Standardization and Coding of
Gastrointestinal Endoscopy reports

Standardization and Coding of Gastrointestinal Endoscopy Reports

Standaardisatie en codering van
gastro-intestinale endoscopie verslagen

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CHAPTER 1

General introduction and outline of the thesis

Gastrointestinal endoscopy

Gastrointestinal endoscopy has developed rapidly in the last five decades. It started in the sixties, when the first commercial model of the then recently invented fully flexible fiberoptic gastroscope was developed.[1] In the late sixties fiberoptic endoscopes changed to forward viewing, with an open channel for air insufflation, aspiration and a passage for accessories, especially biopsy instruments.[2] In the seventies with the introduction of a new side-viewing endoscope it became possible to visualize the pancreatic duct and to perform endoscopic sphincterotomy, later accompanied by stone extraction.[3] Enteroscopy was first established in the mid seventies and advanced into balloon-assisted enteroscopy, which enabled visualizing and treating the whole small intestine in the new millennium. Endoscopic ultrasound (EUS), developed in the 1980's, has in recent years become tool for diagnosis and therapy of a range of esophageal, gastric, hepatobiliary, pancreatic and rectal disorders.[4]

Nowadays these innovative techniques have evolved into a routine investigation of the gastrointestinal tract. Patients with gastrointestinal complaints generally undergo an endoscopic examination. In the Netherlands yearly approximately 400,000 examinations of the gastrointestinal tract are performed. With these endoscopic studies abnormalities in esophagus, stomach, duodenum, colon, small intestines and bile ducts are diagnosed and therapeutic interventions are performed. The findings of these investigations have important implications for patient management, for example for the selection of medical therapy for a gastric ulcer or for the indication for a surgical intervention of a malignant process. The endoscopist generates a report of the performed examination for the referring physician. The reports range from short written or dictated reports to standardized computer reports.

As endoscopy is primarily a real-time visualizing investigation, it is of extreme importance to report the diagnostic findings and therapeutic interventions in well understood terminology to others. Guidelines from different gastrointestinal endoscopy societies have for that purpose been published to specify minimal standards for an endoscopy report.[5-6] These however only describe the elements that are required in a report, not the way how a report has to be composed.

The Quality Committee of the Dutch Society of Gastroenterologists and Hepatologists (NvMDL) published a report in 2005 entitled 'Tijd voor Kwaliteit' (Time for Quality). In this report quality standards of the Society were defined. These standards can be seen as a part of a quality system for gastroenterologists, designed to establish, test and improve quality of care. It was stated that the results of an endoscopic investigation should be reported in written and/or digital format. Compulsory elements of the report are listed in Table 1.

Traditionally most of the reports were handwritten, but since 1980 several endoscopic information systems have been developed to record endoscopic findings, to store images and to assist in report composition.

Table 1 *Eelements that should be mentioned in a report*

- Date, eventually time of examination
- Type of endosopic examination
- Patient characteristics (Name, birth date, registration numbers)
- Referring doctor
- Indication
- Setting
- Clinical versus Outpatient/ambulatory procedure
- Elective versus emergency procedure
- Location (Endoscopy unit, intensive care unit, operating room)
- Relevant medication
- Informed consent
- Pre-medication
- Monitoring (oximetry, blood pressure, pulse rate)
- Administering oxygen or medication (e.g. flumazenil, atropine)
- Equipment used (type of endoscope)
- Procedural aspects (discomfort for patient, process of examination)
- Findings and diagnostic procedures
- Therapeutic interventions and material used
- Biopsies, punctures, samples
- Image capture and image storage
- Complications
- Advice to referring doctor following the examination
- Information, advice, prescriptions given to the patient
- Name of endoscopist

Quality Report 'Tijd voor Kwaliteit' Dutch Society of Gastroenterologists and Hepatologists (NvMDL)

Quality indicators for gastrointestinal endoscopic procedures

Quality assurance in endoscopy has taken increased importance. This was further enhanced by the introduction of colorectal screening programs started in various countries and the demonstration that the quality of bowel preparation and colonoscopy had a major influence on the prevention of cancer.

High quality endoscopy requires that the patient receives a well indicated procedure, that correct and clinically relevant diagnoses are made, that therapies are properly performed, and that all is accomplished with minimum risk for the patient. To provide patients with the best possible care, quality indicators for endo-

scopy have been developed. These indicators may be used to improve overall quality of endoscopy services.

Two quality indicators for endoscopy units are specified in the 'Basisset ziekenhuizen kwaliteitsindicatoren 2011' from the Dutch Healtcare Inspectorate (IGZ).[7] The first indicator refers to the 7 × 24 hour availability of a trained team to perform intervention endoscopy. The second indicator comprises of the execution of an emergency endoscopy within 24 hours in case of bleeding from the upper gastrointestinal tract.

Besides these accepted quality indicators, a number of further indicators have been proposed by endoscopy societies.[8-9] These can be divided in pre-procedure , procedure, and post-procedure indicators. Pre-procedure indicators address the indication, medical history, risk assessment, and patient consent. These indicators must be documented before any procedure has begun. There must be a proper indication that the information gained or the therapy provided will help the patient. The patient must be properly informed about the most common complications, and the patient's consent must be obtained and filed. The patient's medical history must be recorded and it is important to notice prior gastrointestinal surgery, implanted defibrillators, previous adverse experience with sedation, drug allergies etc. The use of anticoagulants or antiplatelet medications has to be recorded. Risk stratification should be performed before sedation is begun. Prophylactic antibiotics should be administered to high risk patients in high risk procedures. The intended level of sedation should be specified before the procedure. A time-out procedure to confirm the correct patient and the correct procedure should be performed

Procedural indicators include photo-documentation, in which images of major abnormalities and landmarks like coecum are recorded; patient monitoring during sedated endoscopic procedures comprising pulse oximetry, pulse rate and blood pressure; recording of administered doses and route of the medication, including any reversal agents like flumazenil or naloxon when applied. Post-procedure indicators include documentation of the discharge from the endoscopy unit. The patient should be provided at discharge with written instructions and with information regarding the nature of potential delayed complications and how to act upon them. A procedure report should be prepared immediately after the procedure, containing the elements of the endoscopic procedure that are listed in the different guidelines.[10] Complications like adverse events or unplanned interventions should be reported by the endoscopy unit. Patient satisfaction should be collected by a validated questionnaire. The eventually resumption of anticoagulants or antiplatelet medication should be recorded. The complete report comprising the endoscopic findings, therapy and follow-up recommendations should be stored for immediate retrieval if needed, and sent to the referring doctor.

Most mentioned quality indicators are directly related to the endoscopy report.

These can be conveniently recorded using advanced computerized endoscopy report systems.

Computerization of endoscopy reports

During the last decades various computerized systems have come available for medical reporting including for gastrointestinal endoscopy.[11-23] Most of these systems were stand-alone report-systems, designed to compose a report of the performed examination. Some systems have also the possibility to store images and videos taken during the endoscopy. It is essential to store the endoscopy images DICOM (Digital Imaging and Communications in Medicine) compatible in order to enable their export to other sources. Recording digital images is of vast importance for medical quality control, therapy evaluation, and education purposes.

Computerization of endoscopy reports has many important aspects. When only the report is generated, it is necessary to link the system to the Hospital Information System (HIS), making the report available for every authorized doctor at any time. These links exists in two directions. One link runs from the HIS to the report system transporting patient characteristics like name, gender, birth date, address, insurance number, name of general practitioner, risk factors. In the other direction the report is sent form the report system to the HIS and eventually directly to the referring doctor via electronic means. In this way the report can be assessed 24 hours a day and in a good readable format.

Endoscopic electronic medical record systems to serve endoscopy units

Besides their central role of generating the endoscopy procedure report, endoscopic electronic medical record systems (EEMR's) have also evolved into sophisticated databases with extensive possibilities which all add to practice management, patient care, risk reduction, research purposes and so lead to continuous quality improvement of the endoscopic practice.

With connection to the HIS, any risk factors and allergies of patient can be easily recalled. Further functions may include interfaces with other medical systems such as pathology databases and direct electronic communication with the referring physicians.

The system can be used for patient scheduling and automated follow-up. More recent features are the possibility to track inventory, such as drugs, endoscope usage and endoscopic accessories. The system allows generation of endoscopy unit

productivity statistics, like involvement of nursing and technician personnel. Physicians and trainees can also monitor their procedure volumes and proposed quality indicators like coecum intubation and polyp detection rates. These features can assist to streamline practice management.

In these systems it is also possible to store nursing information before, during and after the investigation, which can be included the patient care document.

Complications that appear during the endoscopic examination, direct after or some days later has to be recorded in the system. Also when sedation is given patient vital sign monitoring, with oxygen saturation, heart rate and blood pressure, has to be recorded according to guidelines. Intraprocedure medication can be entered in the system and transferred automatically to the report.

The information of the endoscope used in a patient has to be stored. In some systems the endoscope is automatically recognized by a chip in the endoscope at the moment the endoscope is connected to the processor. At the moment that the patient data are connected to the same processor, the endoscope is coupled to the patient in the EEMR. Information of the cleaning process and subsequently drying process is stored in the same way in the EEMR. In this way a complete track and tracing of the endoscope is guaranteed and the risk for infection is hereby minimized. In case of a not correctly cleaned or stored endoscope, a message is given at the time of selection a new patient to act upon prior to start of the procedure.

During composition of the endoscopy report diagnostic codes can be automatically generated. These codes are based on indications, findings and therapeutic interventions that are selected. Furthermore, procedure codes for financial registration can also be automatically produced.

Because the data of former investigations are stored in the EEMR, it is easy to review reports, images and eventually videos of endoscopic investigations performed in the past. Pre-medication given at earlier investigations can prophesy the needed dosage of pre-medication for a new endoscopy.

Coding of data

The data gathered in the electronic medical record is not always appropriate for research purposes. Because different ways of report writing are available it is hard to compare these different data. Besides this it is nearly impossible to compare the endoscopic data produced by diverse systems because of dissimilar semantics.

To enhance the consistency and comparability of endoscopic reports we intend to develop a comprehensive WHO-approved code system for gastrointestinal endoscopic terminology. The International Classification of Diseases, 10th edition (ICD-10), and the ICD-10 clinical modification (ICD-10-CM) were used as basis and

expanded to allow description of every possible gastrointestinal endoscopic term under conditions defined by the WHO.

The new extended code system was named Gastrointestinal Endoscopic Terminology Coding (GET-C). The GET-C is incorporated in the electronic report system Endobase that is used in the TRANS.IT project so that endoscopic data, produced in different ways of report writing, are coded and consequently comparable.

TRANS.IT Project

In 1998, ten Dutch hospitals started a collaboration entitled TRANS-IT, seeking to further develop and improve the uniform standardized reporting of gastrointestinal endoscopic findings. All TRANS.IT hospitals use the same report system, Endoalpha Documentation (former Endobase), with standard reports, text blocks, and structured input. Three academic hospitals (Amsterdam Medical Center, Erasmus Medical Center, University Medical Center Utrecht), and 7 district hospitals (Atrium Hospital Heerlen, Elisabeth Hospital Tilburg, Ikazia Hospital Rotterdam, Meander Medical Center Amersfoort, Rijnstate Hospital Arnhem, Tergooi Hospital Blaricum, Vlietland Hospital Vlaardingen) participate in the TRANS.IT work group.

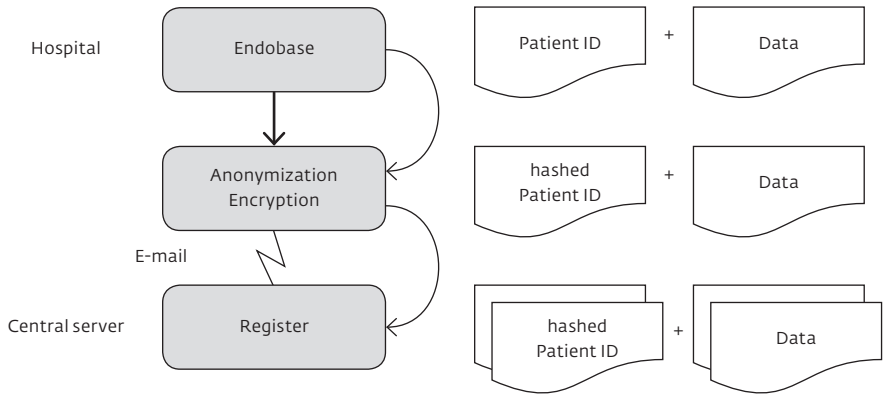
From each of these hospitals at least one gastroenterologist has a permanent seat in the TRANS.IT project group. The work group meets regularly to discuss new developments and improvements. Within the work group, the members work continuously on improving the quality of the standard reports and text blocks. It is partly in response to comments and recommendations from the TRANS.IT project group that the Endobase program has been continuously modified to accommodate the requirements of those using it. All standard reports and text blocks have been discussed and accepted by the members of the work group.

Users of Endobase can also recommend changes to the standard reports and text blocks. No modification can be introduced without the agreement of the majority of the TRANS.IT group. Immediately after acceptance, the modifications are made by remote control in all TRANS.IT hospitals. This guarantees the necessary uniformity in report writing.

Central database of TRANS.IT

One goal of the TRANS.IT Project is to build a central database with anonymous data of endoscopy investigations from the participating hospitals, which jointly carry out some 30,000 to 40,000 examinations annually. This gives rise to a large database with an abundance of information on endoscopic examinations. Thanks to

Figure 1 *Procedure of exporting anonymous endoscopic data*



the uniform report system and use of GET-C coding, it is possible to analyze the data anonymously. After a few years, it will be possible to obtain important information on the epidemiology of various disorders and the effects of diagnostic and therapeutic intervention for doctors and policy makers in the healthcare sector.

In order to save the data in a central database, a safe communication structure is needed, which can also anonymize the data. An export tool was developed for this purpose. This involves the following activities: export, anonymization, and encryption (coding).

During the export procedure, the patient and source ID is modified so that the patient can no longer be identified on the basis of the data. A new code is added, which guarantees the anonymity of the patient whilst enabling the central database to keep various details of the same patient together. Finally, to safeguard the confidentiality of the data, all information is encrypted before sending. This means that during the transfer of data the information can be coded in such a way that it cannot be read.

Description of Endobase/Endoalpha

The research in this thesis was performed on the endoscopic electronic medical record system Endobase. Endobase is a software solution for endoscopy units. It was developed in the 1980's as a report module. In the beginning of the nineties the first version of Endobase was upgraded to version Endobase 2, in which simple standard reports and text blocks were added. In 2000 a complete new version with another

database structure and extensive possibilities was launched, named Endobase III. The TRANS.IT work group started using this version and most of the research was done on this version of Endobase. The last years Endobase III developed in a program serving the endoscopy unit including an integration with other hospital systems which facilitate the practice management of the whole endoscopy unit. With this adaptation also the name changed to Endoalpha, the reporting module is named Endoalpha Documentation. In total 43 of the 92 Dutch hospitals have implemented Endoalpha Documentation for their gastroenterology departments. Besides gastroenterology also pulmonology, surgery, gynecology, urology and ear, nose and throat specialists are using Endoalpha Documentation for reporting.

Scheduler and patient data and examination data

A scheduler module provides a planning for the whole endoscopy unit. The number of available endoscopy rooms, the identification of the endoscopes, the required time for a specific examination and the number of available endoscopists can be put in the system listing endoscopy capacity per day. Preceding the examination the scheduler module plans each investigation taking these different variables in account.

