critical t-value on 1.96 and this means we reject $H_0$*

<u>When the HPRT is negative</u>

$T=20.38-15.6/\sqrt{(0.33 + 0.35)} = 4.8/0.82 = 5.85$

*The t-value is above the critical t-value on 1.96 and this means that we reject $H_0$*

TABLE C.2When the serologic test is positive:

$T=76.54-79.57/\sqrt{(1.694 + 1.466)} = - 3.03/1.77= - 1.71$

*The t-value is not above the critical t-value on 1.96 and this means that we cannot reject $H_0$ saying that the two means are equal.*

TABLE C.2

**For GPs without HPRT**

TABLE C.3

When the serologic test is negative:

T=9.13-16.4/√(1.07 + 1.81) = - 7.3/1.69 = - 4.3

*The t-value is above the critical t-value on 1.96 and this means that we reject* $H_0$

## Appendix D - Full models

Table D.1 and table D.2 include all the estimation results of full models

*TABLE D.1*

*TABLE D.2*

## Appendix E The effect of changes in significant variables

We have non-linear data, and cannot interpret the coefficients as we do in ordinary linear regression. Let $P_1(X_i)$ be the probability of $GP_i$ choosing alternative 1. If we study a change in

$P_1(X_i)$ as a result of a change in one of the continuous variables (variable nr. k), we will get;

$$(10) \qquad \partial P_1(X_i)/\partial X_{ik} = (1-P_1(X_i))P_1(X_i)\beta_k.$$

For continuous variables this means that the effect of the variable will depend on the level of the variable, for example if the GP is 30 or 40 years old.

Many of our explanatory variables are binary, and here they have the value 1 or 0, depending on the characteristics of the GP. If we want to study the effect of a change in a binary variable, we do this by calculating the difference:

$$(11) \qquad P_1(X^*_i) - P_1(X_i) = 1/[1 + \exp(-X^*_i\beta)] - 1/[1 + \exp(-X_i\beta)]$$

where $X^*_i$ is the vector of characteristics after the change, and $X_i$ is the vector of variables before the change.

We want to study the magnitude of the effect of significant variables on the probability of choosing referral vs. Balancid/Zantac and of choosing triple therapy vs. Balancid/Zantac. As an example, a GP with the following characteristics (after this named “our GP”):

- male, 45 years old
- needs information on the use of HPRT
- the HP-analysis is positive
- does not use supplier's information only
- works 35 hours with 90 consultations per week in a group practice
- is paid fee-for-service
- lives in an urban area
- estimates a pre-test-probability of 30% and with a positive H.pylori analysis estimates a post-test-probability of 50% that the dyspepsia is due to a H pylori infection
- does not have a specialist licence in general practice/family medicine
- gives the relative importance of the HPRT-test 3 points on a scale from 1 to 10
- does not recommend sick leave for Mrs Hansen
- does not schedule a follow-up appointment
- has one hour's travelling time for upper endoscopy, and 4 weeks waiting time
- chooses Zantac/Balancid in the first consultation (in GPs without HPRT)

We study the effect of significant variables and calculate the probability of choosing triple therapy or referral in $GP_i$, by putting in the values of the coefficients and the characteristics in the formula for the probability of choosing triple therapy or referral vs. Balancid/Zantac.

When we study the effect of a change in a characteristic of the GP, we do similar calculations and change one characteristic leaving the others unchanged. We name the new probability $P_1(X^*)$ as in (11).

**GPs with HPRT**

In estimating the probability we use results from the standard model in table 6.1 and the characteristics on the GP mentioned in section 7.

**Calculation of the probability of choosing Referral vs. Balancid/Zantac**

We calculate the probability by setting in for $\beta$ and $X_i$ in the formula $1/[1 + \exp(-X_i\beta)]$

$1/1+e^{-(1.630 + 2.847*1-0.088*3 - 0.030*30 + 0.0004*900 + 0 + 0.003*45 - 0.125 – 0.422 + 0 - 0.351+ 0 – 1.097 – 0.013*1 + 0.008*4+ 0.009*35+0.002*90 + 0 - 0 + 0)} =$

$1/1+e^{(1.630 + 2.847 - 0.264 - 0.90 + 0.36 + 0.135 - 0.125 – 0.422 - 0.351 – 1.097 –0.013 – 0.032+ 0.315+0.18)}$

$=1/1+e^{-(2.263)}=1/1+0.104= 0.905$, thus there is a 90.5% probability that this GP will choose Referral vs. Balancid/Zantac and $P_1(X_i) = 90.5\%$.

