**International Journal of Technology Assessment in Health Care, 15:4** (1999), 629–637.


# WHICH FACTORS DETERMINE THE USE OF DIAGNOSTIC IMAGING TECHNOLOGIES FOR GASTROINTESTINAL COMPLAINTS IN GENERAL MEDICAL PRACTICE?

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Abstract

**Objective:** Even though gastrointestinal complaints are among the most frequent reasons to contact general medical practioners, little is known about the actual care of these patients, especially the use of diagnostic imaging technologies.
**Methods:** In a network of 57 family practitioners and 29 general internists in Lower Saxony, Germany, 1,217 contacts with patients with gastrointestinal diseases (16%, gastritis; 12%, gastroenteritis; 6%, cholelithiasis; 5% each, ulcus ventriculi and duodeni, and 14%, no final diagnosis) were documented. The effects of patient and physician/practice side factors on the use of ultrasonography and radiography were modeled using multivariate logistic regression.
**Results:** For ultrasonography, diagnosis and ownership of an ultrasound unit (odds ratio [OR] = 3.33) were highly significant predictors ($p < .0001$), followed by unknown diagnosis at beginning of contact (OR = 1.92; $p = .0019$), physician specialty (OR for internists = 1.89; $p = .0025$), and severity ($p = .0085$). For radiography, ownership of an ultrasound unit was the most significant factor (OR = 0.34; $p < .0001$), followed by severity ($p < .0009$), ownership of x-ray apparatus (OR = 2.56; $p = .0025$), physician specialty (OR for internists = 1.98; $p = .0358$), and unknown diagnosis at beginning of contact (OR = 1.79; $p = .0451$). Not significant were age and sex of patient and diagnosis for radiography.
**Conclusions:** Physicians use diagnostic imaging technologies for patients with gastrointestinal complaints according to severity and knowledge about the diagnosis, but ownership of technology is the most predictive factor.

**Keywords:** Gastrointestinal diseases, Physicians, family, Ultrasonography, Radiography, abdominal, Physician self-referral

Although gastrointestinal (GI) complaints are a frequent and important reason for contacting family practitioners (12), little is known about practitioners' diagnostic

and therapeutic strategies. Therefore, in an observation of actual practices as a means of "encounter-based epidemiology," a suitable instrument for health care research (14), we analyzed the link between the type and severity of the illness or of the reason for visiting the practitioner, age and sex of the patient, how well the patient was known, and the practice's equipment for the imaging diagnostic procedures carried out or prompted.

With regard to these procedures, the phenomenon known as self-referral, whereby doctors make increasing use of their own diagnostic resources, is well documented. In the United States, Childs and Hunter (4) described for the first time in 1972 how doctors with their own radiography equipment take x-rays of their patients about twice as often as those who have to refer their patients for this procedure. In 1987, a similar figure was found for family practitioners (15). More recent studies in the United States point to an even bigger difference: the factor for doctors who carry out x-rays themselves and those referring their patients for x-rays was, depending on the indication, between 4.0 and 4.5 for 65,000 illness episodes studied (7), and in another study, depending on the diagnosis, between 1.7 and 7.7 for around 175,000 episodes (8). There have been few similar studies in other countries, although it can be assumed that the problem exists in all countries without a gatekeeper system between primary and secondary ambulatory care.

Germany is an especially worthwhile country to study: The monopoly for the physicians' associations to provide ambulatory care in freestanding physicians' practices has caused a strict separation of the ambulatory from the in-patient sector. Therefore, all technologies that can be used on an ambulatory basis, which includes all imaging technologies, exist both in the ambulatory as well as in the hospital sector. All practices are freely accessible by all patients, i.e., a gatekeeping system does not exist. The ownership of equipment—and its use—is further stimulated through the reimbursement mechanism, which is fee for service based on relative point values. The monetary value of the points depends on the total number of services delivered by all physicians in one region, since they receive a predetermined budget. This situation has created a "prisoner's dilemma" in which every doctor tries to increase the number of services to maintain the share of the total budget (13).