Endobase uses a Health Level-7 protocol to communicate with other electronic medical systems to exchange medical data.[24] At the moment that the patient personal identification number is entered, all the available relevant personal, medical and administrative data can be extracted from the hospital information system. The data set contains personal data like name, address, birthday and gender, details of the general practitioner; medical data about risks like allergies and previous gastrointestinal surgery, including perform-date, relevant before starting the endoscopic examination; administrative date such as the name of the insurance company and the insurance number, useful for the financial administration, for which the data or procedure codes can be transmitted to the financial department by another HL-7 connection. Any alteration in the patient's personal data or e.g. general practitioner will automatically be changed in the system.

After input of the patient data, the different examination data are selected. The user can define and choose between several kinds of examinations. The endoscopy-room where the examination is performed is selected. Next, you can select the referring doctor, the endoscopist and up to three residents and three endoscopy-assistants.

The indication of the examination is selected out of a definable table with one or more possible indications for that particular examination. These indications are linked to a specific GET-C code for research purposes. Medication given during the examination can be filled in beforehand from a defined list with recording of the dose given.

The kind of endoscope used and the internal number of this scope are automatically recognized and recorded in the system. At the moment the investigation is started, the start time and subsequently after finishing, the end time are being recorded. In the new version, certain landmarks, such as ileo-coecal valve, can be registered on time to be able to calculate the withdrawal time.

If the examination is an emergency, this option can be selected and it is stored the way the patient was referred for the endoscopy, by out-patient clinic or from within the hospital.

It is user-definable which fields are obligatory to fill in at the patient and examination data input. This is an essential feature to be able to build a complete database appropriate for research purposes. Without given in all the obligatory data the user gets a message to fill in all the fields.

Examination and images

During the examination, there is a direct connection between the Endobase computer system and the endoscope module in the endoscopy room. Patient characteristics are sent to the monitor in the endoscopy room. At the same time a video signal with the scene of the endoscope is transported to the system. The performed examination can be followed live from behind the computer.

During the endoscopy images can be captured by remote-buttons on the endoscope. It is also possible to capture an image directly from behind the computer. From the endoscopy room the endoscopist can add voice notes to the images, so that these can be reproduced during the selection of the images. Besides still images also short movies can be stored by remote control. The resolution of the movies can be predefined.

All images and movies are stored as digital files in the system and will be available for review and future use. After the examination up to twelve images (user definable) can be selected to print in the report. Failed images can be deleted to keep the database clean. In this field, it is also easy to compare images taken at earlier examinations. Results of therapy or alterations in severity of some chronic gastrointestinal diseases can be easily visualized.

One can localize the position of the images in an anatomical picture of the gastrointestinal tract. In this anatomical picture, also the localization and number of biopsies taken are recorded. This picture with the images is transported to the definitive report or can directly be printed together with the patient data.

For a better visualization of certain abnormalities in the images it is possible to edit the image in a draw module. One can enter some free text as comment, draw lines or circles and zoom in. Colors can be adapted and saved in a separate file, however the original image stays stored despite the changes made. Movies can be edited.

To build a personal database of noteworthy images you can copy some images in a user definable image-box. Because the images and movies are digitally stored, they are quickly exported and can be used in presentations or consultations of other specialists.

There is an option to create patient lists. If for example a patient is included in a trial, you can add the patient to such an own defined list.

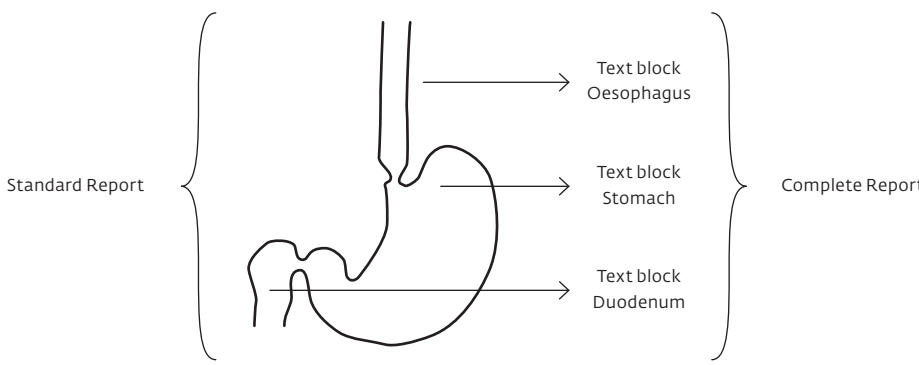
After performing the examination it is possible to adapt and complete the administering of medication, changes of any endoscopes and diagnosis of former gastrointestinal operations of the patient.

When biopsies are taken, an order to the pathologist can be generated electronically or in a paper report. Endoscopic images and the report can accompany the request for the pathologist.

Report writing

There are four different types of report writing in Endobase. Besides free text which is not usable for statistics, there are three other kinds of report writing from which can be chosen after performing the examination depending on the findings during the examination or the preference of the endoscopist.

Figure 2 *Standard reports and Text blocks*

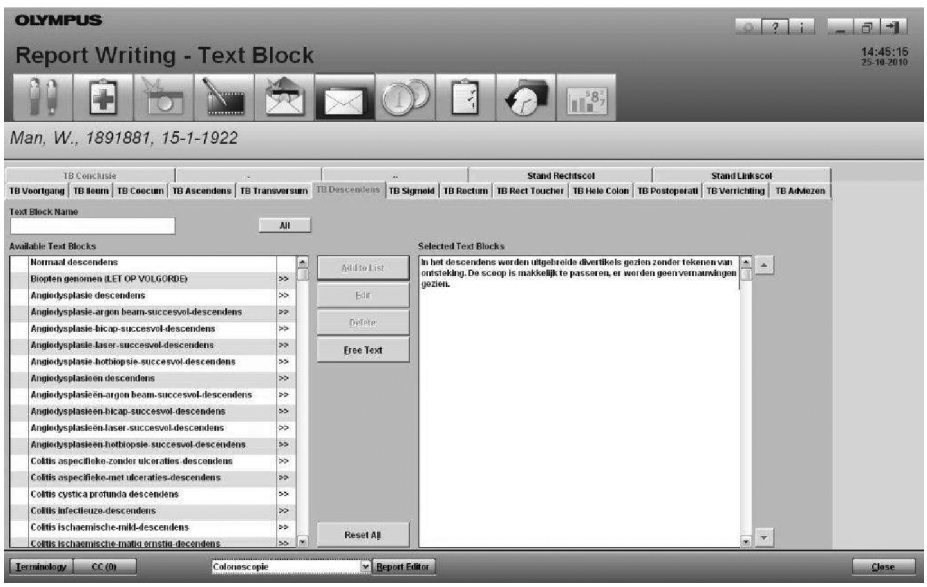


First option is the standard report. Standard reports are based on diagnosis or combination of diagnosis. They contain the complete text describing the examination performed and all of the corresponding findings during this endoscopy.

This type of report is especially suited for about 30-40% of the endoscopic examinations in which no abnormalities are found.[25]

Secondly, it is possible to compose a report by using text blocks. These reports are composed by selecting one or more diagnosis or findings from different sections of text-blocks. Each text-block consists of one or more sentences describing the selected diagnose or finding. The combination of these different diagnosis or sections concurrently creates the report. Almost every possible combination of findings can be composed with the use of these text-blocks.

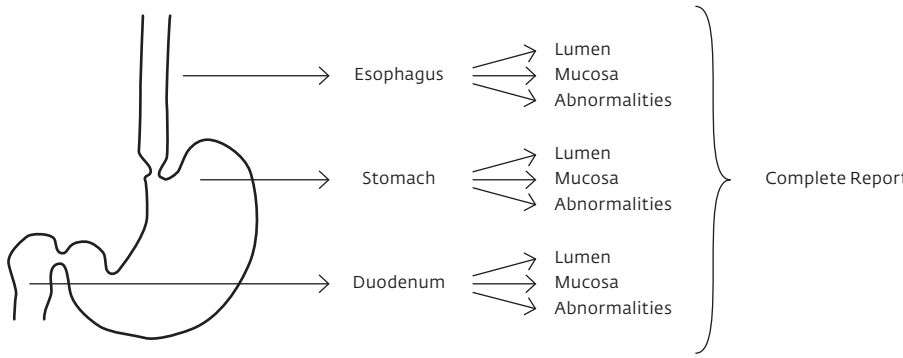
Figure 3 *Screenshot Text blocks*



Thirdly, Minimal Standard Terminology can be used for report writing. This minimal standard terminology is composed by a commission of the ESGE. Version 2.0 is used in the program.[26] It was translated into Dutch and some extensions were made. Almost every part of the examination can be described by using this terminology. A sentence is build up out of different choices and all these sentences together compose the report.

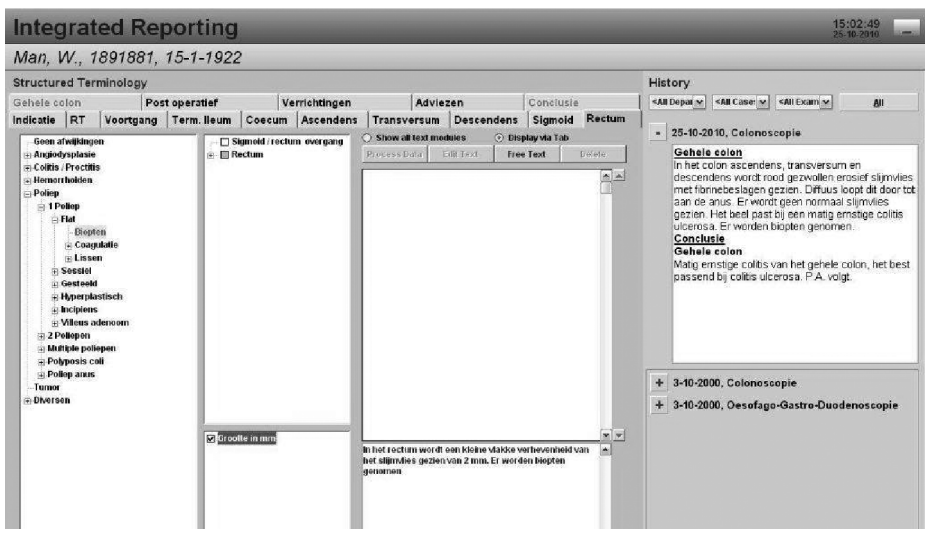
All the three standardized ways of composing a report (Standard Reports, Text Blocks and Minimal Standard Terminology) are linked to GET-C. By selecting the diagnosis during the composing of the report, in the background, the corresponding codes are recorded in the database.

Figure 4 *Structured data entry*



Besides diagnostic codes for research, procedure codes for financial aspects can be recorded. For a specific examination user-definable standards can be generated. Also manual selection of procedure codes out of a predefined list is possible. These codes are automatically transferred to the Hospital Information System and the financial department via HL-7 protocol.

Figure 5 *Screen shot structured data entry*



Patient history and external documents

In the patient history all the endoscopic data of one specific patient are gathered. In this field one can quickly review the patients history of endoscopic examinations performed. The complete report of the examination is presented, and it is possible to view the captured images and movies of that particular examination. The characteristics of the patient and the particular examination are provided. In this way, the name of the endoscopist, the referring doctor and the used pre-medication of the former examination are directly accessible. All the patient characteristics like allergies and former operations are shown.

Any external document like histology results or X-ray images can be coupled to a specific examination. These results can be scanned by an attached photo-scanner or imported electronically from e.g. the hospital information system. In this way you can visualize the results of any taken biopsies.

This field is also suitable to register any possible complication that occurs. Complications occurring during the endoscopy need to be described in the report, but complications that appear later can be recorded at a specific examination in this history field.

With a browser based application it is allowed after authorization to view the complete patient file with all reports, images and videos throughout the hospital.

Patient care documentation and vital monitoring system

In the Endoscopic Electronic Medical Record full patient care can be documented, like preparation protocol and informed consent form. The nurse can fill in any examination documentation and discharge documentation.

Progressively sedation is given during endoscopy. Vital sign monitoring like, hart rate, blood pressure and oxygen saturation are mandatory. Registrations of these signs are automatically recorded in the system during the examination and after the examination in the recovery room.

Statistics

The first Endobase 2 program was built on Interbase from Borland; Endoalpha uses Microsoft SQL database. These are convenient SQL Database programs. All data entered in the system can easily been extracted from the system for any purpose.

Endobase itself has a statistic module to execute extensive queries on different data-fields as well as on images. The results can be printed or exported. The exported endoscopic data can be imported into a program especially made for statistic analysis like e.g. SPSS for further analysis and presentation. Finally it is possible to build up a general database with endoscopic results of different hospitals.

Material consumption
For management of the endoscopy room it is possible to register the consumption of all the materials that are used during the endoscopy. Costs per endoscopy can be calculated and stock management can be performed.

The system can be connected to the disinfecting machines (ETD, Olympus) of the endoscopes to control and record the cleaning and disinfecting program of the endoscopes. Through its unique number, the endoscope that is used during the examination is recorded and followed in the cleaning process. After the cleaning process endoscopes are dried by a constant flow of air. The correct drying process and storage of the scope is recorded as well and a message is shown if anything in the cleaning, disinfection and drying process went wrong. Also the maintenance and any repair of endoscopes can be documented in the system, making endoscopes traceable at any time. By this procedure the quality control of the endoscopy unit is assured.

Management of endoscopy unit
During daily work with an Endoscopic Electronic Medical Record multiple endoscopic data are stored. With a module named EndoQlik reports of all cost-related and logistical details are available whenever needed. These reports can improve transparency of costs and visualize any logistical problems.

Ease of use
For the successful implementation of a endoscopy recording and management system it is essential that the system is uncomplicated and user friendly. Any doctor, also the inexperienced computer user, must be able to work easily with a new program. The learning curve has to be relatively short as most doctors simply don't have the time or interest to take a course just for using a program.

Secondly, it has to be a stable and fast working program. Any often-appearing error or fault in the program will lead to abandoning the program.

Thirdly, the program should be developed for the future and regularly updated with new features. The program should have options that can be used in the future but are not necessary at this moment. From the moment that a computerized program is in use, the users prefer to combine more tasks within the same program and to use only one computer program to manage the entire endoscopy unit.

Objectives and outline of the thesis

Gastrointestinal endoscopy investigations are an important part in examination and treatment of patients with complaints of the gastrointestinal tract, but also in

screening for malignancies and therapeutic interventions. The result of the visual investigations has to be formulated into a report by the endoscopist for the referring physician and other professionals involved in the treatment of the patient. The quality of this report is of extreme importance for further management of the patient.

To enhance the quality of the reports and to perform research on gastrointestinal endoscopic data a specific standardized way of reporting was developed. The aim of this thesis was to analyze different aspects of this endoscopic electronic medical record system for report writing and stimulate further research with the produced data.

For composing an endoscopy report three different ways of report writing were created as mentioned above. In **Chapter 2** the first developed two methods of standardized report writing, that is standard reports and text blocks are described and discussed.

An often heard criticism on computerized reporting systems, especially in medical settings, is the time aspect required to work with them. Physicians often insist to keep their usual way of working. We therefore studied in **Chapter 3** time aspects of three different ways of report writing. Computerized reports were compared to dictated and handwritten reports. The time needed to compose the report and to send it to the referring doctor was compared.

Starting with computerized systems demands a great investment in hardware, software and various links between the system and the hospital information system. Computerized systems are also known to record investigations more accurate, leading to billing benefits, and to improve quality aspects. In **Chapter 4** a study on costs for the above mentioned three different ways of report writing (computerized, dictated and handwritten) to compose the report was performed. A cost benefit analysis was executed between dictated and computerized reporting.

In the computerized system, besides standard reports and text blocks also structured data entry is allowed. For every examination the endoscopist is free to choose one of the three ways of report writing. To be able to compare the results of the investigations, the reports need to be coded in a similar way. For this reason a coding system had to be developed. It was chosen to extend a widely used coding system, the International Classification of Diseases, 10th version, of the World Health Organization (WHO). In **Chapter 5** this extension is described with a new developed chapter for endoscopic interventions. The complete coding system is available on www.trans-it.org.