Effect of the result of HPRT

When we study the effect of a GP receiving a negative vs. a positive laboratoryresult, other variables remaining unchanged, we get $1/1+e^{-(2.263-2.847)}=1/1+1.793= 0.358$, thus there is a 35.8% probability that this GP will choose Referral vs. Balancid/Zantac and $P_1(X_i^*) = 35.8\%$.

The effect of HPRT is a decrease in the probability by

$dP_1(X_i)/dX_{if} =P_1(X_i^*)-P_1(X_i)= 54.5\%$.

Effect of the GPs follow-up

A) We study the effect of a GP making a new appointment vs. not making a new appointment, other variables remaining unchanged and get $1/1+e^{-(2.263-1.744)}=1/1+0.595 = 0.627$, thus there is a 62.7% probability that this GP will choose Referral vs. Balancid/Zantac and $P_1(X_i^*) =62.7\%$.

The effect of the new appointment is a decrease in the probability by $dP_1(X_i)/dX_{inf} =P_1(X^*_i)-P_1(X_i)= - 27.8\%$.

B) We study the effect of a GP asking the patient to make a new appointment if she does not get better vs. not asking the patient to make a new appointment, other variables remaining unchanged, and get $1/1+e^{-(2.263-2.158)}=1/1+0.90= 0.526$, thus there is a 52.6% probability that this GP for will choose Referral vs. Balancid/Zantac and $P_1(X_i^*) = 52.6\%$

The effect of the GP asking the patient to make a new appointment is a decrease in the probability by $dP_1(X_i)/dX_{inf} =P_1(X^*_i)-P_1(X_i)= - 37.9\%$.

**The probability of choosing triple therapy vs. Balancid/Zantac**

We calculate the probability by setting for $\beta$ and $X_i$ in the formula $1/[1 + \exp(-X_i\beta)]$

$$1/1+e^{-(-5.918 +5.911*1+0.310*3 + 0.059*30 - 0.0004*900 + 0.006*45 - 0.035 – 0.444 + 0 - 0.683+ 0 + 0.286 - 0.0003*35+ 0.001*90+0- 0 +0)} =1/1+e^{-(-5.918 + 5.911+0.930 + 1.77 –0.36 + 0.27 - 0.035 – 0.444 - 0.683+ 0.286 - 0.0105+ 0.090)}$$

$=1/1+e^{-(1.81)}$ = 1/1 + 0.164= 0.859, thus it is a 85.9% probability for this GP to choose triple therapy vs. Balancid/Zantac and $P_1(X_i)$ = 85.9%.

Effect of the result of HPRT

When we study the effect of a GP receiving a negative vs. a positive laboratoryresult other variables remaining unchanged, we get $1/1+e^{-(1.81-5.918)}$=1/1+ 60.8= 0.016, thus it is a 1.6% for this GP to choose triple therapy vs. Balancid/Zantac and $P_1(X_i^*)$ = 1.6%.

The effect of HPRT is a decrease in the probability by

$dP_1(X_i)/dX_{if} = P_1(X_i^*)-P_1(X_i)$= - 84.3%.

Importance of lab.

When we study the effect of a GP giving the importance of HPRT-test 5 points, increased from 3 points other variables remaining unchanged, we get $1/1+e^{-(1.81+0.31*2)}$=1/1+ 0.088= 0.919, thus it is a 91.9% for this GP to choose triple therapy vs. Balancid/Zantac and $P_1(X_i^*)$ = 91.9%.

The effect of HPRT is a increase in the probability by

$dP_1(X_i)/dX_{if} = P_1(X_i^*)-P_1(X_i)$= + 6%.