To our knowledge, no study has yet systematically looked at the link analyzed in this study, namely the extent to which the higher rates of imaging diagnostics by equipment owners are due, in addition to equipment ownership, to other doctor-related or practice-related factors (such as the ownership of equipment for alternative imaging procedures) and the effects of patient-related factors such as age, sex, diagnosis, and severity.

## METHODS

In the context of the Medical Location, Factor Assessment, and Outpatient Management Project (3;9;10), randomly selected doctor–patient contacts for typical reasons for general practitioner consultation were recorded in set study periods for a base of family practitioners and general internists. The criteria to include a doctor–patient contact were related to the complaints expressed by the patient and not to the diagnosis—which may not have been reached until treatment was under way—so that day-to-day patient care could be analyzed on the basis of the definition of the problem for diagnostic strategy and for treatment.

In late 1993, the topic was "gastrointestinal problems, including liver, gall bladder, and pancreas in patients from 20 years of age." Eighty-six doctors (57

family practitioners [66%] and 29 general internists [34%]) documented 1,279 doctor–patient contacts, of which the 62 repeat contacts in the study period were excluded from the analysis. Of the contacts, 64% were documented by the family practitioners and 36% by the general internists. The physicians documented the age and sex of the patient; reason for this contact as given by the patient; whether the patient had been seen before (generally and for this problem); functional severity of the presented problem (four categories) in their own view; and diagnostic and therapeutic procedures during the contact, referrals, and the (preliminary) diagnosis.

In addition to the contact documentation, a questionnaire about the care topic was used to obtain information about, for example, regional shortfalls in the care situation, cooperation options, and patient needs not covered (data not shown). Furthermore, in a general introductory questionnaire, practice characteristics such as ultrasound and x-ray equipment ownership were recorded.

Because of the prospective design of the study, relative chances (or relative risks [RR]) can be determined for carrying out or referring for diagnostic or therapeutic measures depending on doctor and patient characteristics. If two groups, A and B, are compared with each other, where $p_A$ and $p_B$ score the probability of the measure, the RR for group A compared with group B is $RR = (p_A / p_B)$. The odds ratio $[p_A / (1 - p_A)] * [p_B / (1 - p_B)]$ is used as a further measure, since estimates of the regression coefficients in the multivariate logistic regression models can be converted by the exponential function directly into OR estimates, adjusted for the other variables, thereby allowing for comparison with the unadjusted ORs.

In the logistic regression models for sonography and radiography, both patient-related and doctor/practice-related characteristics were modeled cumulatively onto the probability of the use of radiography or ultrasound, in order to identify the main factors. The patient-related variables included were knowledge of diagnosis at the beginning of contact (diagnosis status), case severity, diagnosis (at end of contact), age (in three groups: 20–39, 40–59, and 60 years and over), and the sex of the patient. The doctor/practice-related variables were speciality, ownership of equipment for the imaging procedure studied in each model, and ownership of equipment for the alternative procedure (to show possible substitution effects or the technological orientation of the practice). The significant factors in the multivariate models were then analyzed in greater detail.

## RESULTS

### Patients, Doctors, and the Diagnostic Process

Of the 1,217 contacts, 47.7% were male and 52.3% female patients; 31.0% were between 20 and 39 years old, and 32.0% were at least 60 years old. Of those over 60 years old, female patients accounted for 59.7%, while in the middle age range, the proportion of men was greater, at 53.4%.

The five most frequent diagnoses were: gastritis (15.9%), gastroenteritis (12.3%), cholelithiasis (5.8%), ulcus ventriculi (5.3%), and ulcus duodeni (4.5%). At 85.2%, gastroenteritis was frequently diagnosed by family practitioners; on the other hand, cholelithiasis and ulcus duodeni were overrepresented in the general internists' contacts, at 46.6% and 57.9%, respectively. In 13.8% of cases, no diagnosis could (yet) be made. In 35.1% of cases, the diagnosis was clear from the beginning of the doctor–patient contact.