The automatically recorded codes are stored in the database of each hospital. Within the TRANS.IT Project research will be performed on the anonymous data. Therefore a central database is created with the anonymous data of all investigations in the participating hospitals. Within the project it was agreed to use stan-

dard reports and text blocks although the report maker can use free text or adjust the report. Obviously, this could potentially influence the correctness of the automated terminology coding. In **Chapter 6** a multicentre study is described to assess to what extent automatically generated GET-C codes are in agreement with the actual text of the endoscopy report.

In the Ikazia Hospital, Rotterdam, the computerized system was used from 1996 onwards. It was possible to analyze the endoscopic data over a ten year period. Trends in different diagnoses were analyzed. In **Chapter 7** gastric and duodenal ulcer disease is described over time. Classification of severity and re-bleeding risk are changing over time. In **Chapter 8** different referring groups and their yield of upper gastrointestinal endoscopy is compared in an open access endoscopy unit.

Finally, in **Chapter 9** the results of these studies are summarized and discussed.

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CHAPTER 2

Computerization of endoscopic reports using standard reports and text-blocks

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Abstract

BACKGROUND The widespread use of gastrointestinal endoscopy for diagnosis and treatment requires effective, standardized report systems. This need is further increased by the limited storage of images, and by the need for structured databases for surveillance and epidemiology. We therefore aimed to a report system which would be quick, easy to learn, and suitable for use in busy daily practice.

METHODS Endobase III® is an endoscopic information system offering three different ways of report writing, i.e. standard reports, text-blocks and Minimal Standard Terminology (MST). A working group of two academic and four general hospitals worked as a reference group for development of standard reports and text-blocks. Guidelines of different gastrointestinal endoscopic societies were followed to compose the reports

RESULTS Standard reports were based on a list of distinct diagnoses, text-blocks were based on anatomic landmarks and individual procedures. As such, 316 standard reports were developed for upper and lower gastrointestinal endoscopy, and ERCP. In this way selecting one diagnosis produces a complete report. A total of 1571 different text-blocks were additionally developed for every part of the GI-tract and for procedures during endoscopy. This module allowed generation of a full report on combination of text blocks. Reports could be composed and printed within two minutes for 90% of cases.

CONCLUSIONS Standard reports and text-blocks is a quick, user-friendly way of report writing accepted and used by different gastroenterologists in the Netherlands.

Introduction

Gastrointestinal endoscopy has become a standard, widely available technique for diagnosis and treatment of gastrointestinal disorders. The number of endoscopic procedures is ever increasing, among others as a result of the continuous development of newer techniques, the introduction of screening and surveillance programs for gastrointestinal disorders, and the increasing incidence of various gastrointestinal disorders. A recent survey among endoscopists in the Netherlands showed that 325.000 gastrointestinal endoscopies are performed annually in a population of 16.000.000.[1] As an imaging method with numerous repetitive maneuvers as well as findings, gastrointestinal endoscopy reports are particularly suitable for electronic storage and processing.[2] Besides this there is a need for structured databases for surveillance, epidemiology, quality control and research. This need is further increased by the limited storage of images during endoscopy, making the report essential.

For that purpose, several endoscopic information systems have been developed in the past decade to record endoscopic findings, to store images and to compose reports.[3-13]

Most of these systems are stand alone report systems, not suitable for implementation in a hospital information system. The combination of report writing and digital image storing is not available in all the systems. The structure of the database of most of the systems is poorly accessible for research and export of data.

There are several crucial criteria for a report system that need to be fulfilled to get it generally used, suitable for every hospital and implemented in a hospital information system.

In further development of healthcare informatics it is necessary for such systems to be readily acceptable for most endoscopists in a hospital unit. Secondly it should be possible to exchange and compare data and digital images between different consultants and hospitals. Standardized protocols should be used to communicate between different systems within a hospital based on the Health Level 7 – protocol (HL-7). For exchanging images a standard format such as DICOM (Digital Imaging and Communications in Medicine) is essential.

To get the system accepted in daily practice it is crucial that first of all, data entry is fast and accurate. Thus the system has to be accessible for the computer illiterate and the learning time should be limited.[14]

Programs using the currently available structured data-entry, like the Minimal Standard Terminology (MST),[15-18] do not fulfill all these crucial criteria. Firstly, composition of a report by means of MST is usually time-consuming because of the different options available. Secondly, there is a risk of getting lost in the data-entry module, caused by the numerous available choices that has to be selected.

Our aim was to develop a report system that is quick, easy to learn and can be used in busy daily practice by any endoscopist. Moreover, we considered it necessary that the program would have the capacity to build up a database with endoscopic findings for various purposes including management of surveillance programs, and epidemiological studies and quality control. Therefore the findings should be linked to a specific comprehensive code-system. This would allow anonymous evaluation of data.

Finally, consensus of gastroenterologists from different hospitals should be achieved for use of the new report system.

Materials and Methods

Endoscopic Information System

In the latest version of Endobase III®, developed by Olympus Software, it is possible to combine different text-blocks to compose a complete report besides the use of standard reports and MST.

After selecting the different standard reports, text-blocks or MST the composed report can be adapted in a word processor. In the program an extensive relational database structure was build. In this way it became suitable to store all different data produced in an endoscopy unit, digital images and video included, and retract it separately with all kinds of queries. Also a structured data entry is available, the Minimal Standard Terminology (MST). The MST has been translated into Dutch in 1998 by our group in co-operation with Dr Delvaux during a workshop on MST.

TRANS.IT-working group

In the end of 1999 a working group, the TRANS.IT-project group, has been founded as a peer reference group to design the standard reports and text-blocks that were developed and used in the endoscopy units by the participating gastroenterologists. This group gathers on a regular basis to discuss the reports, a comprehensive coding system and new developments for endoscopic information systems.

The TRANS.IT working group consist of two academic hospitals and 4 general hospitals and perform about 15% of all gastrointestinal endoscopies in the Netherlands. All the participants of the TRANS.IT-group use the same version of standard reports, text-blocks and translated MST. An alteration in the content of a standard report or text-block will only be executed with agreement of a majority of the working group members.

All various standard reports and text-blocks are directly linked to a specific code. The codes are based on the ICD-10 code system and are extended for specific endoscopic findings.[19]

Structure of an endoscopic report

Several committees of societies for Gastrointestinal Endoscopy have proposed guidelines to get a standardized format for endoscopic reports. Considering the American Society of GE proposal,[20] the European Society of GE adaptation,[15] the advice of the Netherlands Society of Gastroenterology and our experiences with an electronic report-system we developed an extended structure of an endoscopic report suitable for our endoscopy units [**Table 1**].

Table 1 *Used structure of an endoscopic report*

- Patient identification data
- Date of procedure
- Referring doctor
- Endoscopist
- Assisting doctor
- Instruments used
- Reasons for examination
- Preparation
- Type of endoscopic examination
- Identification number of the Endoscope
- Medication (Anaesthesia, Analgesia, Sedation)
- Anatomical extent of examination
- Limitation(s) of examination
- Findings and specimens obtained
- Therapeutic intervention(s) and result(s)
- Notation of images captured
- Complications (during endoscopy and within 24-48 hours)
- Endoscopic diagnosis
- Recommendations for referring doctor
- Comments
- Recall letter

For the description of the findings at the investigation a list of items proposed by the Netherlands Society was used [**Table 2**].

We used this structure and the proposed items as guidelines to compose the standard reports and text-blocks in our system. The grading and severity of findings is classified by for example the LA-Classification for reflux disease[21] and Forrest classification[22] for ulcers.

Preceding the examination most of the basic data of the patient necessary for the endoscopic report, like indication, medication, endoscopist, endoscope identification number, referring doctor, general practitioner, medical history and risk factors, are already recorded in the system. The patient data can be extracted with HL-7 protocol from the Hospital Information System by using the personal identi-

Table 2 *Items used to describe findings at upper GI endoscopy*

- Use mm or cm in describing the dimensions of a lesion
- Findings in oesophagus. Give distance in cm from lesions to teeth
- Distance of Z-line to teeth
- Distance of hiatal narrowing to teeth
- Aspect of contents of stomach
- Peristaltic and inflation of the stomach
- Findings in antral region
- Findings in corpus of the stomach
- Findings in cardia and fundus in retroversion
- Findings in angular region
- Findings in pylorus and passing
- Findings in duonal bulb
- Findings in proximal duodenum
- Location of biopsies taken
- Capture of images
- Other procedures
- Comment on proceedings of examination

fication number (PIN) of the patient. Other features are recorded during or shortly after the examination date e.g. Helicobacter Pylori tests, histology or laboratory results, complications appearing after the examination and results of other gastrointestinal examinations like ultrasonography, X-ray or manometry studies.

Presentation and selection of different text-blocks

The presentation of the different standard reports and text-blocks was based on the experience that endoscopists translate their findings into a diagnosis at the end of an endoscopy. To shorten the time of searching the corresponding diagnosis, the text-blocks are presented in different subsections. First of all different text-blocks were divided into anatomical regions, that are easily defined during endoscopic investigations, e.g. esophagus, stomach, duodenum. Within an anatomical region the possible different diagnosis are grouped, e.g. esophagitis contains reflux, caustic, viral. Within these groups eventually a classification or grading is added.

All the text-blocks are presented alphabetically in the program. By typing the first characters of a diagnosis the selection of the group of diagnosis is presented.

Results

Standard reports

Based on individual diagnoses, we constructed 316 different standard reports. One-hundred-thirty-four of these reports pertained to esophago-gastro-duodenoscopy, 143 to lower digestive endoscopy, and 39 to ERCP. In an open-access endoscopy unit

at a district general hospital in 32,3% of the endoscopic examinations no abnormalities are found during endoscopy.[23] Likewise in our own data these same numbers of around 30 % are found between two different referring groups.[24] The reports composed for these examinations are simple and fully standardized. Nevertheless all the items listed in table 2 have to be included, to obtain a complete report.

The reports of the remaining 67,7% of the endoscopic examinations, where at least one abnormality is found, must also contain all items to make them complete. In some of these examinations only one abnormality is found leaving the remainder of the examination without any abnormalities. These examinations can also be reported using standard reports.

Table 3 *Examples of some different standard reports for oesophago-gastro-duodenoscopy*

Barrett's mucosa	1	Barrett's mucosa
	2	Barrett's mucosa with reflux oesophagitis grade A
	3	Barrett's mucosa with reflux oesophagitis grade B
	4	Barrett's mucosa with reflux oesophagitis grade C
	5	Barrett's mucosa with reflux oesophagitis grade D
	6	Barrett's mucosa control endoscopy
	7	Barrett carcinoma
Reflux esophagitis	8	Reflux oesophagitis grade A
	9	Reflux esophagitis grade B
	10	Reflux esophagitis grade C
	11	Reflux esophagitis grade D
	12	Reflux esophagitis grade D with ulcer
	13	Reflux esophagitis grade D with stricture
Duodenal Ulcer *	14	Duodenal ulcer, Spurting bleeding (Forrest Ia)
	15	Duodenal ulcer, Non-spurting active bleeding (Forrest Ib)
	16	Duodenal ulcer, Visible vessel, no active bleeding (Forrest IIa)
	17	Duodenal ulcer, Non-bleeding with overlying clot (Forrest IIb).
	18	Duodenal ulcer, With hematin-covered basis (Forrest IIc)
	19	Duodenal ulcer, Clean ulcer ground, no clot, no vessel (Forrest III)
	20	Normal oesophago-gastro-duodenoscopy
Hiatal hernia	21	Sliding hiatal hernia
	22	Sliding hiatal hernia with Cameron lesions
	23	Sliding hiatal hernia and gastritis
	24	Sliding hiatal hernia and gastritis and duodenitis
Varices	25	Varices oesophagus grade I
	26	Varices oesophagus grade II
	27	Varices oesophagus grade III
	28	Varices oesophagus grade IV
	29	Varices bleeding banding
	30	Varices bleeding injection

* Similar standard reports for gastric ulcer

Other examinations show more abnormalities, making standard reporting less applicable. In less common combinations of abnormal findings or rare findings, the use of the specific text-blocks is recommended.

The composed standard reports are based on the endoscopic diagnoses or a combination of diagnoses made during endoscopy [**Table 3**]. After the examination the endoscopist has to select this endoscopic diagnosis out of the list of different standard reports.

For reflux esophagitis six different standard reports are created for the generally used LA-classification, grade A to D and an ulcer or stricture of the esophagus. For the frequently seen combination of columnar mucosa (Barrett) and reflux esophagitis four additional standard reports with this combination are written.

Gastric and duodenal ulcers are described according to the Forrest classification, resulting in 30 different standard reports for a number of various locations.

Infrequent findings or findings at rare locations can be described with the use of text-blocks.

The reports are alphabetically arranged in Endobase and can be searched for by giving the first one or more characters of the diagnosis.

During a normal program at our endoscopy unit the time needed to compose a report by selecting standard reports was measured. Various endoscopists composed a total of 291 reports in this way. A student was positioned behind the endoscopist and timed different items during report writing. The average reporting time including selection of the standard report, addition of some details in the word processor and printing of the report was 1 minute 21 seconds (SD 51 seconds) for standard reports.

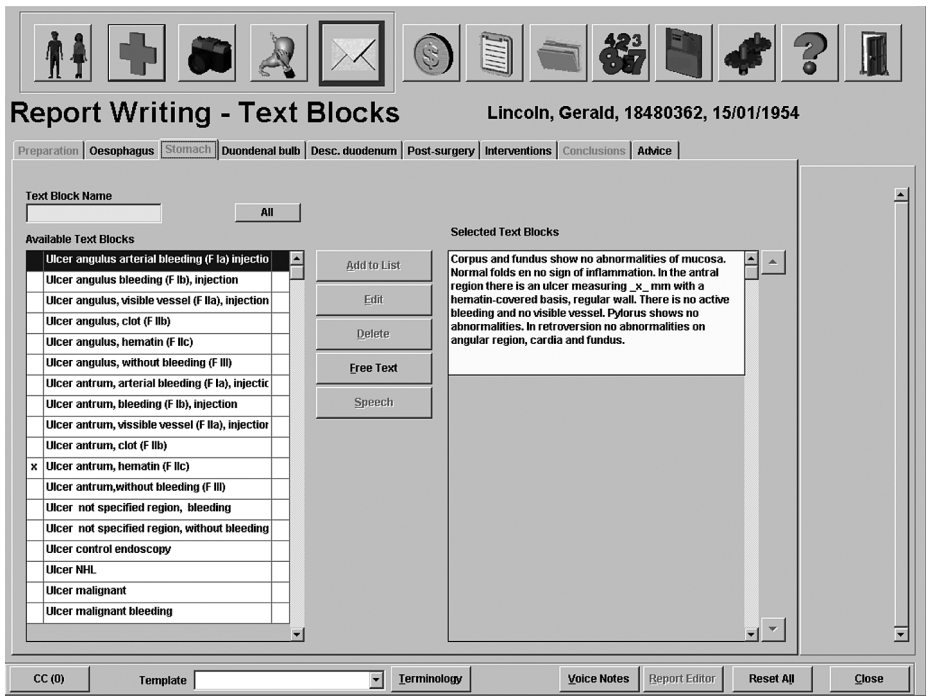
Text-blocks

The text-blocks were divided in different sections and presented in tabs according to different anatomical sections seen during the endoscopy and some specific parts. Reports created with text-blocks were composed by selecting a diagnosis or finding from different sections of text-blocks.

For upper endoscopy 8 different sections were made [**Table 4**] [**Image 1**].