Effect of recommending sick leave

When we study the effect of a GP *not* recommending sick leave vs. a GP recommending sick leave, other variables remaining unchanged, we get $1/1+e^{-(1.81 + 1.461)}$=1/1+0.038 = 0.963, thus it is a 96.3% for this GP to choose triple therapy vs. Balancid/Zantac and $P_1(X_i^*)$ =96.3%

The effect of whether or not sick leave is recommended is an increase in the probability by $dP_1(X_i)/dX_{inf} = P_1(X^*_i) - P_1(X_i) = 10.4\%$

## Figures

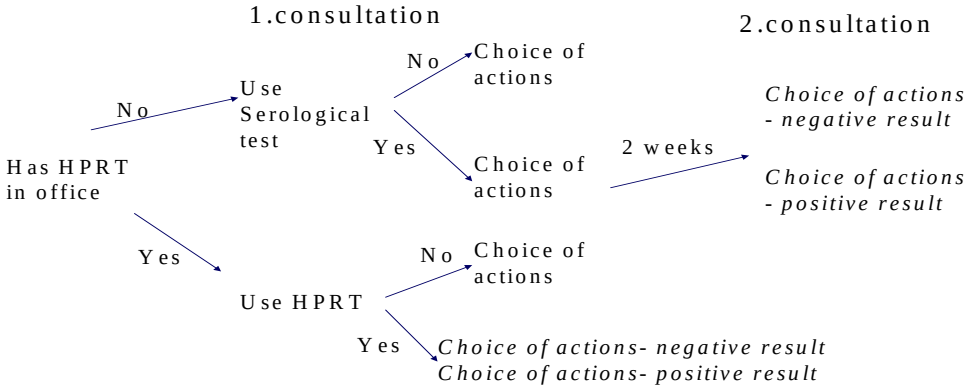


*Figure 1 The GP's decision-making in General Practice*

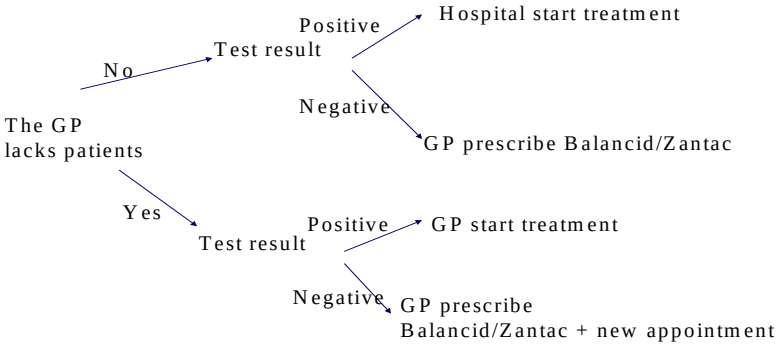


*Figure 2 The GPs possibilities influencing the number of consultations*

## Tables

*Table 1 Overview over the medical strategies chosen by the GPs*

| **Independ.variables** | **GPs with HPRT** | | **GPs without HPRT** | | |
|---|---|---|---|---|---|
| **Medical strategies** | **Negative** | **Positive** | **1.consultation*** | **Negative** | **Positive** |
| 1. Balancid/Zantac | 112 (56%) | 8 ( 4%) | 55 (71%) | 14 (19%) | 2 (2%) |
| 2. Referral | 85 (42%) | 101(53%) | 22 (29%) | 65 (81%) | 44 (52%) |
| 3. Triple therapy | 4 (2%) | 83 (43%) | 0 (0%) | 0 (0%) | 37 (46%) |

*9 GPs chose ”no medical action” in addition to a serological test in the first consultation, but chose medical actions in the second consultation