**Table 1.** Case Severity in Relation to Diagnosis

| | Severity | | | |
|---|---|---|---|---|
| Diagnosis | Insignificant | Moderate | Significant | Severe |
| Gastritis | 22.3% | 52.3% | 23.8% | 1.6% |
| Gastroenteritis | 7.1% | 55.5% | 31.0% | 6.5% |
| Cholelithiasis | 8.3% | 37.5% | 47.2% | 6.9% |
| Ulcus ventriculi | 14.1% | 25.0% | 51.6% | 9.4% |
| Ulcus duodeni | 3.6% | 39.3% | 55.4% | 1.8% |
| Other diagnosis | 17.6% | 42.1% | 30.2% | 10.1% |
| No diagnosis | 10.5% | 40.9% | 40.9% | 7.6% |

Complaint severity was not age-dependent but varied considerably with diagnosis (Table 1). The severity of the male patients' conditions was estimated to be slightly higher than that of the female patients, with 46.0% versus 37.3% classified as "significant" or "severe."

The general internists were very differently equipped than the family practitioners: 15% of family practitioners and 75% of general internists had x-ray equipment, with 51% and 82%, respectively, having ultrasound equipment. Every general internist had at least one piece of imaging equipment.

The following diagnostic measures were carried out or prescribed on the documentation day (i.e., not during the whole illness period) in the individual practices: physical examination, 82.3%; history-taking, 81.0%; laboratory tests, 35.0%; ultrasound, 22.6%; endoscopy, 14.3%; and x-ray, 7.5%. Where the diagnosis was known at the start of the contact, in 13.6% of cases ultrasound was carried out or prescribed and in 5.6% x-ray diagnostics was carried out or prescribed, while this was the case in 27.9% and 8.6%, respectively, where no diagnosis was known at the start of the contact.

### Diagnostics Depending on Multiple Factors

With regard to ultrasound examination, the patient-related factors of "diagnosis," "diagnosis status," and "severity" (in descending order) proved to be highly significant predictors. With regard to diagnoses, cholelithiasis and "no diagnosis (despite diagnostics)" were notable by their very high ultrasound rates. Severity was significant due to the "severe" cases, while otherwise no linear effect was apparent. Ultrasound was used to reach a diagnosis almost twice as often as to track the course of the illness where the diagnosis was already known. In contrast, the general patient characteristics of age and sex did not prove to be significant variables (Table 2).

Of the doctor/practice-related factors, ownership of an ultrasound unit and specialty were highly significant factors, while ownership of an x-ray unit was not relevant. With the doctor/practice-related variables, it should be borne in mind—as with the patient-related variables—that the effects given in the table for equipment ownership and specialism have a multiplying effect on each other: thus, internists with ultrasound equipment have an OR of 6.3 compared with 1 for the reference category of "family practitioners without ultrasound equipment."

With the second imaging procedure—radiography—severity and diagnosis status, but not actual diagnosis, were the only patient variables that proved to be significant predictors. Severity proved, considerably more clearly than with ultrasound, to be a relevant factor because x-ray frequency was correlated with

**Table 2.** Multiple Logistic Regression Models for the Probability of the Use of Sonography and Radiography with *p* Values and Odds Ratios of Effects

| Effect (degrees of freedom) | Sonography | | Radiography | |
|---|---|---|---|---|
| | *p* value | Odds ratio | *p* value | Odds ratio |
| Intercept (1) | .8630 | | .0001 | |
| *Patient-related characteristics* | | | | |
| Diagnosis status, i.e., diagnosis unknown at beginning of contact (1) | .0019 | 1.92 | .0451 | 1.79 |
| Case severity (3); reference category: "insignificant" | .0085 | "Severe": 2.05<br>"Significant": 0.72<br>"Moderate": 0.76 | .0009 | "Severe": 14.89<br>"Significant": 8.13<br>"Moderate": 4.53 |
| Diagnosis (5); reference category: "other diagnosis" | .0001 | Cholelithiasis: 7.89<br>Gastritis: 0.64<br>Gastroenteritis: 0.13<br>Ulcus: 0.82<br>No diagnosis: 4.28 | .4064 | Cholelithiasis: 2.31<br>Gastritis: 1.38<br>Gastroenteritis: 0.00<br>Ulcus: 1.67<br>No diagnosis: 1.61 |
| Age (2); reference category: 60 years and older | .2442 | 20–39 years: 0.78<br>40–59 years: 1.14 | .2318 | 20–39 years: 0.67<br>40–59 years: 1.22 |
| Sex; i.e., male (1) | .6955 | 1.07 | .2318 | 1.35 |
| *Doctor/practice-related characteristics* | | | | |
| Speciality; i.e., general internist (1) | .0025 | 1.89 | .0358 | 1.98 |
| Ownership of relevant imaging equipment (1) | .0001 | 3.33 | .0025 | 2.56 |
| Ownership of alternative imaging equipment (1), i.e., radiography for sonography model and vice versa | .2335 | 1.28 | .0001 | 0.34 |