First of all the preparation and progress of the examination was selected. Four sections were designed for the various anatomical regions: esophagus, stomach, duodenal bulb and descending duodenum. A separate section was made for aberrant anatomy after gastrointestinal surgery. One section consisting of 'therapeutic' interventions, e.g. taking of biopsies and placing of endoprothesis. Another section was composed with different kinds of recommendations to the referring doctor. Finally a section with conclusions which is automatically built up by the different selected text-blocks.

Figure 1 *Text-blocks with different sections*



It is possible to select one or more text-blocks from each section, but also to select none and omit a section. A total of 252 text-blocks were created for upper endoscopy.

Lower gastrointestinal endoscopy exists of 13 different sections [**Table 4**]. Again it starts with the preparation and progress of the examination. Seven different sections for anatomical regions: Ileum, cecum, ascending colon, transverse colon, descending colon, sigmoid colon, rectal and anal region. A separate section was made for digital rectal examination. Again one section for post surgery anatomy and a section for therapeutic interventions. Recommendations for the referral doctor are within the last section. A total of 607 text-blocks were created for lower endoscopy.

Reports of endoscopic retrograde cholangiopancreatography (ERCP) were mainly composed with text-blocks and consist of different anatomical and therapeutical parts [**Table 4**].

Each text-block consists of one or more sentences describing a diagnosis or finding of that particular text-block. For this purpose a total of 1571 different text-blocks were written and used at this moment [**Table 5**].

In the same way as with using standard reports the time needed to compose a report with text-blocks was timed. In total 133 examinations were reported by different endoscopists and the needed time was measured. The mean time for selecting different text-blocks, making some adaptations in the word processor and printing of the report was 1 minute 37 seconds (SD 55 seconds).

Table 4 *Different sections for text-blocks*

Examination		
Oesophagogastroduodenoscopy	**Colonoscopy**	**ERCP**
Preparation and progress of examination	Digital rectal examination	Introduction and Preceeding
Oesophagus	Preparation and progress of examination	Papilla Major
Stomach	Ileum	Papilla Minor
Duodenal bulb	Cecum	Canulation and Pre-Cut
Descending duodenum	Ascending colon	Common bile duct
Post-surgery	Transverse colon	Cystic duct and gall bladder
Therapeutic interventions	Descending colon	Bifurcation and hepatic ducts
Conclusions	Sigmoid colon	Pancreatic duct
Advice	Rectal and anal region	Sphincterotomy and balloon dilatation
	Post-surgery	Therapeutic interventions bile duct
	Therapeutic interventions	Therapeutic interventions pancreatic duct
	Conclusions	Conclusions
	Advice	Advice

Table 5 *Number of Standard reports and Text-blocks*

Examination	**Number of Standard Reports**	**Number of text-blocks**
Oesophago-gastro-duodenoscopy	134	252
Sigmoidoscopy	47	420
Colonoscopy	96	697
ERCP	39	202
Total	316	1571

In comparison the using of MST was also measured in 250 reports made by an experienced user. The mean time for this way of report writing is 2 minutes and 50 seconds (SD 1 minute 10 seconds).

Coding

All endoscopic reports are coded automatically with an extension of the ICD-10. The different used report systems all produce the same code for identical findings. In this way extensive research possibilities are created. For example a search on 13081 upper endoscopies for a specific ICD-10 code for duodenal ulcers (K26) result in 511 (3.9%) duodenal ulcers. In time this incidence declines from 4.1% in 1996 to 2.8% in 2005. Twenty-one of these duodenal ulcers (4.1%) showed active bleeding and were classified as Forrest I, six of these as Forrest Ia. Signs of recent bleeding were found with a visible vessel in 45 patients (8.8%), an overlying clot, Forrest IIb, in 31 (6.1%) and a haematin covered basis, Forrest IIc, in 28 patients (5.5%).

Discussions

Structured computerized report systems are essential for modern gastrointestinal practice. They should enable systematic, rapid, informative, comprehensive reporting of endoscopic findings and at the same time allow database handling for various purposes. Potentially, they should also be used for safety and quality control, as well as other issues including maintenance of equipment, management of stocks, and billing. We showed in this study that a structure report system, in our setting the Olympus developed Endobase III® system, allows incorporation of standard reports as well as text blocks. With 316 reports and 1571 text blocks, 90% of the endoscopic examinations could regularly be composed within 2 minutes. This makes it useful for the busy daily practice of many endoscopy units. All endoscopists in the participating hospitals use this system for report writing in every case.

Standard reports can be used to report examinations without abnormalities and examinations with frequently seen abnormalities. In case of more rare findings and/or a combination of diagnoses the use of text-blocks is more suitable. This still makes it possible to compose a comprehensive report of the performed examinations in a short time. For those examinations (ca 5-10 %) where it is hard to compose a report with standard reports or text-blocks, we propose to use a standard structured data entry like the MST. In our experience MST is more complex, takes more time and there is a risk of getting lost in the data tree. The advantage is that you can describe the findings in a very punctual way and build up a structured database.

In comparison, in using MST to compose a complete report you have to make about 40 different choices for the description of an examination with only a few abnormalities. The possibility for the endoscopist to choose the type of report writing after the examination makes the program user-friendly and well accepted. With

standard reports and text-blocks it is possible to register a standard list of all the requirements on medical records and endoscopic reports in particular.[25] With all legal consequences nowadays, registration of endoscopic information should be as complete as possible. With this system all this information can be stored and easily retrieved.

All the standard reports and text-blocks are directly linked to an extended ICD-10 code system in the database. Also other data in the system like reason of examination, medication, complications are coded. With these codes an anonymous database can be build with endoscopic data from different hospitals.

The Standard reports and text-blocks are written in Dutch, and will be translated. They are used in the Endobase system, but can be applied to any system that can work with text-blocks and a code system.

All the reports and text-blocks are tested and eventually adapted by the TRANS.IT working group. The TRANS.IT working group will stay operational for at least three years, in order to improve the functionality and quality of the reports and to create a large anonymous central database. After three years we will have the possibility to answer specific research questions from the results of a database with approximately 60.000 upper endoscopies performed in a uniform way.

Nowadays the system with the standard reports and text-blocks is accepted and used in about 30 % of the Dutch Hospitals.

Appendix

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CHAPTER 3

Computerized endoscopic reporting is time competitive with conventional methods

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Abstract

BACKGROUND Endoscopists use different methods for reporting a gastrointestinal endoscopy. These may result in handwritten, dictated or computerized reports. The time needed to create the report is an important parameter for acceptance of the used method. Besides the issue of time-consumption it is important to be aware of the possible advantages and disadvantages of these different methods.

Aim of the study was to compare time aspects of different methods of report writing.

METHODS Three different methods of report writing, i.e. handwritten, dictated and computerized were compared. In three different endoscopy departments one investigator recorded the time needed to compose the report and send it to the referring doctor.

The time needed to describe different diagnoses at endoscopy was compared between the systems.

RESULTS Handwritten reports were completed in an average time of 113 seconds, free-text dictated reports by the endoscopist in 65 seconds where additional time for the typist was 172 seconds, and computerized predefined reports in 86 seconds. The incidences of abnormalities found in the reports of the different hospitals were comparable.

CONCLUSION To a large extent, computerized predefined reports could be composed in almost the same time as handwritten and dictated reports. Free-text dictated and computerized predefined reports are both stored in the hospital information system, but only computerized predefined reports including endoscopic pictures are stored in a structured database, which makes statistical analysis possible.

Introduction

Approximately 400,000 endoscopies are carried out in the Netherlands each year. Endoscopy reports are extremely important to inform the referring doctor about the findings of the investigation. At present, endoscopy results are recorded in different ways namely free-text handwritten reports, free-text dictated and typed reports or computer-generated standardized reports using databases with either predefined text or structured data entry.

Computer systems have become a part of everyday working life in all areas of work, including hospitals. The aim of using computer technology is usually to improve quality, reduce costs, save time, collect research data and also for convenience. Although several commercial reporting programs are available, they are not widely used.[1-2] Some of these systems are not found sufficiently satisfactory because of their complexity of use and the time needed to create a report.[3-4]

The publication of several national and international recommendations regarding the documentation of findings and images, represents evidence of a growing demand for quality control among endoscopists and other health care providers.[5-6] In the mean time, advances in information technology and software engineering have yielded more powerful tools for reporting. Computerized reporting may promote doctors' acceptance of endoscopy standards, improve the quality of the report, and include topics that tend to be omitted in free text reports.[7-10]

Computerized reporting may have advantages compared to other report writing methods, but might be more time-consuming. To establish whether time is the limiting factor for computerized reports, existing methods of report writing were compared.

Materials and Methods

The study was carried out in three medium-size hospitals that used three different report writing systems for endoscopy results, i.e. handwritten, dictated free-text, and computerized reports based on predefined text blocks. In a period of six months one investigator visited the endoscopy units of the study hospitals. Reporting times of endoscopies, performed as part of the regular endoscopy program were evaluated. All upper and lower gastrointestinal endoscopies were included in a defined period. Upper or lower gastrointestinal (GI) endoscopies were evaluated separately during the study. Total report processing time was recorded by using a stopwatch and was noted in seconds. The main diagnosis of each endoscopy was written down. A total of 217 endoscopies were evaluated in the form of hand-written reports, 201 as dictated reports, and 232 as computerized predefined reports. Data were analysed

in Statistical Package for the Social Sciences (SPSS), version 11.5 (SPPS, Chicago, IL). Data are described by means and 95%-confidence interval (CI).

Handwritten reports

Two experienced endoscopists participated in collecting the data in this hospital. The endoscopists made handwritten reports straight after the endoscopy. The endoscopists wrote the reports in free text on a blank form, on which the secretary printed the patient's identity through a punched card. The reports were handed over to the patient or sent to the referring doctor and a copy was stored and filed in the endoscopy unit.

When necessary, photographs were printed using a photo printer. Neither reports nor photos where saved in an electronic database. Reporting time was recorded and started upon beginning with writing the report and ended when the endoscopist finished the report. Photos were only printed in a minority of the investigations and therefore capturing and printing time was not recorded.

Dictated reports

Two experienced endoscopists participated in collecting the data in this hospital. Dictated reports were partly created by the endoscopist and partly by a typist. After an endoscopy the endoscopist dictated the findings in free-text on a voice recorder. Immediately afterwards the typist typed out the report in a text editor, which was linked to the hospital information system and the computer diary of the endoscopy department. From this diary the patient's identity, the name of the referring doctor, and the type of examination were retrieved. The verbatim text was typed out without using fixed text blocks. In case the general practitioner ordered the investigation, the report was handed over to the patient straight away. In other cases reports were sent to the referring doctor by mail. All the reports were stored in the hospital information system, making them accessible from any computer in the hospital at any time.

In analogy to handwritten reports, captured images were printed with a photo printer. Time recording was divided in two parts, dictating time by the endoscopist and typing time by the typist. Again printing of photos was not included in the recorded time because it was only performed in a few investigations.

Computerized reports

Two experienced endoscopists participated in collecting data in this hospital. Computerized predefined reports were created by the endoscopists with a commercially available software system, called Endobase III® of Olympus Software. Patient information was retrieved from the hospital information system. The type of examination, the referring doctor and the endoscopist planned to perform the procedure,

were retrieved from the computer diary. The endoscopists entered through a predefined selection list details such as indication of endoscopy and medication. Reports could be created in two different ways, by predefined 'Standard Reports' or 'Text Blocks' (11). Standard reports describe an entire endoscopy without or with one abnormality. Text blocks describe only one part of the gastrointestinal tract with a specific abnormality. All standard reports and text blocks are linked to one or more specific gastrointestinal endoscopic terminology codes (GET-C) based on the International Classification of Diseases (ICD-10) (12). Images could be unlimited captured during endoscopy by a remote button on the endoscopes and saved in the database. Afterwards up to three images were selected and printed in the report on plain paper. The final text of the report could be edited, e.g. entering free text or filling in the measurements like the size of an abnormality. The reports were authorized, printed and automatically saved in the computer database and the hospital information system, making them accessible from any computer in the hospital at any time. Reports were sent to the referring doctor immediately after endoscopy or given to the patients to hand them over to their general practitioner. Time for computer recording was recorded as follows: time for selecting photographs to be printed in the report, time for creating the report by selecting standard reports or text blocks and time for editing the report and free-text. These are consecutive actions.

Photo selection is a standard part of computerized reporting. Photo selecting time was recorded separately for computerized reports to make a reliable comparison of the net reporting time compared to handwritten and dictated reports.

Results

A total of 650 endoscopy reports were evaluated. Respectively 217 handwritten reports (105 upper and 112 lower GI reports), 201 dictated reports (106 upper and 95 lower GI reports) and 232 computerized predefined reports (102 upper and 130 lower

Table 1 *Mean time in seconds for endoscopists involved in composing report*

	Handwritten reports	Dictated reports	Computerized reports
Upper GI	114 (109-120)	69 (64-75)	74 (65-84)
Lower GI	113 (108-117)	61 (55-67)	95 (86-104)
All endoscopies	113 (110-117)	65 (61-69)	86 (79-93)

Mean time in seconds (95 % confidence interval) for endoscopists involved in different methods for upper lower gastrointestinal (GI) endoscopies and all endoscopies without selecting endoscopic images.

Table 2 *Mean total time for composing complete reports*

	Writing	Dictating	Typing	Selecting Photos	Composing Report	Total
Handwritten N=217	113 (108-117)					113 (108-117)
Dictated N=201		65 (61-69)	172 (163-181)			237 (225-250)
Computerized N=232				20 (19-22)	86 (79-93)	102 (95-110)

Mean time in seconds (95 % confidence interval) for composing complete report in seconds. N = number of reports encountered in this study. 'Selecting photos' is time needed to select photos to be printed in the report. 'Composing report' is time to select a predefined standard report or text blocks and editing the report completing if desired with free text. 'Writing' is the time needed to handwrite the report. 'Dictating' is the time for the endoscopist to dictate the report on tape. 'Typing' is the time needed for the typist to type and print the report.

GI reports) were evaluated. The mean time the endoscopists of the three hospitals were involved in composing the report is shown in the **Table 1**.

Handwritten reports were performed in a mean time of 114 seconds (CI 109-120) for upper and 113 seconds (CI 108-117) for lower GI endoscopies respectively.

Dictated reports were completed in 242 seconds (CI 225-258) for upper and 232 seconds (CI 213-251) for lower GI endoscopies respectively. The time the doctor needed to dictate the report was 69 seconds (CI 64-75) for upper and 61 seconds (CI 55-67) for lower GI endoscopies respectively. The remaining time was needed to type the report by the typist, which took a mean time of 172 seconds (CI 163-181).

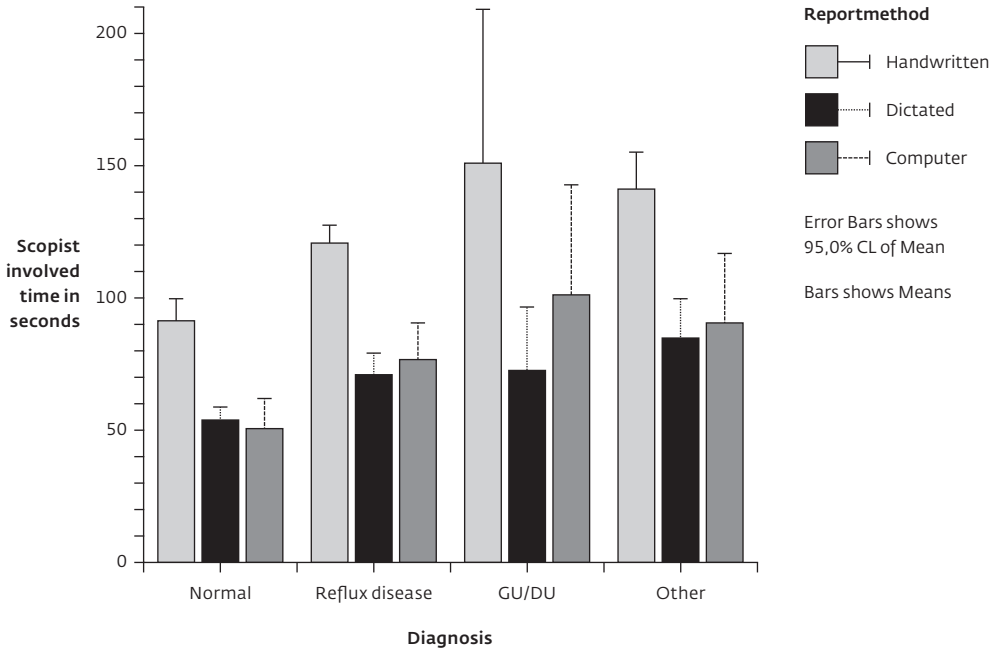
A report based on computerized predefined text blocks took a mean time of 74 seconds (CI 65-84) for upper and 95 seconds (CI 86-104) for lower GI endoscopies respectively. An additional mean time of 20 seconds (CI 19-22) was needed to select the endoscopic images

For the different methods the mean times of all endoscopies, divided in different stages, are shown in detail in **Table 2**.