*Table 2 Descriptive statistics of the variables included.*

| **Variables** | **Definition** | **With HPRT** | | **Without HPRT** | |
|---|---|---|---|---|---|
| | | **Mean.** | **Std.dev** | **Mean** | **Std.dev** |
| Sex | Binary variable:1 if male, 0 if female | 0.806 | | 0.762 | |
| Age | Number of years | 46.200 | 7.299 | 45.400 | 8.464 |
| Need of info | Need for information about the use of HPRT; Binary: 1 if some or a lot, 0 if none or only modest | 0.642 | | 0.429 | |
| Type of info | The two most important information sources of HPRT. Binary variable; 1 if only suppliers info, 0 if other | 0.517 | | 0.607 | |
| Group practice | Type of practice. Binary variable: 1 if group practice, 0 if solo practice | 0.776 | | 0.774 | |
| Urban | Reference category for location of practice: Binary variable: 1 if inhab.>15000, other 0 | 0.632 | | 0.500 | |
| Semi-Urban | Category for location of practice. Binary variable: 1if 5000≤inhab.≤15000, 0 if other | 0.209 | | 0.321 | |
| Rural | Category for location of practice Binary variable: 1 if inhab.<5000, 0 if other | 0.159 | | 0.179 | |
| Consultations | Number of consultations per week | 89.139 | 27.316 | 74.881 | 27.224 |
| Working hours. | Number of working hours per week | 35.129 | 8.088 | 32.637 | 9.548 |
| Private practice | Binary:0=fixed salary, 1=are reimbursed | 0.92 | | 0.798 | |
| Specialist | The GPs education. A number of courses are required to have a specialist certificate- Binary variable: 1 if specialist certificate, 0 if other | 0.721 | | 0.655 | |
| Wait.upper endo. | Waiting time in weeks for upper endoscopy where the GP uses to refer | 4.900 | 3.700 | 5.023 | 3.727 |
| Trav.upper endo. | Travelling time in hours for the patient (one way) for upper endoscopy where the GP usually refers | 1.015 | 3.495 | 0.778 | 0.918 |
| Pre-test-probability | The pre-test probability that Mrs Hansen's symptoms are due to a H.pylori infection | 49.459 | 20.515 | 48.085 | 20.866 |
| Importance of negative test | The importance of HPRT-test on a scale from 1 to 10 | 2.797 | 1.447 | - | - |
| Importance of positive test | The importance of HPRT-test on a scale from 1 to 10 | 3.923 | 1.8 | - | - |
| Post-test-prob. negative test | The post-test probability that Mrs Hansen's symptoms are due to a H.pylori infection | 16.492 | 17.170 | 15.809* | 19.663 |
| Post-test-prob. positive test | The post-test probability that Mrs Hansen's symptoms are due to a H.pylori infection | 76.166 | 10.016 | 79.669* | 17.967 |
| Sick leave – neg | Binary:0= not sick leave, 1=sick leave | 0.269 | | 0.107* | |
| Sick leave – pos | Binary:0= not sick leave, 1=sick leave | 0.318 | | 0.100* | |
| New appointment Negative | Binary:0= no appointm.1=new appointm | 0.438 | | 0.060* | |
| New appointment positive | Binary:0= no appointm.1=new appointm. | 0.477 | | 0.071* | |
| Patient initiated appointm. – neg | Binary:0= no appointm.1=new appointm. | 0.468 | | 0* | |
| Patient initiated appointm. – pos. | Binary:0= no appointm.1=new appointm. | 0.248 | | 0.024* | |
| First consultation | Binary:0= no actions, Balancid/Zantac 1=referral | - | - | 0.262 | |

* information from the second consultation

*Table 3 Results of the estimation of the model for GPs with HPRT* - Reference; Balancid/Zantac