**Table 3.** Use of Imaging Techniques in Relation to Diagnosis and Case Severity, Stratified for Knowledge of Diagnosis at the Beginning of Contact

| | Diagnosis unknown at beginning of contact, per diagnosis/severity group | | Diagnosis known at beginning of contact, per diagnosis/severity group | |
|---|---|---|---|---|
| | Use of sonography | Use of radiography | Use of sonography | Use of radiography |
| *Diagnosis* | | | | |
| Gastritis | 23.3% | 9.1% | 2.5% | 3.8% |
| Gastroenteritis | 3.5% | 0% | 0% | 0% |
| Cholelithiasis | 81.6% | 15.8% | 37.1% | 14.3% |
| Ulcus | 22.7% | 14.7% | 14.3% | 10.2% |
| Other diagnosis | 24.1% | 8.1% | 16.1% | 4.9% |
| No diagnosis | 50.8% | 11.3% | | |
| *Severity* | | | | |
| Insignificant | 37.5% | 1.9% | 7.4% | 0% |
| Moderate | 26.6% | 6.0% | 10.9% | 5.0% |
| Significant | 23.6% | 11.1% | 19.7% | 9.8% |
| Severe | 37.1% | 19.4% | 30.4% | 8.7% |

severity and was almost 15 times higher for "severe" than for "insignificant" cases. As with ultrasound, general patient characteristics were not significant factors (Table 2).

Of the doctor/practice-related factors, alongside ownership of x-ray equipment and specialism, the most significant factor was ownership of the alternative imaging equipment. Doctors with ultrasound equipment had an OR lower by a factor of 3 for x-ray examination compared with doctors without ultrasound equipment.

### Diagnostics Depending on Significant Patient Characteristics

Imaging procedures were more frequently used (or referrals for such procedures made) for diagnosis purposes than to track patient progress (Table 3). When assessing diagnostic use with regard to severity, a factor to be taken into account is that the various diagnoses also show a differing spread of severity (Table 1). With increasing severity, the relative frequency of the diagnostic measures observed rose, in particular where the diagnosis was known (Table 3).

### Diagnostics Depending on Significant Doctor/Practice Characteristics

In practices with ultrasound equipment, ultrasound was used in 31.1% of cases, while in the other practices, referrals for ultrasound were made in just 9.9% of cases (Table 4). This gives a relative chance ("risk") of 3.13 ($p$ value $< .001$). The corresponding relative chance for an x-ray in practices with radiography equipment is 3.83 ($p$ value $< .001$).

The crude OR estimates can be compared to the estimates in the multivariate model. For ultrasound owners, the crude OR of 4.10 is only slightly higher than the estimate of 3.33 in the multivariate model, i.e., the adjustment for patient-related factors in the logistic regression model does not explain the increased "risk" of ultrasound with equipment owners. The explanatory power of patient variables is a little bit higher for radiography. The crude OR for practices with an x-ray unit is 4.34, while it is 2.56 in the multiple regression model.

**Table 4.** Use of Imaging Techniques in Practices with and without Imaging Equipment: Frequency, Relative Change ("Relative Risk"), and Crude Odds Ratio

| | Contact with relevant imaging technique | Relative risk | Crude odds ratio |
|---|---|---|---|
| *Sonography* | | | |
| General internists with/without sonography unit | 44.4%/7.8% | 5.68 | 9.43 |
| Family practitioners with/without sonography unit | 19.7%/10.3% | 1.91 | 2.14 |
| All doctors with/without sonography unit | 31.1%/9.9% | 3.13 | 4.10 |
| *Radiography* | | | |
| General internists with/without x-ray unit | 19.6%/0% | | |
| Family practitioners with/without x-ray unit | 5.1%/4.8% | 1.06 | 1.06 |
| All doctors with/without x-ray unit | 15.2%/4.0% | 3.83 | 4.34 |