As also the diagnoses were recorded, it was possible to compare the average report times for the different diagnoses for each report method. These are presented in **Figure 1** for upper and **Figure 2** for lower gastrointestinal endoscopies.

In about 25-35% of the endoscopies performed no abnormalities were found. It is noticeable that normal findings and most often seen abnormalities could be described faster or in similar time by computerized report writing. Furthermore, in all three types of endoscopy reporting, composing a report took longer if the diagnosis was more complex.

Figure 1 *Endoscopist involved time for upper gastrointestinal endoscopies, grouped by diagnosis*



Endoscopist involved time for upper gastrointestinal endoscopies for different reporting methods, grouped by diagnosis without selecting photos. GU/DU = Gastric and Duodenal Ulcer disease.

Discussion

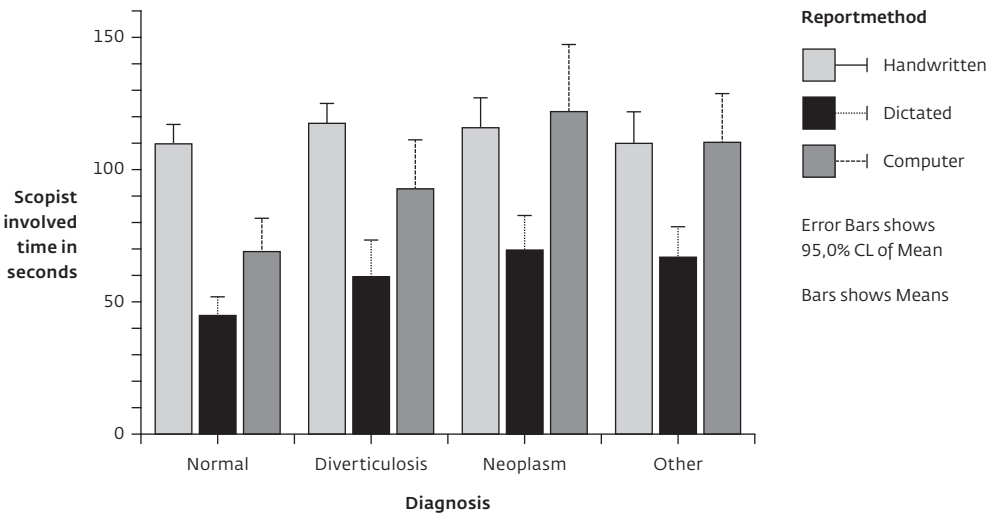
This study shows that preparing an endoscopy report using a computer-generated method is not more time consuming than the conventional way. Contrary to the 5 minutes that have been suggested by Waye et al,[4] computerized predefined reports including the selection of endoscopic images can be performed in 102 seconds (CI 95-110). These reports are produced significantly faster than dictated reports and almost equalling handwritten reports [**Table 2**]. It should be noted that the actual time an endoscopist is involved in creating a dictated report is lower than the time creating a computerized report [**Table 1**]. However, if we include report checking in the time necessary to create the report, an additional 10–30 seconds are needed to finalize and approve the dictated report. Adding an average of 20 seconds to dictation time would result in an average time of about 85 seconds the endoscopist is en-

gaged with composing and finalizing a dictated report. This is comparable to computerized predefined reports without endoscopic image selection time (86 seconds).

According to the ESGE guidelines, a certain number of endoscopic images are needed to document the whole tract thoroughly.[13] Printing on photo paper with ordinary photo printers, as done in handwritten and dictated reports, is expensive. For this reason endoscopists often don't illustrate handwritten and dictated reports with the recommended number of images. For computerized predefined reports an unlimited number of endoscopic images can be stored in the database. This off course needs an investment in storage capacity and a large database could have impact on the performance of the program. The digital images are stored as 'jpeg-file' and comprise only about 100 kB per photo, making this a minor problem. These images can also be compared with images of previous examinations. Computer hardware and software for computerized predefined reports are expensive, but these costs can be saved on the costs of a typist.

In computerized predefined reports all descriptions are standardized text. The content of this text has been subject of discussion in a working group of gastroenterologists in the Netherlands, which has reached consensus on this matter. The

Figure 2 *Endoscopist involved time for lower gastrointestinal endoscopies, grouped by diagnosis*



Endoscopist involved time for lower gastrointestinal endoscopies for different reporting methods, grouped by diagnosis without selecting photos.

reports are automatically linked to extended ICD-10 based code, the gastrointestinal endoscopic terminology coding (GET-C).[12] These codes are stored in the database, which offers possibilities for automated statistic reports and research.

This study primarily reports on the time aspects of the three report writing methods. No conclusions can be made about the content of the reports, as this was not the subject of this study. It is however clear that codes associated with the computerized predefined reports allow automated statistical analysis of endoscopic findings, whereas the use of free text in handwritten and dictated reports does not.

This study demonstrates that composing a computerized report of endoscopic findings is not more time consuming than generating a dictated or handwritten report. The storage of all endoscopic findings, including endoscopic images in a database offers a potential advantage to the other described reporting systems. Besides this it is important to make the report available in the hospital information system or patient record at any time.

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CHAPTER 4

A cost-benefit analysis of endoscopy reporting methods: handwritten, dictated and computerized

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Abstract

BACKGROUND AND STUDY AIMS Gastrointestinal endoscopy investigations are frequently requested by gastroenterologists, general practitioners and other physicians. In addition to the classic methods of report writing, several electronic endoscopic report systems are currently available. The aim of the study was to evaluate the costs of three different ways of producing reports; by hand, by dictation, or by computer.

METHODS Three methods of report writing were compared, with special attention to costs. The endoscopy process was analyzed, from arrival of the patient to sending the report to the referring doctor, and including production of endoscopic images or video, logging of used endoscopes and their disinfection, and storage costs for endoscopy data.

RESULTS During the first 5 years, the mean costs per procedure were € 4.78 for handwritten, € 6.39 for dictated and € 8.90 for computerized reports. Due to depreciation, after this initial period, the respective costs declined to € 4.37, € 5.20 and € 5.13, respectively. Despite high initial costs, a cost–benefit analysis already revealed a financial benefit from a computerized system after 3 years.

CONCLUSIONS The electronic production of an endoscopic report turned out to be the most expensive way of report writing during the first 5 years, due to high initial costs. After 5 years the costs of the different systems were comparable with each other. Cost–benefit analysis showed a positive financial benefit for computerized reports after 3 years.

Introduction

As gastrointestinal endoscopy is a visual examination, it is of utmost importance that the endoscopist's findings should be reported to the referring doctor. Traditionally this has been done by means of a handwritten report or a transcription of a dictated report. Nowadays, an increasing number of electronic report systems are becoming available.[1] These provide easily readable, well-structured, and complete reports that fulfill all the recommendations of several gastrointestinal endoscopy societies.[2-3] As an additional benefit, an electronic report system often makes the report available within the hospital information system (HIS) and thereby continuously accessible for doctors.

Computerized systems need high initial investment, for hardware, software, and linkage to other medical computerized systems. Till now, the potential financial benefits of specific computerized systems have not been documented and evaluated, hindering effective consideration of implementation of such a system.

At present about 50% of hospitals in the Netherlands use a computerized endoscopy report system, mostly the Endobase III developed by Olympus. In most hospitals without computerized endoscopy reporting, the reports are produced by dictation and transcription or are still written out by hand. To the best of our knowledge, so far there has been no cost–benefit analysis of the different methods of generating endoscopy reports.

In the current study, the overall costs and the benefits of these three methods of report writing have been documented and compared. In our comparison we hypothesized that computerized report writing, apart from its nonfinancial benefits, is cost-effective after high initial investment.

Methods

In this study we compared the overall costs of three different methods of generating reports: written out by hand, by the clinician; dictation and transcription; and production using a computerized system. The study was performed in three different endoscopy units in the Netherlands, one for each method. These centers were comparable in several important respects, such as in the open-access character of the endoscopy unit, in endoscopy equipment, and in patient population. In the hospital with handwritten reports, three endoscopists between them performed a total of 4600 endoscopies in two endoscopy rooms. In the hospital with dictated records, four endoscopists between them performed a total of 5400 procedures in three endoscopy rooms, and in the hospital with computerized reporting four endoscopists between them performed a total of 4950 procedures in three endoscopy rooms.

The steps in the reporting process were investigated. These steps began with the preparation for the endoscopy session and, if necessary, retrieval of the reports of previous endoscopies, followed by selection of patient information and noting which endoscope was used. The next steps involved the endoscopist's capturing and printing the endoscopic images and then generating the endoscopic report. The logging of the endoscope and its cleaning process was also documented. The last step was dispatch of the endoscopy report to the referring doctor.

All resource costs for this process, such as for personnel, workspace and patient record storage, computerization, software, license, and material, were documented and subsequently evaluated for the three methods.

The initial and recurring (annual) costs were distinguished, and total costs per year and per endoscopic examination were calculated. For the costs per examination, a 5-year depreciation period was applied for the initial investment costs. Personnel costs were calculated on the basis of the time the persons involved were actually working on the report, multiplied by their costs per hour.

In order to compare the three reporting methods, time and personnel requirements were described for each stage in the procedure, as listed in **Tables 1-3**.

Table 1 *Steps, personnel, and time needed for handwritten endoscopy reporting.*

Step in report process	Performed by	Time, min:sec
Preparation		
1 Carbon copy referral paper stickered	Secretary	0:05
2 Paper medical record with referral paper to endoscopy unit	Nurse	0:05
Endoscopy procedure and report production		
3* Report composed on carbon copy paper Declaration form completed	Endoscopist	1:58
4 Images printed on photo paper	Endoscopist	0:14
5 All forms placed in paper medical record or handed over to patient for general practitioner New appointment checked	Secretary	0:43
6 Paper medical record stored	Secretary	0:15
7 Carbon copy of report placed in "endoscopy" file	Secretary	0:15
Reprocessing of endoscope		
a Patient details logged, along with date, time endoscope number, endoscopist and nurses	Nurse	0:15
b At central sterilization department, logging of endoscope identification, number of disinfection machine, name of employee, and disinfection program used		0:15
Total time		4:05

* Date of examination, endoscopist name, description of findings, conclusion, advice, medication

Handwritten reports [Table 1]
The reason for endoscopy was filled in on a blank carbon copy form at referral. The patient's records were retrieved from the archives at 1 or 3 days before the endoscopy procedure, depending on whether the archive was located inside or outside the hospital.

Endoscopic images could be captured on a color video printer (Sony UP-21MD). Not all endoscopies had image records.

Because paper patient records were needed in this setting, the costs of archiving patient records, consisting of room and filing cabinets in the outpatient clinic, hospital archive, and external archive, were also taken into account.

Dictated reports [Table 2]
Reports of previous endoscopic investigations could be obtained from the HIS, but without endoscopic images. The endoscopist dictated the report following the endoscopic examination. For patients referred by a general practitioner the tape was transcribed by the typist immediately after the examination. Otherwise the report was typed after the endoscopy clinic. Typing of endoscopic reports took half of the working time of one typist (20 hours a week). Endoscopic images could be captured

Table 2 *Steps, personnel, and time needed for dictated and transcribed endoscopy report.*

Step in report process	Performed by	Time, min:sec
Preparation		
1 Appointment checked and indication form received	Secretary	0:12
2 Paper medical record with sticker supplied to endoscopy unit	Secretary	1:11
Endoscopy procedure and report production		
3 Dictationof report to tape after endoscopy	Endoscopist	1:04
4 Selection of patient record from HIS* before typing	Secretary	0:39
5 Report typed	Secretary	2:51
6 Report saved and printed	Secretary	0:05
7 Report read and agreed by endoscopist	Endoscopist	0:22
8 Report handed to patient or put into internal post	Secretary	0:05
Reprocessing of endoscope		
a Sticker with patient details given to endoscope disinfection operative to place in logbook	Nurse	0:05
b After procedure, operative logs their own name, endoscope identification, and number of disinfection machine		0:30
Total time		7:04

* HIS, hospital information system

on a color video printer (Sony UP-5200). Not all endoscopies were recorded with images.

Endoscopes were logged in the disinfection room. There was no logging of the disinfection process in this hospital.

Computerized reports [Table 3]
A computerized endoscopy report system was used in which reports of all previous endoscopies, including the endoscopic images, were retrievable from the system before the investigation. The relevant patient data were automatically transferred from the scheduling program of the HIS into Endobase III. On arrival, the patient's information was brought up on the computer terminal. During the examination an unrestricted number of digital endoscopic images as well as video tracks could be captured. Endoscopic images or video tracks were stored in about 90% of all examinations.

Table 3 *Steps, personnel, and time needed for computerized endoscopy reporting.*

Step in report process	Performed by	Time: min:sec
Preparation		
1 Appointment checked, indication form received, patient entered into system	Secretary	0:11
2* Fields completed in Endobase by nurse	Nurse	0:20
Endoscopy procedure and report production		
3 Images selected, report composed and printed	Endoscopist	1:49
4 Report handed over to patient or sent by internal post	Secretary	0:05
C *Reprocessing of endoscopes*		
a Endoscope automatically linked to patient, endoscopist, endoscopy nurse, and disinfection machine, in Endobase		0:00
b Disinfection operative is recognized via batch with microchip by disinfection machine		0:03
Total time		2:28

* Name of endoscopy nurse, referring doctor, indication, and premedication

The report could be composed in three ways: by using standard reports, by selecting text blocks or by structured data entry.[4] All of these automatically generated a report using an extended code system based on the International Classification of Diseases (ICD)-10, known as gastrointestinal endoscopic terminology coding (GET-C).[5]

The Endobase program was continuously linked to the disinfection machines by a network connection. All information concerning the disinfection process, the disinfection machine and the employees involved was recorded. Thus, the entire history of an endoscope from its disinfection to its use and disinfection again, could be quickly ascertained.

Results

The mean time for the entire process of report production and endoscope documentation was 7 minutes 4 seconds using dictation and transcription, 4 minutes 05 seconds for handwritten reports, and 2 minutes 28 seconds for computerized reporting with Endobase III.

Initial costs

Initial costs are listed in **Table 4**. For handwritten reports, the initial costs included: (I) storage area including shelves to store paper patient records; (II) material costs, including a color photo printer for image reproduction and two paper books for the documentation of endoscopes and their disinfection; and (III) a computer system including software with a connection to the HIS, for finding and storing patient information and printing stickers.

Dictated reports had higher initial costs for computerization, with workstations for the typists, software and license for the SAP server. Other initial (material) costs were for dictaphones, tape players, tapes, and a color photo printer for endoscopic images.