| Independent variables | Medical action | Standard Model Parameter | t-ratio | Random effect Parameter | t-ratio |
|---|---|---|---|---|---|
| Constant | Referral | 1.630 | 0.911 | 2.290 | 1.023 |
| | Triple therapy | **-5.918** | **-2.210** | - 7.643 | -1.919 |
| Result of HPRT | **Referral** | **2.847 (17.2)** | **6.213** | **3.139 (23)** | **5.576** |
| | **Triple therapy** | **5.911 (369)** | **7.939** | **6.874 (966)** | **4.640** |
| Importance of lab | Referral | -0.088 (0.92) | -0.812 | -0.107 (0.89) | -0.801 |
| | **Triple therapy** | **0.310 (1.36)** | **2.213** | **0.483 (1.62)** | **2.042** |
| Pre-test-probability | Referral | -0.030 (0.97) | -0.955 | -0.038 (0.96) | -0.984 |
| | Triple therapy | 0.059 (1.06) | 1.251 | 0.078 (1.08) | 1.280 |
| Pre-test-probability$^2$ | Referral | 0.0004 (1.0004) | 1.175 | 0.0005 (1.0005) | 1.191 |
| | Triple therapy | -0.0004 (0.9996) | -0.922 | -0.0006 (0.9994) | -1.004 |
| Type of info | Referral | **0.690 (1.99)** | **2.096** | *0.818 (2.26)* | *1.957* |
| | Triple therapy | **0.867 (2.38)** | **1.947** | *1.064 (2.89)* | *1.881* |
| Private practice | Referral | -1.097 (0.33) | -1.633 | -1.378 (0.25) | -1.593 |
| | Triple therapy | 0.286 (1.33) | 0.306 | 0.591 (1.81) | 0.465 |
| New appointment | **Referral** | **-1.744 (0.17)** | **-3.849** | **-2.126 (0.12)** | **-3.651** |
| | Triple therapy | -0.831 (0.43) | -1.472 | -0.800 (0.51) | -1.065 |
| New appointment initiated by patient | **Referral** | **-2.158 (0.12)** | **-4.685** | **-2.664 (0.07)** | **-4.274** |
| | Triple therapy | *-1.051 (0.35)* | *-1.720* | -1.166 (0.31) | -1.478 |
| Sick leave | Referral | **0.755 (2.12)** | **2.009** | *0.838 (2.31)* | *1.806* |
| | **Triple therapy** | **1.461 (4.31)** | **2.983** | **1.853 (6.38)** | **2.529** |
| Variance of the random effect | **Referral** | - | - | **1.169** | **2.859** |
| | Triple therapy | - | - | 1.241 | 1.167 |
| Log-L | | -348.8615 | | -346.0475 | |
| Restricted Log-L | | | | -490.7482 | |
| McFaddens $R^2$ | | 0.283 | | 0.295 | |
| McFaddens adjusted $R^2$ | | 0.254 | | 0.265 | |

Bold figures indicate that the effect is significant at 5% level, and figures in italics are significant at 10% level. The odds rates are given in parentheses.

*Table 4 Results of the estimation of the model for GPs without HPRT - Reference: Balancid/Zantac*

| Independent variables | Medical actions | Standard Model Parameter | t-ratio | Random effect Parameter | t-ratio |
|---|---|---|---|---|---|
| Constant | Referral | -1.039 | -0.287 | -0.947 | -0.258 |
| | Triple therapy | *-8.949* | *-1.928* | **-9.483** | **-1.974** |
| Post-test probability | **Referral** | **0.285 (1.33)** | **3.253** | **0.288 (1.33)** | **3.245** |
| | **Triple therapy** | **0.393 (1.48)** | **3.845** | **0.397 (1.48)** | **3.813** |
| Post-test probability$^2$ | **Referral** | **-0.003 (0.997)** | **-3.143** | **-0.003 (0.997)** | **-3.138** |
| | **Triple therapy** | **-0.003 (0.997)** | **-3.369** | **-0.003 (0.997)** | **-3.338** |
| First consultation | Referral | 1.450 | 1.403 | 1.483 | 1.407 |
| | Triple therapy | 1.057 | 0.909 | 1.117 | 0.935 |
| Semi-Urban | **Referral** | **-2.035 (0.13)** | **-2.189** | **-2.058 (0.13)** | **-2.185** |
| | Triple therapy | -1.731 | -1.654 | -1.705 | -1.602 |
| Rural | Referral | 0.020 | 0.012 | 0.048 | 0.029 |
| | Triple therapy | 0.912 | 0.509 | 1.048 | 0.571 |
| Private practice | Referral | -1.766 | -1.113 | -1.776 | -1.113 |
| | Triple therapy | -1.596 | -0.838 | -1.596 | -0.838 |
| *Waiting time* | *Referral* | *0.165 (1.18)* | *1.917* | *0.166* | *1.893* |
| New appointment | Referral | -0.823 | -0.747 | -0.813 | -0.725 |
| | Triple therapy | -1.373 | -1.010 | -1.421 | -1.016 |
| Variance of the random effect | Referral | - | - | 0.313 | 0.740 |
| | Triple therapy | - | - | 0.361 | 0.527 |
| Log-L | | -74.63944 | | - 74.16657 | |
| Restricted Log-L | | - | | -152.7071 | |
| McFaddens $R^2$ | | 0.375 | | 0.378 | |
| McFaddens adjusted $R^2$ | | 0.282 | | 0.286 | |