Table 4 also demonstrates that the speciality effects shown in the logistic models are rather complex upon closer analysis: internists without ultrasound equipment, for example, referred patients for ultrasound less often than family practitioners without ultrasound equipment, and did not refer them for x-rays at all. One should bear in mind here that all internists without x-ray equipment did, however, have an ultrasound unit, whereas family practitioners without one type of equipment often did not have the other type either. These doctors without imaging equipment referred 19.3% of all cases, of which 58.1% were for diagnostic (partial) clarification. With the other doctors, 11.2% of cases were referred, with 47.5% of them being for diagnostic purposes.

## DISCUSSION

With the data obtained, actual diagnostic patient care can be described with regard to the use of imaging procedures, something that is not possible with routine data from physicians' associations or sickness funds. It is evident that diagnostic imaging technologies are not used randomly by doctors, but that severity, knowledge of the diagnosis, and at least for ultrasound, actual diagnosis are taken into account to differing degrees. In addition, there appears to be a significant and quantitatively relevant link between practice equipment and number of imaging services: in this study, patients of practices with ultrasound equipment received ultrasound over three times more frequently than patients of practices without this equipment were referred for ultrasound. With regard to x-rays, a factor of over 2.5 was found, despite stratifying for patient-related characteristics.

In the United States, self-referral became the subject of heated debate a few years ago, not just among radiologists (1;5;6;11;16), with demands made for better quality assurance measures as well as for a ban on this practice. Since then, a number of federal states have enacted legislation to enforce this ban (16). The present study shows that the German system has the same problems with self-referral. Earlier, we described this self-referral in imaging diagnostics for Germany with regard to x-ray examinations for rheumatic complaints (3) and with regard to Doppler ultrasound examinations for venous diseases, mainly varicose veins and

phlebitis (10). The relative chances in these patients were 2.7 and 2.2 respectively, i.e., slightly lower than in this study.

There are various possible reasons for self-referral:

1. Doctors with diagnostic imaging equipment use it when its use is not necessarily medically indicated, e.g., to redeem fixed costs or to increase their profit. Among other things, the use of ultrasound and radiography even for cases classified as insignificant supports this possibility.
2. Despite medical indications, doctors with no diagnostic imaging equipment do not refer patients or only refer them late to doctors with the relevant equipment, so as not to lose patients.
3. With referral cases, patients are referred for general diagnostic clarification and not specific diagnostic measures so that the diagnostic measures used may not all be recorded.
4. A further reason described in the literature for intensity differences in the diagnostics used is the selection and information process, which leads patients wanting frequent technical diagnostics to contact doctors who meet this demand (18).

A significant and clear effect not hitherto described relates to the substitution between the two procedures studied. In practices with ultrasound equipment, patients are x-rayed or referred for x-ray examination three times less often than in practices without ultrasound equipment. In other words, an x-ray is to be expected primarily where no ultrasound can be carried out. For this reason, general internists without one kind of imaging equipment make fewer referrals than family practitioners without that equipment because they can substitute the alternative diagnostic equipment more easily. These interrelations should be investigated in further studies in other settings.

It cannot be concluded directly from these data whether doctors without special diagnostic facilities set the indications too narrowly or doctors with the relevant diagnostic equipment use it for cases with questionable medical indication. To analyze this would require the determination of the appropriateness of the imaging technique used in every individual case. A different—and technically probably more feasible—approach would be a comparative study in a country with a gatekeeper system such as the United Kingdom where general practitioners neither have the relevant imaging equipment nor need to fear losing patients referred for diagnostics.

As a preliminary stage for quality assurance measures in outpatient care, such as the issue of relevant guidelines, the effectiveness of imaging diagnostics and their alternatives should be further evaluated. This process would require longitudinal observation of patients with equivalent complaints and complaint severity, in order to analyze whether and to what extent the increased use of technical equipment in diagnostics leads to a faster and more precise diagnosis, and what the consequences are on the therapy and, finally, the outcome for the patient (2;17).

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