Table 4 *Initial costs in Euros for different methods of endoscopy reporting: handwritten, dictated and transcribed, and computerized.*

	Initial costs, €		
	Handwritten	**Dictation**	**Computerized**
Storage of records*	420		
Material costs†	5 500	7 353	
Computerization‡	4 325	22 388	94 214
Total initial costs	10 245	29 741	94 214

* Storage area and equipment for paper medical records.
† Material costs are for photo printers and photo printer paper, carbon copy paper, dictaphones, tapes and tape-players.
‡ Computerization initial costs are for workstations, servers, printers, etc. and for primary software licenses.

Computerized reporting had the highest initial costs because of the investment in computer hardware and software. Additionally, several links between the Endobase system and the HIS had to be established. In total the creation of four Health Level Seven (HL-7) links was needed: (I) from the HIS to Endobase, to schedule the endoscopy sessions; (II) from the HIS to Endobase, to obtain patient information; (III) from Endobase to the HIS, for report storage; and (IV) from Endobase to the HIS, to add endoscopic images to the report.

Recurring costs

The highest costs were for personnel, and were similar for all three reporting methods, with an annual cost, based on 5000 endoscopy reports, of € 13 233 for handwritten, € 14 380 for dictated and € 10 709 for computerized reports [**Table 5**]. Handwritten reports incurred personnel costs for the endoscopist who composed the report and for administrative staff who retrieved and stored medical records and who recorded data needed for finance purposes. Dictated reports incurred the personnel costs for the endoscopist and the typist. The personnel costs for computerized reports were mainly for the endoscopist producing the report. It took in general less

Table 5 *Annual (recurring) costs in euros for reporting on 5000 endoscopies, using different reporting methods: handwritten, dictated and transcribed, and computerized.*

	Annual costs for 5000 endoscopies, €		
	Handwritten	**Dictation**	**Computerized**
Personnel			
Endoscopist	(10 663	(7 215	(9 179
Endoscopy nurse	389	50	1 530)
Endoscope cleaner	197	700	
Secretary	1 984)	6 415)	
Total personnel costs	13 233	14 380	10 709
Workspace and storage	2 623	9 600*	
Computerization		900†	7 355‡
Software licenses			7 211
Material costs§	5 983	1 110	361
Total annual costs	21 839	25 990	25 636

* Additional workspace needed for secretary
† Back-up for system
‡ Back-up and costs for links between Endobase and hospital information system
§ Carbon copy forms (handwritten), photo printing paper (handwritten and dictated), tapes for dictaphones (dictated), printing paper for reports, and postage costs

than 2 minutes to compose a computerized report and print it, depending on the findings during the examination; this was comparable to findings in a larger study where time aspects of report writing were studied.[6]

Besides personnel, the recurring costs for handwritten reports were largely for storage of endoscopic reports in paper patient records. The remaining cost was for materials such as carbon copy forms and photo paper.

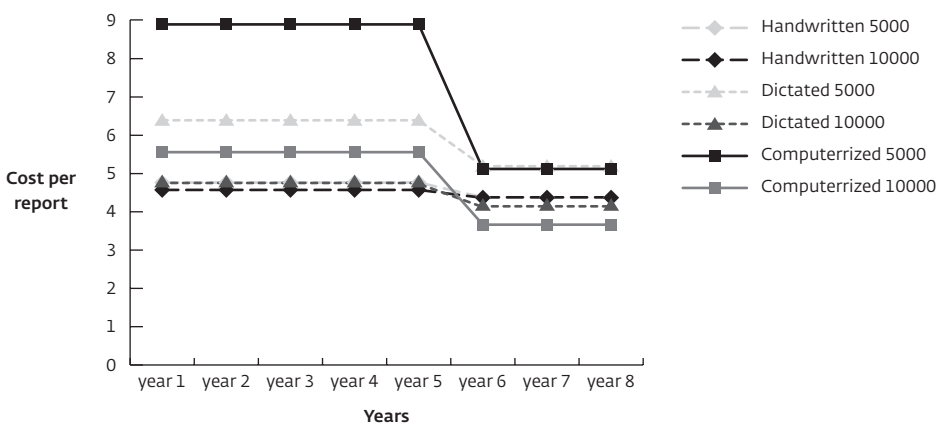
For dictated report writing, recurring costs were for the typists' workspace and some information technology (IT) costs for back-ups. The other costs were for materials including dictaphone tapes, photo print paper, and normal print paper for reports.

Computerized report writing incurred recurring costs related to maintaining HL-7 links between the Endobase and the HIS; making back-ups; Endobase software licenses and service contracts; and print paper for reports. After 5 years of depreciation, further investment would have been needed for computer hardware. This item was booked for € 5000.

Costs per report

To calculate the cost per report, the yearly costs and the depreciation costs were added together. Given the 5 years' depreciation period, reporting costs were calculated for the first 5 years as well as after 5 years. Based on 5000 endoscopy procedures per year, the costs per report were € 4.78, € 6.39 and € 8.90 for handwritten, dictated, and computerized reports, respectively, during the first 5 years and € 4.37, € 5.20 and € 5.13 after 5 years [**Figure 1**].

Figure 1 *Costs per report during and after the depreciation period, with 5000 and 10 000 endoscopy procedures per year.*



Benefits

We have now considered the costs of the three methods, but not yet the associated financial benefits that might arise for the hospital, including those beyond the endoscopy process itself. Comparing the computerized method with dictation, typing costs can be saved.

For each of the first 5 years, the computerized system would have been €12 541 more expensive (€44 479 – €31 938), due to the substantially higher depreciation costs. After 5 years, all the initial investments have been fully depreciated and the small computer reinvestment in year 6 is taken as an incidental cost. Hence, from year 6 on, the difference in cost between dictated and computerized reporting is changing to the advantage of the latter. Moreover, there are some differential 'income' benefits that make the investment in computerized reporting attractive at an even earlier point.

In the hospital with dictated reporting, typically one secretary is assigned for half of a working week (0.5 full-time equivalent [FTE]) to transcribing endoscopic reports. While we have chosen to only attribute labor costs for the effective time the secretary spends on transcribing dictated reports (€6 415), the actual salary costs for a secretary working 0.5 FTE were €14 134. In other words, a secretary effectively spends about 45% of the time on typing reports. In the transition to computerized reporting, the costs of the secretary's nonproductive time were also considered to represent potential savings (€7 719). Hence, these additional savings have been included in **Table 6**.

Computerizing the endoscopic report process can improve the capturing of in-office procedures that are carried out but not documented. Based on other studies, a 2% improvement in billing capture was estimated.[7] For 5000 endoscopies, this represents a yearly increase of billing by 100 procedures; with a mean of €87 per investigation, this would mean €8700 additional annual revenue.

The difference in material costs of dictated compared with computerized reporting, amounted to €750.

Besides these benefits there were many other nonmaterial benefits that are hard to express in concrete financial terms (see Discussion).

Comparing the costs and the material benefits of changing from dictated to computerized report writing, a net annual benefit of the computerized system is already apparent after 1 year. In the fourth year this leads to a cumulative financial benefit for the computerized system. After 5 years, when all the initial costs are depreciated, the cumulative benefits rise to about €20 000 yearly in an endoscopy unit with 5000 investigations yearly [**Table 6**].

Table 6 *Cost–benefit analysis for change from dictated and transcribed reporting to computerized reporting, based on 5000 endoscopy procedures per year. All amounts are in euros (€).*

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Total
Costs								
Excess annual costs, computerized vs. dictation	12 541	12 541	12 541	12 541	12 541	-354	-354	
New computers						5 000		
Total costs	12 541	12 541	12 541	12 541	12 541	4 646	-354	66 997
Benefits								
Saving in personnel costs	7 719	7 719	7 719	7 719	7 719	7 719	7 719	
Billing benefits	0	8 700	8 700	8 700	8 700	8 700	8 700	
Total benefits	7 719	16 419	16 419	16 419	16 419	16 419	16 419	106 233
Net annual benefits	-4 822	3 878	3 878	3 878	3 878	11 773	16 773	
Cumulative benefits	-4 822	-944	2 934	6 812	10 690	22 463	39 236	39 236

Discussion

This is the first known study comparing the costs of different methods of generating endoscopic reports. As suspected, the initial costs of a computerized system are much higher than conventional methods of endoscopic report writing. This has its impact on the costs per report, especially in the initial period, when these costs have to be depreciated. After a period of 5 years, the costs per report are similar for the three different ways of report writing. This calculation does not take into account savings on other costs, such as the financial benefits mentioned above, due to a switch from conventional to computerized report writing. If 10 000 investigations were to be performed annually, the costs per report change dramatically. The main advantage is for the computerized reports, where the costs per report decline from € 5.13 to € 3.67 after 5 years [**Figure 1**].

Dictation of endoscopy reports involves more people, resulting in a higher risk of errors. Checking the typed reports would require a third manual stage.

Previous studies on electronic medical records have shown a positive cost–benefit balance.[7] Computerized reporting saves material, workspace, and personnel costs compared with handwritten or dictated reporting. Over years the costs of personnel and workspace might rise unequally compared with the main costs of hardware and software that are associated with computerized systems, and this might lead to even higher benefits for computerized reporting. In this study only

one computerized system was compared with the other ways of report writing. Other computerized systems would probably show similar benefits, but this has to be studied further.

With computerized and dictation systems the endoscopy report is available in the electronic medical record, and accessible to doctors whenever needed. Compared with handwritten reporting, this results in a saving for computerized reporting on the personnel costs for retrieval of paper patient records. In other studies these personnel savings from easier retrieval of patient data are estimated as one FTE per year.[8] Annual savings were also associated with the storage costs for paper patient records, accounting for € 2623 with handwritten reporting.

The reduction of billing inaccuracy when using a computerized system that automatically generates a billing code when a report is produced can only be estimated. The 2% value for the increase in billing is based on findings in other studies where an increase between 1.5% and 5% was generated.[7, 9-10] The mean price for an endoscopy of € 87 is based on different endoscopic procedures (upper, lower, and therapeutic) with different reimbursement fees (range € 46 to € 104).

Benefits related to materials are especially related to the cost of photo printing paper. A computerized system does not require the expensive photo printing paper needed with handwritten and dictated reports. Only storage capacity is required, which is not a big problem with files of about 150 kB per image. Digital video capturing with a storage requirement of 40 MB per minute is a more expensive option. Newer high-definition digital images also need greater capacity (600 kB), but still only a small fraction of that needed, for example, for radiologic investigations. Digital storage of endoscopic images and video makes it possible to review these images at any time in the future. According to European Society of Gastrointestinal Endoscopy (ESGE) guidelines, capture of eight specific images is recommended for every endoscopic investigation.[11] American Society for Gastrointestinal Endoscopy (ASGE) quality guidelines require photographic documentation if an abnormality is encountered.[12] If these guidelines are followed, images should be stored for at least 70% of investigations, this being the proportion in which any abnormality is found.[13] With printed images this would lead to costs ranging from € 6125 (3500 investigations [75% of 5000] with at least one sheet of photo paper, at € 1.75 per sheet), to € 12 250 (eight endoscopic images printed on two photo paper sheets, with up to 4 images per sheet).

Several benefits cannot be readily expressed in concrete financial terms. For example, the continuous availability of a report for a doctor in the HIS improves patient care. This makes debate about duration of storage of patient records redundant and is conducive to efficiency in the endoscopy department as well as throughout the hospital.

Other quality aspects concern the completeness of endoscopy reports. Studies

have shown that computerized structured systems produce superior reports compared with free text.[14]

The risk of transmission of infection between patients during an endoscopy procedure is low.[15] However, if there is suspicion of infection of an endoscope, the patients in whom this endoscope had been used could be traced in less than a minute in the computerized system, in contrast to the other two systems, where most of the history was handwritten. Additionally, the risk of transmission is diminished by the use of an automatic monitoring system that makes it impossible to use an endoscope that has not been thoroughly cleaned and disinfected without a notification in the Endobase program.

This study has shown that computerized endoscopy reporting is cost-effective after an initial high investment, especially in hospitals where more than 5000 examinations are performed annually. Besides cost-effectiveness, computerized reporting shows many benefits that cannot be directly expressed in financial terms. All these advantages have to be taken into account when the purchase of a computerized endoscopy report system is considered.

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CHAPTER 5

Gastrointestinal Endoscopic Terminology Coding (GET-C): a WHO-approved extension of the ICD-10

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Abstract

PURPOSE Technological developments have greatly promoted the interest in the use of computer systems for recording findings and images at endoscopy and create databases. The aim of this study was to develop a comprehensive WHO-approved code system for gastrointestinal endoscopic terminology.

The International Classification of Diseases 10th edition (ICD-10) and the ICD-10 clinical modification (ICD-10-CM) were expanded to allow description of every possible gastrointestinal endoscopic term under conditions defined by the WHO.

RESULTS Classifications of specific gastrointestinal disorders and endoscopic locations were added. A new chapter was developed for frequently used terminology that could not be classified in the existing ICD-10, such as descriptions of therapeutic procedures. The new extended code-system was named Gastrointestinal Endoscopic Terminology Coding (GET-C).

CONCLUSIONS Gastrointestinal Endoscopic Terminology Coding (GET-C) is a complete ICD-10 related code system that can be used within every endoscopic database-program for all specific endoscopic terms. The GET-C is accessible for free on http://www.trans-it.org/.

Introduction

Technological developments and the introduction of hospital information systems have strongly promoted the interest in the use of computer systems for recording findings and images at endoscopy. Several database systems have been developed for this purpose, most only working as report generator. These systems are however hampered by the lack of a specific code system for endoscopic diagnoses and terminology. As a result of this shortcoming, the composition of reports and storage of data differ considerably between systems. The systems use different database structures and variable terminology and are thus not compatible or comparable.

The International Classification of Diseases (ICD) is designed to promote international comparability in the collection, processing, classification, and presentation of mortality statistics. This ICD is developed, published and maintained by the World Health Organization (WHO). The system is, in its current setting, not applicable for endoscopy as it does not include descriptive terminology. However endoscopic findings are classified according to their appearance. The adequate description of this appearance in uniform terminology is essential for the interpretation of endoscopy reports, and allows deriving important conclusions with respect to therapy and prognosis. This makes it important to uniformly store and code endoscopic findings.

This is however hampered by the lack of a specific, uniformly applicable code system for endoscopic terminology and findings. Besides that, only about 80% of the report systems are able to use a code in their database.[1]

Different code systems for medical data are being used. The International Classification of Diseases 9th version (ICD-9) and the clinical modification (ICD-9CM) have already been used and proven their value in a specific and defined gastrointestinal endoscopic setting.[2]

The ICD has been revised periodically to incorporate changes in the medical field. The tenth revision (ICD-10) differs from the ninth revision (ICD-9) in several ways although the overall content is similar. First, ICD-10 has alphanumeric categories rather than numeric categories. Second, some chapters have been rearranged, some titles have changed, and conditions have been regrouped. Third, ICD-10 has almost twice as many categories as ICD-9. The new version, International Classification of Diseases 10th version (ICD-10), has been available since 1992 and was translated into Dutch in 1997.[3] Other medical specialties, such as oncology and dentistry have produced an extended code system based on the ICD-10 for their field of interest.[4]

The aim of this project is to develop a comprehensive code system for gastrointestinal endoscopic terminology, based on the widely accepted ICD-10 code system, to be used in any gastrointestinal endoscopic information system.

Methods

As basis for the new code system the latest ICD-10th version was chosen. The reason for choosing this code system was that a predecessor has already been in use for some gastrointestinal endoscopic databases.[2] Besides that, the new version of ICD has now been accepted in a majority of the countries throughout the world.[5]

Extensions to the ICD-10 are made according to the recommendations of the WHO, without changing the structure of the ICD-10. The first 4 characters are never changed, but one or more characters are added behind those first four descriptors. In this way it is always possible to delete the extension to come back to the original ICD-10. We used the Dutch translation of the ICD-10. Also the draft version of the ICD-10 CM of the National Center for Health Statistics (NCHS) was studied, which is available on the Internet.[6] Conflicts with this ICD-10 CM system were avoided, to rule out coding conflicts.