Bold figures indicate that the effect is significant at 5% level, and figures in italics are significant at 10% level.
The odds rate are given in parentheses

*Table 5. The marginal effects of significant variables on the probability of certain medical actions of GPs – using HPRT*

| **Independent variables** | **Referral vs.Balancid/Zantac 90.5%** | **Triple therapy vs. Balancid/Zantac 85.9%** |
|---|---|---|
| Result of the HP-analysis<br>Positive result → negative result | - 54.5 | - 84.3 |
| Importance of lab. 3→ 5 | | + 6.0 |
| Not a new appointment → new appointment | - 27.8 | |
| The patient is not asked to make a new appointment → is asked | - 37.9 | |
| Does not → does recommend sick leave | | + 10.4 |

## Tables to the appendixes

*Table C.1 The results of the calculations when 15% of the population are healthy carriers*

| | Nr of persons | prevalens ulcus | Healthy carriers of the bacteria |
|---|---|---|---|
| | 1000 | 0,2 | 0.15 |
| | sens bact | spes. bact=1-healthy carriers of the bacteria | |
| | 1 | 0,85 | |
| | Ulcus + | Ulcus neg | |
| Bakt + | 200 | 120 | |
| Bakt - | 0 | 680 | |
| | 200 | 800 | |

HPRT

| | sensitivity | specificity |
|---|---|---|
| | 0,85 | 0,8 |

| | Bact +; ulc+ | Bact +; ulc - | Bact -, ulc- | Pred. Value |
|---|---|---|---|---|
| positive test | 170 | 102 | 136 | 0,416667 |
| negative test | 30 | 18 | 544 | 0,949324 |
| | 200 | 120 | 680 | |

*Table C.2 Overview for GPs with HPRT*

All results based on nonmissing observations.
Stratification is based on TEST

| Variable | Mean | Std.Dev. | Minimum | Maximum | Cases |
|---|---|---|---|---|---|
| Stratum is TEST = Negative Obs.= 768.000, Sum of wts. = 768.000 | | | | | |
| POSPRED | 20.3750000 | 15.9786363 | .000000000 | 100.000000 | 768 |
| POSTSAN | 15.5661376 | 16.2491436 | .000000000 | 100.000000 | 756 |
| Stratum is TEST = Positive Obs.= 768.000, Sum of wts. = 768.000 | | | | | |
| POSPRED | 68.0416667 | 21.8387676 | .000000000 | 100.000000 | 768 |
| POSTSAN | 76.3078947 | 18.9247505 | 10.0000000 | 100.000000 | 760 |

*Table C3 Overview for GPs without HPRT*

| Variable | Mean | Std.Dev. | Minimum | Maximum | Cases |
|---|---|---|---|---|---|
| Stratum is TEST = Negative Obs.= 234.000, Sum of wts. = 234.000 | | | | | |
| POSPRED | 9.12820513 | 15.8293141 | .000000000 | 100.000000 | 234 |
| POSTSAN | 16.4066667 | 20.1566455 | .000000000 | 90.0000000 | 225 |
| Stratum is TEST = Positive Obs.= 234.000, Sum of wts. = 234.000 | | | | | |
| POSPRED | 76.5641026 | 19.9182383 | .000000000 | 100.000000 | 234 |
| POSTSAN | 79.5743243 | 18.0394896 | 5.00000000 | 100.000000 | 222 |