A working group, the TRANS.IT-working group, was founded comprising of representatives from two academic hospitals, (Utrecht, Amsterdam) and 4 general hospitals. This working group used the Endobase III® system (Olympus). In this system, the endoscopist can choose between three different ways of report writing. Besides the Minimal Standard Terminology (MST)[7] also Text-blocks and Standard Reports are available. A standard report is a complete report based on a diagnosis or a combination of diagnoses. With text-blocks, different parts of text are combined to compose a complete report. These two variants enable a more rapid generation of reports, and are well accepted and widely used in the Netherlands.[8]

In the TRANS.IT-project group, which was founded as a peer reference group, the standard reports, text-blocks and the link to the new code-system were discussed.

A list of every endoscopic finding, intervention or complication described within one of the three different ways of report writing available for TRANS.IT users was generated. All the items on this list were linked to a specific code.

Results

We first generated a list of different fields necessary for evaluation of endoscopic data [**Table 1**]. The program automatically generated the data during composition of endoscopic reports. All these fields are necessary to generate a comprehensive anonymous database with endoscopic information for extensive research. In addition, demographic data like gender and age of patients, specialty of referring doctor, etc are recorded.

Table 1 *Different fields that need a specific code*

Fields in endoscopic information systems that need a specific code
Reason for endoscopy
Medication use
Sedation and medication during the endoscopy
Preparation
Proceeding of the investigation
Endoscopic diagnosis / findings
Therapeutic and Diagnostic Interventions
Histology results
Therapy started
Advice to referring doctor
Complications

We included all available standard reports, text-blocks and diagnoses of MST accepted by the TRANS.IT-group. The endoscopic findings, interventions and complications were extracted and linked to a specific code. In this way, a total of 316 standard reports and 1571 text-blocks were coded, to assure coding of every item within this project.

In total 2593 different items were extracted and received a specific code. Of these items, 630 (24%) could be coded with the existing ICD-10. Thus, 1963 new codes were required and added to the ICD-10 system, in order to be able to specifically code every endoscopic term.

The used ICD-10 was originally designed for mortality and discharge statistics. The problem of that design is that the used structure in the ICD-10 is not very detailed. This is especially for gastrointestinal endoscopic terms, which do not always contain a mortality risk but most of the time descriptive items essential for prognosis and therapy. For example, specific descriptions of peptic ulcers are relevant for determination of outcome risks, therapy and prognosis. We therefore introduced the Forrest Classification for description of gastric and duodenal ulcers.[9] We thus for instance changed the diagnosis K25.2, (Acute gastric ulcer with both haemorrhage and perforation) into K25.21 (Acute gastric ulcer with ***spurting bleeding*** and perforation; Forrest Ia) in the GET-C [**Table 2**].

Besides such an adaptation of the ICD-10 system, endoscopy is still developing and new terms and endoscopic techniques are continuously being created. For example, new disease classifications are from time to time being introduced, such as the semi recent LA-Classification for reflux esophagitis.[10]

For several fields, there was no ICD-10 code available, and the item could thus not be categorized under an existing ICD-10 code. For example, the proceeding of the investigation and interventions could not be covered within the ICD-10 and even the

ICD-10 CM system. Because these items are essential for good analysis of endoscopic data, a new chapter with the same structure of the ICD-10 was developed. The items in this new chapter start with the Greek letter μ. We chose to categorize the therapeutic interventions in this new chapter also because new therapies are developed frequently so they can be adapted.

Adaptations were made in different chapters of the ICD-10.

Table 2 *ICD-10 and GET-C for Gastric Ulcer*

ICD-10	Description	GET-C	Description
K25.0	Gastric ulcer, acute with haemorrhage	K25.0 K25.01 K25.02	Gastric ulcer, acute with haemorrhage Gastric ulcer, acute with spurting bleeding (Forrest Ia) Gastric ulcer, acute with non-spurting active bleeding (Forrest Ib)
K25.1	Gastric ulcer, acute with perforation	K25.1	Gastric ulcer, acute with perforation
K25.2	Gastric ulcer, acute with both haemorrhage and perforation	K25.2 K25.21 K25.22	Gastric ulcer, acute with both haemorrhage and perforation Gastric ulcer, acute with spurting bleeding and perforation (Forrest Ia) Gastric ulcer, acute with non-spurting active bleeding and perforation (Forrest Ib)
K25.3	Gastric ulcer, acute without haemorrhage or perforation	K25.3 K25.31 K25.32 K25.33 K25.34	Gastric ulcer, acute without haemorrhage or perforation Gastric ulcer, acute with visible vessel (Forrest IIa) Gastric ulcer, acute non-bleeding with overlying clot (Forrest IIb) Gastric ulcer, acute with hematin-covered basis (Forrest IIc) Gastric ulcer, acute with clean ulcer ground (Forrest III)
K25.5	Gastric ulcer, chronic or unspecified with perforation	K25.5	Gastric ulcer, chronic or unspecified with perforation
K25.6	Gastric ulcer, chronic or unspecified with both haemorrhage and perforation	K25.6 K25.61 K25.62	Gastric ulcer, chronic or unspecified with both haemorrhage and perforation Gastric ulcer, chronic or unspecified with spurting bleeding and perforation (Forrest Ia) Gastric ulcer, chronic or unspecified with non- spurting active bleeding and perforation (Forrest Ib)
K25.7	Gastric ulcer, chronic without haemorrhage or perforation	K25.7 K25.71 K25.72 K25.73 K25.74	Gastric ulcer, chronic without haemorrhage or perforation Gastric ulcer, chronic with visible vessel (Forrest IIa) Gastric ulcer, chronic non-bleeding with overlying clot (Forrest IIb) Gastric ulcer, chronic with hematin-covered basis (Forrest IIc) Gastric ulcer, chronic with clean ulcer ground (Forrest III)
K25.9	Gastric ulcer, unspecified, without haemorrhage or perforation	K25.9 K25.91 K25.92 K25.93 K25.94	Gastric ulcer, unspecified, without haemorrhage or perforation Gastric ulcer, unspecified, with visible vessel (Forrest IIa) Gastric ulcer, unspecified, non-bleeding with overlying clot (Forrest IIb) Gastric ulcer, unspecified, with hematin-covered basis (Forrest IIc) Gastric ulcer, unspecified, with clean ulcer ground (Forrest III)

In Chapter 1, Certain infectious and parasitic diseases (A00-B99), the exact locations in the gastrointestinal tract of some specific infections were added.

In Chapter 2, Neoplasm's (C00-D48), besides exact locations in the gastrointestinal tract the endoscopic characteristics of polyps were described and coded in more detail. It is important to register if a polyp is pedunculated, sessile, flat or has a villous endoscopic aspect. Also the number of polyps found in a specific part of the intestine has to be coded, because of important diagnostic and therapeutic options for the patient and the follow-up of these patients.

In Chapter 9, Diseases of the circulatory system, (I00-I99), hemorrhoids and varices were described according to a classification. Different gradings of protrusion were used for Haemorrhoids. The endoscopic Paquet's classification for esophageal varices was coded.[11]

Most changes were however made in chapter 11, Diseases of the digestive system (K00-K93). The description of esophagitis was divided in different origins and severity. Gastric and duodenal ulcers were coded according to the Forrest classification and their specific location in stomach or duodenum. Gastritis and duodenitis were coded to their specific location and the endoscopic suspected cause. Inflammatory bowel diseases were coded according to their endoscopic severity and location. Some complications related to gastrointestinal procedures were more coded in more detail.

In Chapter 18, Symptoms, signs and abnormal clinical and laboratory findings that are an indication for endoscopic investigations were coded in more detail.

In Chapter 21 post-operative situations important for gastrointestinal endoscopic investigations like gastric and colon operations were extensively coded.

In the new 13th chapter of the GET-C, about 446 new codes were generated. These codes start with the Greek symbol μ. The first part of this chapter including coding of various indications for endoscopy that could not be categorized in the ICD-10. The second part consisted of specific codes for detailed locations in the gastrointestinal tract. The third part of this chapter contained procedures, which were divided in diagnostic and therapeutic procedures. Diagnostic procedures contained for example sampling of histology and culture specimens.

Examples of therapeutic procedures were different kinds of polypectomies, endoscopic mucosal resections, the placement of endoprotheses, and dilatation of stenoses. Another part of these therapeutic interventions was used for the management of gastrointestinal bleeding like injection-therapy with or without coagulation, band ligations, and clipping.

Preparation and proceeding of the endoscopic examination can also be coded in this chapter.

The extensions of the GET-C were checked by the Dutch translation board of the ICD-10 to preclude any conflicts between the two code systems.

Discussion

The increased use of computer systems within healthcare and the need for communication between these systems necessitate the availability of generally accepted code systems. Good coding gives epidemiological information for research purposes. Coding is of importance for hospitals and professionals because most of the financial systems within healthcare are based on different codes. In addition, statistical analysis of different diagnoses and the collection of rare diagnoses are easier. With international acceptation of a coding it is possible to compare and share information in one field of interest.

Most code systems are regional or national. Only some code systems, like the ICD-10, are translated into different languages and in use in different countries.

For endoscopic report writing and endoscopic databases, different systems have been developed. These systems are now being used in many hospitals. We used the Endobase III system from Olympus Europe in our project to compose reports and record different codes. The system runs as a network-version with different workstations as well as a stand-alone unit.

The system enables the generation of reports via three different pathways; besides standard reports and text-blocks also the latest translated version of MST is used to compose an endoscopic report. This makes it essential that all different generated data are coded in the same way to be able to analyze the data anonymously.

Within the system, all standard reports and text-blocks are linked to one or more specific GET-C codes. The choice of a standard report or text-block directly leads to the recording of the correct GET-C code in the Endobase database. For the MST, the automatic link is more complex to realize, due to the structure of the MST. We chose to link the diagnoses with the GET-C code, which is separately selected within the MST by the endoscopist at the end of the report. Automatically linking is essential to ensure a correct and complete selection of codes and to make it workable for an endoscopist.

Within the TRANS.IT project, an anonymously central database of endoscopic investigations was build. In this central database, only coded data instead of free text can be collected for privacy reasons. After having been used for three years, a database of about 120.000 investigations with the same code system will be build by this working group.

The GET-C system allows encoding any data collected during endoscopic investigations and recorded in any endoscopic database. By extending the ICD-10 in respect to the structure developed by the WHO it is always possible to retract the original ICD-10 code out of the GET-C. Thus, it is possible to link the endoscopic database with other healthcare systems throughout the world.

Because endoscopy is an evolving medical specialty, new techniques are contin-

uously becoming available. This requires new codes. These codes will be discussed within the TRANS.IT project.

The Dutch Association of Gastroenterologists in the Netherlands has accepted the GET-C.

The GET-C will be available for use in other systems, and has been discussed at the WHO Family of international classifications network meeting in October 2004.[12] The GET-C is accessible for free on http://www.trans-it.org. We hope that this code system will be helpful in making endoscopic databases and endoscopic report writing programs more valuable.

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CHAPTER 6

Validation study of automatically generated codes in colonoscopy using the endoscopic report system Endobase®

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Abstract

OBJECTIVE Gastrointestinal endoscopy databases are important for surveillance, epidemiology, quality control and research. A good quality of automatically generated databases to enable drawing justified conclusions based on the data is of key importance. The aim of this study is to validate the correctness of coding of a national automatically generated anonymous endoscopy database.

MATERIAL AND METHODS We evaluated a total of 500 colonoscopies performed in five larger hospitals of the TRANS.IT project focusing on endoscopy reporting. Randomly 500 examinations were selected from a total of 5,000 examinations and their generated endoscopic terminology codes as well as complete reports were analysed. Indications for the examination and described findings were scored for correctness and clinical relevance of the coding that would be exported to the anonymous database.

RESULTS Indications were correctly coded in 92% of all examinations (range 76-100%) per hospital. Correct coding of findings ranged from 42% to 93% per hospital (mean 77%). Different correct coding proportions were seen varying with the diagnosis, with the highest correct coding rates in polyps, carcinoma and diverticular disease. Incorrect coded examinations were scored for clinical relevance. Overall 11% of the investigated examinations were incorrectly coded with clinical relevance.

CONCLUSIONS Accuracy of clinical relevant endoscopy data recorded in the TRANS.IT anonymous central database is high. Further improvement is desirable, which may be achieved by education of individual endoscopists and enhancement of the program.

Introduction

Gastrointestinal endoscopy has become a routine, widely available technique for diagnosis and treatment of gastrointestinal disorders. A recent survey among endoscopists in the Netherlands showed that more than 400,000 gastrointestinal endoscopies were performed annually in a population of over 16 million.[1] These numbers can likely be extrapolated for the European Union, which means that the EU population receives more than 12 million endoscopic investigations per year.

An imaging method with numerous repetitive manoeuvres and findings, is particularly suitable for electronic storage and processing of data.[2] Computerized endoscopic databases may play an important role in quality control and patient care, including monitoring of complications and outcome as well as identification of individuals eligible for endoscopic surveillance procedures. Endoscopic databases may also allow and facilitate epidemiological and other types of scientific research and may be very helpful in teaching.

For these purposes, a number of systems have been developed for recording endoscopic findings, storing images and composing reports.[3-13] Unfortunately however, most of these are stand-alone report systems which cannot be integrated into general hospital information systems. Other disadvantages of most systems include the inability of combined report writing and digital image storing, poor accessibility of stored data for research and limited or absent possibilities for extracting or exporting data.

In close to 50% of all hospitals in the Netherlands, one particular endoscopy report and database system (Endobase®, Olympus, Software) is used.

This Endobase system offers different methods of report writing for composing an endoscopic report in a structured way. For all gastrointestinal endoscopic investigations a Dutch version of this medical information was developed. Besides standard reports, text blocks and structured data entry can be used for more complex or multiple diagnoses.[14-15]

Endobase® (nowadays named Endoalpha Documentation®, Olympus, Software) was built around an extensive relational database structure. In this way it becomes suitable to store all data produced in an endoscopy unit, including patient characteristics, patient monitoring data, digital images and video, endoscope information, and complications. These data can be separately retracted with all kinds of queries.

In 1999 the TRANS.IT group, a working group consisting of members from three university and seven general hospitals, was founded to develop a uniform, consensus-based endoscopy report writing system using Endobase®. A secondary aim was to establish a system of automated linkage of the composed report to an extended diagnostic coding system based on the tenth version of the International Classifi-

cation of Diseases (ICD-10). This Gastrointestinal Endoscopic Terminology Coding (GET-C) is automatically linked to the selected standard reports and text blocks entry when assembling a report.[16] The indications for the examinations are important details for analysing outcome of endoscopy investigations and are also automatically coded by the system.

Besides report making, Endobase also facilitate direct financial and administrative tasks related to the endoscopic procedure.[17]

Although the Endobase system for report making is based on the use of structured data entry, text blocks or (nearly) complete reports, the reporter can add free text or adjust the automatically generated report. Obviously, this may possibly interfere with and impair the adequacy of the automated terminology coding. As the Endobase system is now becoming a standard for endoscopy reporting and thus also serves as an example for other systems, it is relevant to evaluate to assess the consistency of the data generated by such a system which is of key importance for future research. Therefore, the present multicenter study was performed to assess to what extent automatically generated GET-C codes are in agreement with the actual text of the endoscopy report.

Methods

Type and selection of reports

This was a retrospective study involving five hospitals (2 university and 3 general hospitals) employing the Endobase report system and participating in the TRANS. IT endoscopic database project. The endoscopists in the five hospitals had agreed to use both standard reports and text blocks.