*Table D.1 Results of the estimation of the model for GPs with HPRT- Reference: Balancid/Zantac*

| Independent variables | Medical action | Standard Model | | Random effect | |
|---|---|---|---|---|---|
| | | Parameter | t-ratio | Parameter | t-ratio |
| Constant | Referral | 1.630 | 0.911 | 2.290 | 1.023 |
| | Triple therapy | **-5.918** | **-2.210** | - 7.643 | -1.919 |
| **Result of HPRT** | Referral | **2.847 (17.2)** | **6.213** | **3.139 (23)** | **5.576** |
| | Triple therapy | **5.911 (369)** | **7.939** | **6.874 (966)** | **4.640** |
| Importance of lab | Referral | -0.088 (0.92) | -0.812 | -0.107 (0.89) | -0.801 |
| | Triple therapy | **0.310 (1.36)** | **2.213** | **0.483 (1.62)** | **2.042** |
| Pre-test-probability | Referral | -0.030 (0.97) | -0.955 | -0.038 (0.96) | -0.984 |
| | Triple therapy | 0.059 (1.06) | 1.251 | 0.078 | 1.280 |
| Pre-test-probability$^2$ | Referral | 0.0004 | 1.175 | 0.0005 | 1.191 |
| | Triple therapy | -0.0004 | -0.922 | -0.0006 | -1.004 |
| Age | Referral | 0.003 | 0.128 | 0.003 | 0.102 |
| | Triple therapy | 0.006 | 0.179 | -0.002 | -0.044 |
| Sex | Referral | -0.125 | -0.284 | -0.069 | -0.125 |
| | Triple therapy | -0.035 | -0.058 | -0.082 | -0.109 |
| Need of info | Referral | -0.422 | -1.186 | -0.477 | -1.075 |
| | Triple therapy | -0.444 | -0.907 | -0.635 | -1.007 |
| **Type of info** | Referral | **0.690 (1.99)** | **2.096** | *0.818 (2.26)* | *1.957* |
| | Triple therapy | **0.867 (2.38)** | **1.947** | *1.064 (2.89)* | *.1881* |
| Group practice | Referral | -0.351 | -0.858 | -0.411 | -0.804 |
| | Triple therapy | -0.683 | -1.227 | -0.888 | -1.255 |
| Semi-Urban | Referral | -0.231 | -0.556 | -0.294 | -0.572 |
| | Triple therapy | -0.107 | -0.192 | 0.018 | 0.026 |
| Rural | Referral | 0.172 | 0.354 | 0.203 | 0.341 |
| | Triple therapy | -0.259 | -0.377 | -0.306 | -0.365 |
| Private practice | Referral | -1.097 | -1.633 | -1.378 | -1.593 |
| | Triple therapy | 0.286 | 0.306 | 0.591 | 0.465 |
| Travelling time | Referral | -0.013 | -0.369 | -0.025 | -0.502 |
| | Triple therapy | - | - | - | - |
| Waiting time | Referral | 0.008 | 0.235 | 0.005 | 0.107 |
| | Triple therapy | - | - | - | - |
| Working hours | Referral | 0.009 | 0.380 | 0.011 | 0.374 |
| | Triple therapy | -0.0003 | -0.009 | 0.001 | 0.032 |
| Consultations | Referral | 0.002 | 0.215 | 0.002 | 0.162 |
| | Triple therapy | 0.001 | 0.067 | 0.001 | 0.074 |
| Specialist | Referral | 0.315 | 0.768 | 0.423 | 0.824 |
| | Triple therapy | -0.229 | -0.417 | -0.376 | -0.538 |
| New appointment | Referral | **-1.744 (0.17)** | **-3.849** | **-2.126 (0.12)** | **-3.651** |
| | Triple therapy | -0.831 (0.43) | -1.472 | -0.800 (0.51) | -1.065 |
| New appointment initiated by patient | Referral | **-2.158 (0.12)** | **-4.685** | **-2.664 (0.07)** | **-4.274** |
| | Triple therapy | *-1.051 (0.35)* | *-1.720* | -1.166 (0.31) | -1.478 |
| Sick leave | Referral | **0.755 (2.12)** | **2.009** | *0.838 (2.31)* | *1.806* |
| | Triple therapy | **1.461 (4.31)** | **2.983** | **1.853 (6.38)** | **2.529** |
| Variance of the random effect | Referral | - | - | **1.169** | **2.859** |
| | Triple therapy | - | - | 1.241 | 1.167 |
| Log-L | | -348.8615 | | -346.0475 | |
| Restricted Log-L | | | | -490.7482 | |
| McFaddens $R^2$ | | 0.283 | | 0.295 | |
| McFaddens adjusted $R^2$ | | 0.254 | | 0.265 | |

Bold figures indicate that the effect is significant at 5% level, and figures in italics at 10%level.

*Table D.2 Results from the estimation of the model for GPs without HPRT - Reference; Balancid/Zantac*

| Independent variables | Medical actions | Standard Model Parameter | t-ratio | Random effect Parameter | t-ratio |
|---|---|---|---|---|---|
| Constant | Referral | -1.039 | -0.287 | -0.947 | -0.258 |
| | Triple therapy | *-8.949* | *-1.928* | **-9.483** | **-1.974** |
| **Post-test probability** | Referral | **0.285 (1.33)** | **3.253** | **0.288 (1.33)** | **3.245** |
| | Triple therapy | **0.393 (1.48)** | **3.845** | **0.397 (1.48)** | **3.813** |
| **Post-test probability$^2$** | Referral | **-0.003 (0.997)** | **-3.143** | **-0.003 (0.997)** | **-3.138** |
| | Triple therapy | **-0.003 (0.997)** | **-3.369** | **-0.003 (0.997)** | **-3.338** |
| First consultation | Referral | 1.450 | 1.403 | 1.483 | 1.407 |
| | Triple therapy | 1.057 | 0.909 | 1.117 | 0.935 |
| Age | Referral | 0.006 | 0.092 | 0.005 | 0.079 |
| | Triple therapy | 0.049 | 0.669 | 0.054 | 0.712 |
| Sex | Referral | 0.770 | 0.824 | 0.794 | 0.832 |
| | Triple therapy | 1.402 | 1.236 | 1.448 | 1.238 |
| Need of info | Referral | 0.257 | 0.344 | 0.241 | 0.319 |
| | Triple therapy | 1.489 | 1.687 | *1.577* | *1.721* |
| Type of info | Referral | -0.458 | -0.556 | -0.450 | -0.539 |
| | Triple therapy | -0.608 | -0.616 | -0.643 | -0.640 |
| Group practice | Referral | -0.920 | -0.920 | -0.946 | -0.929 |
| | Triple therapy | -1.684 | -1.386 | -1.741 | -1.386 |
| Semi-Urban | Referral | **-2.035 (0.13)** | **-2.189** | **-2.058 (0.13)** | **-2.185** |
| | Triple therapy | -1.731 | -1.654 | -1.705 | -1.602 |
| Rural | Referral | 0.020 | 0.012 | 0.048 | 0.029 |
| | Triple therapy | 0.912 | 0.509 | 1.048 | 0.571 |
| Private practice | Referral | -1.766 | -1.113 | -1.776 | -1.113 |
| | Triple therapy | -1.596 | -0.838 | -1.596 | -0.838 |
| Travelling time | Referral | -0.022 | -0.032 | -0.083 | -0.115 |
| | Triple therapy | - | - | - | - |
| *Waiting time* | *Referral* | *0.165 (1.18)* | *1.917* | *0.166* | *1.893* |
| | Triple therapy | - | - | - | - |
| Working hours | Referral | -0.008 | -0.160 | -0.008 | -0.167 |
| | Triple therapy | -0.006 | -0.107 | -0.008 | -0.131 |
| Consultations | Referral | 0.038 | 1.504 | 0.038 | 1.497 |
| | Triple therapy | 0.044 | 1.606 | 0.045 | 1.595 |
| Specialist | Referral | -0.932 | -1.001 | -0.953 | -1.003 |
| | Triple therapy | -0.821 | -0.752 | -0.816 | -0.731 |
| New appointment | Referral | -0.823 | -0.747 | -0.813 | -0.725 |
| | Triple therapy | -1.373 | -1.010 | -1.421 | -1.016 |
| Variance of the random effect | Referral | - | - | 0.313 | 0.740 |
| | Triple therapy | - | - | 0.361 | 0.527 |
| Log-L | | -74.63944 | | - 74.16657 | |
| Restricted Log-L | | | | -152.7071 | |
| McFaddens $R^2$ | | 0.375 | | 0.378 | |
| McFaddens adjusted $R^2$ | | 0.282 | | 0.286 | |

Bold figures indicate that the effect is significant at 5% level, and figures in italics are significant at 10%level.