For reasons of variability of findings the study was performed on the results of colonoscopies. The last 1000 colonoscopies, performed before January 2006 in every hospital, were retrieved from the endoscopic database. The name of the endoscopist, indication, medication, selected standard reports and text blocks titles, GET-C codes, and the complete anonymous final report were exported. From these 1000 cases, a random sample of 100 procedures per hospital was obtained with the random sample function of Statistical Package for the Social Sciences version 14.0 (SPSS) from SPSS Inc. Chicago, Illinois.

Definitions

The final complete endoscopy report was considered to be the gold standard. An examination was considered appropriate if all the abnormalities in the final report were correctly coded in the database. Three experienced gastroenterologists, who were blinded for hospital and endoscopist data, scored every examination for

correctness of the GET-C codes and indications for the examinations considering the complete contents of the final report. If any of the three reviewers found any discrepancies between the automatically generated GET-C codes and the endoscopy report text, the procedure was scored as incorrectly coded. If an abnormality was described in the final report but not coded, it was classified as a false-negative coding. If there was a code for a specific abnormality, but this was not described in the final report, it was classified as a false-positive coding.

In the same way, incorrectly coded examinations were classified as clinically relevant or irrelevant. The results were analyzed not only per hospital but also per examiner, to get a impression of inter-examiner variability.

Indications for the examination were scored as false-negative if an indication was not recorded in the database but was only written in the report and as false-positive if an indication has been selected but was not present in the final report.

Results

Hospitals and endoscopists

All hospitals performed at least 1000 colonoscopies in a period of seven months or less. The randomly selected 100 examinations per hospital all showed valid information to allow complete analysis.

A total number of 45 endoscopists were involved; the number of endoscopists per hospital varied from 4 to 20. In 385/500 (77%) procedures the GET C codes corres-

Figure 1 *Percentage of correct coding in 5 different hospitals*

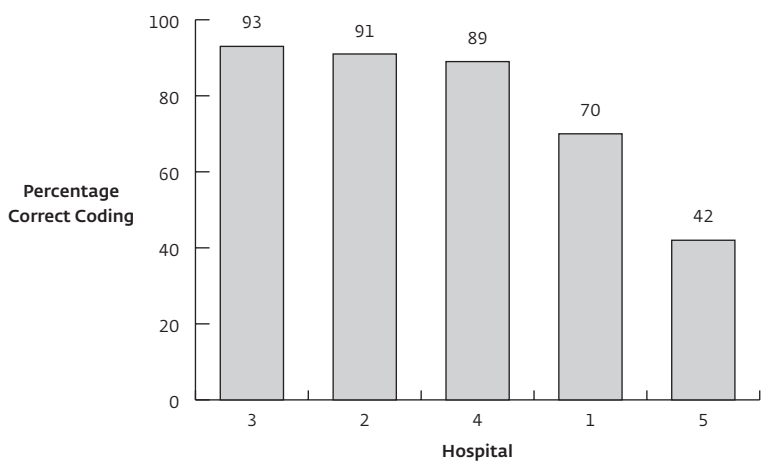
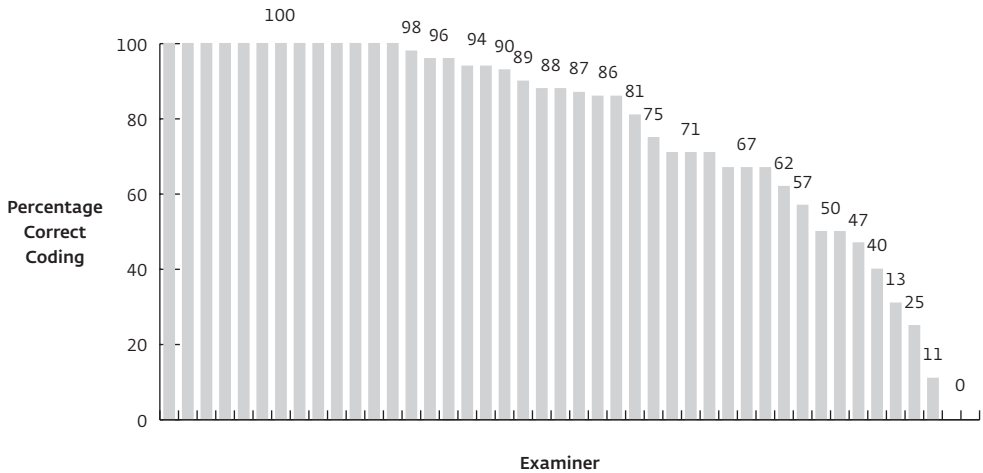


Figure 2 *Percentage of correct coding per individual examiner (n=45)*



ponded completely with the endoscopy report text. These percentages consistent reports varied between hospitals from 42% to 93% [**Figure 1**].

Differences in proportions of correct recordings between endoscopists ranged from 0% to 100% [**Figure 2**]. It should be noted that the number of procedures per endoscopists ranged markedly, with a minimum of one and maximum of 42. If only endoscopists, who performed more than 5 investigations in the present sample, were included the proportion of colonoscopies with concordant data had a mean of 74%.

Analysis showed that results of one particular hospital were markedly different from those of the other centres. In this single hospital, only 42% of examinations were correctly coded, as compared with 86% (range 70%-93%) for the other four hospitals. This can be explained by an incorrect way of report making. Although it was agreed to use standard reports and text blocks, in this hospital in the majority, reports were composed using free text.

Diagnosis groups

Exclusion of the single, low-scores hospital revealed 400 remaining examinations for analysis. These were divided into six different diagnosis groups based on the most relevant findings: Normal, Polyps, Carcinoma, Diverticular disease, Inflammatory Bowel Disease and Other [**Table 1**]. The percentage of procedures with correct coding (81-91%) was not significantly different between the diagnostic categories [**Table 1**].

Table 1 *Main endoscopic findings and percentage correct coding of 4 hospitals. (Hospital 5 excluded from data analysis)*

	Main endoscopic finding		Correct Coding
	Number	Percentage	Percentage
Normal	176	44.0	81.3
Polyps	101	25.3	90.1
Carcinoma	19	4.8	89.5
Diverticular Disease	55	13.8	90.9
IBD	28	7.0	85.7
Miscellaneous	21	5.3	85.7
Total	400	100.0	85.8

The 57 incorrectly coded examinations (14% of total examinations) were scored as false-negative in 54 of the cases (95%) and false-positive in 3 cases. In these three cases extra information was coded in the database, but this was deleted from the final report by the endoscopist.

Evaluating the incorrectly coded examinations, for clinical relevance revealed 44 (77%) of the examinations to be clinically relevant. In the majority these were polyps, not corresponding number of polyps, diverticular disease, but also one rectal carcinoma was not coded.

Table 2 *Number and percentage of incorrect coding and their clinical relevance*

	Incorrect Coding			Correct Coding
	Number	False negative	Clinically relevant	Percentage
Hospital 1	30	28 (93.3%)	19 (63.3%)	70
Hospital 2	9	8 (88.9%)	7 (77.8%)	91
Hospital 3	7	7 (100%)	7 (100%)	93
Hospital 4	11	11 (100%)	11 (100%)	89
Hospital 5[a]				
Total	57 (14.2%)	54 (13.5%)	44 (11.0%)	85.8

a Excluded from data analysis

Of the 57 incorrectly coded examinations 13 were not clinically relevant, containing incipience polyps in a report that was already coded for other polyps, some post-surgical situations, not further defined reddish mucosa, and grade-I haemorrhoids accompanied by already coded abnormalities. [**Table 2**]

Indications

Indications were correctly recorded in the database in 92% of all examinations, ranging from 76.0 % to 100 % per hospital. All incorrectly coded indications were false-negative, due to not selecting an indication in the system and adding the indication in free text only.

Discussion

This study shows that automatically generated codes from gastrointestinal endoscopy reports can firstly be very consistent between different endoscopy units, and secondly with high adequacy reflect the actual endoscopic findings.

A review has been performed on the accuracy of computer based patient records with a high variety in correctness and completeness of data,[18] but little is known about the level of adequacy and inter-individual consistency of automatically generated coding in endoscopy reporting. To our knowledge, there are no studies on reliability of automatically generated codes in endoscopic databases.

This study was performed in the Netherlands, with the objective to investigate the proportion of incorrectly recorded data in a large endoscopy report database, in order to show the usefulness of the database on the one hand and on the other hand to be able to compare these initial results with a planned intervention to improve the quality of database building in the future.

Medical databases are not only important for patient care, but can additionally be used for clinical research, health-system management, health-service planning, total quality improvement, billing, risk management and government reporting. The accuracy of these data is therefore of utmost importance.

The quality of the data in a database depends in the first place on the correctness of the input of data.

If data have to be entered manually, building of a substantial database requires a lot of time of the persons entering the data. However, using advanced computerized systems working with a structured data-input to compose reports enables database building in which, during daily busy practice, a lot of data are recorded and entered automatically. Most of these systems still offer the possibility to adapt text by free input. In this way the system is workable for almost every user. The op-

portunity to use free text enhances detailed description but at the same time creates the risk of incorrect structured data.[19] Due to the possibility to remove information from the final report of already recorded data, false-positive data may be created. On the other hand, the possibility to describe abnormalities in free text without really recording it in the database, may result in false-negative data. The aim of the TRANS.IT working groups is to minimize the use of free-text in our endoscopy report system. This goal is probably not easily achieved nationwide, but shows to be possible after instructions in participating high volume endoscopy centres.

Surprisingly, large differences are seen in correctness between hospitals and between individual endoscopists. It was an eye-opener to see that one of the participating hospitals used another (and thus incorrect) way of reporting than was agreed upon in the working group. All endoscopists in this hospital appeared to record the majority of data incorrectly, suggesting a general problem in making the reports. They appeared to have used free text in the majority of their composed reports, making them unsuitable for generating codes. Considering the fundamental difference with the other hospitals it was decided to exclude this hospital from further specific analysis.

When only the clinically relevant incorrect records were considered, only in 11% of the included examinations the recorded code was not consistent with the final report. This 89% correct coding is high, in comparison with other studies, but triggers a further investment to enhance the results for this specific database.[18]

For different diagnosis groups small differences were seen in correct coding rates. Particularly carcinoma and polyps, which are of extreme importance for diagnosis as well as for follow-up, appeared to contain the best recorded data, with 90% correct data.

As expected, examinations coded as normal, showed the lowest percentage of correct codings. This is probably due to the use of free text to describe abnormalities in a standard report with normal findings.

Therefore adaptations that enable a quicker search for the corresponding text block and education for the endoscopist is planned in the future. Initiating feedback information to the endoscopist of his incorrectly use of the report system will enhance quality of the database input. Additional training for endoscopists working in these hospitals will be performed.

We think that these results are not only applicable for the Endobase system, but are likely to reflect other report systems that generate codes automatically. This hypothesis needs to be confirmed. Unfortunately no data exist to compare our results with other systems. Such a comparison, although seemingly tedious, is relevant as the use of these databases is rapidly increasing in daily patient care, hospital management, and research.

In conclusion, this study shows that overall a high proportion (89%) of clinically relevant data is recorded correctly, making this anonymous database suitable for analysis. However there are remarkable differences in correctness of generated codes between endoscopists. Therefore further improvement of the correctness of the generated data is considered necessary. We intend to induce better recording of endoscopy data in the future by showing each hospital and individual endoscopist their data, compared with the anonymous results of other hospitals. With new recommendations, guidelines for composing the report and training of endoscopists we expect a higher proportion of data in the central database will be coded correctly.

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CHAPTER 7

Incidence of duodenal ulcers and gastric ulcers in a western population; back to where it started

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Abstract

BACKGROUND Over the past decades, important changes have occurred in the epidemiology of ulcer disease. Already more than forty years ago, a decline in the incidence of peptic ulcer was observed. The discovery of *H. pylori* had a further major impact on the incidence of ulcer disease. Our aim was to evaluate the trends in the incidence of ulcer disease in the Netherlands.

METHODS From a computerized endoscopy database of a district hospital, the data of all patients who underwent upper gastrointestinal endoscopy in the years 1996-2005 were analyzed. Incidences of duodenal and gastric ulcers with and without complications were compared over time.

RESULTS Overall, 20,006 upper gastrointestinal endoscopies were performed. Duodenal ulcers were diagnosed in 696 (3.5%) cases, with signs of bleeding in 158 ulcers (22.7%): 45 (6.5%) of these ulcers were classified as Forrest I, 113 (16.2%) as Forrest II.

Gastric ulcers were diagnosed in 487 (2.4%) cases, with signs of bleeding in 60 ulcers (12.3%). Forrest I was diagnosed in 19 patients (3.9%) and Forrest II in 41 (8.4%) patients.The incidence of gastric ulcers was stable over time, while the incidence of duodenal ulcers declined.

CONCLUSIONS The incidence of duodenal ulcer disease is steadily decreasing over time in the Dutch population. With a further declining prevalence of *H. pylori*, the incidence of gastric ulcers is likely to exceed the incidence of duodenal ulcer in the very near future, bringing us back to a similar situation as at the beginning of the last century.

Introduction

Over the past decades, important changes have occurred in the epidemiology of ulcer disease. A peak incidence was seen among those born at the end of 19th century. The peak for duodenal ulcers followed the gastric ulcer peak with a 10-20 years lag.[1] Already more than forty years ago, a decline in the incidence of peptic ulcer was suggested, based on a cohort analysis showing that the mortality due to peptic ulcer decreased in successive birth cohorts.[2] This observation was supported by decreasing hospitalization rates for peptic ulcer over the past decades in the USA as well as in many European countries.[3-4]

The discovery in the early eighties of *Helicobacter pylori (H. pylori)* as major cause of peptic ulcer disease had a significant impact on the treatment of ulcer disease. This significant impact led to the award of the 2005 Nobel Prize in Medicine to Robin Warren and Barry Marshall. *H. pylori* eradication therapy was proven to cure patients with previous chronic recurrent ulcer disease. Further research into the epidemiology of *H. pylori* infection showed that the prevalence of this bacterium was decreasing over time in recent decades, presumably as a result of improvements in living conditions.[5-6] A recent Asian study showed that the prevalence of peptic ulcer disease, mainly duodenal ulcers, was reduced in association with a decreasing trend in the prevalence of *H. pylori*, confirming that *H. pylori* is involved in the development of especially duodenal ulcers.[7]

With decreasing incidence of ulcer disease the incidence of ulcer complications might be affected as well. A recent study in the Netherlands showed that the incidence of the most important complication, ulcer bleeding, remained however stable in the period of 1993 – 2003, notwithstanding decreasing incidence of peptic ulcers.[8] Mortality and rebleeding rates for peptic ulcer bleeding did not change either.[9] Investigators from England reported that the incidence of gastric and duodenal ulcer haemorrhage in fact even increased among older patients. This rise was shown to be correlated with oral anticoagulant, NSAID's and oral corticosteroid intake.[10-11]

Introduction of an endoscopy database allowed closer investigation of incidence and epidemiology of gastric and duodenal ulcers, complications rates and classifications. We aimed to define changes in the incidence of gastric and duodenal ulcer disease and its complications over a ten-years period in a large uninvestigated dyspeptic population in the Netherlands. Moreover, use of the database enabled us to describe the incidence of ulcer complications in more detail over time in a large group of peptic ulcer patients for the first time, by use of the Forrest classification.[12]

Methods

All gastrointestinal endoscopies performed from June 1996 to January 2006 in the Ikazia Hospital in Rotterdam, the Netherlands, were evaluated. The Ikazia Hospital is a district hospital with an open-access endoscopy unit, where about 40% of the patients is referred by general practitioners. The large percentage of referrals by GPs from both the urban agglomeration and rural sites makes the investigated population a cross section of the Dutch population. In July 1995 a computerized endoscopy report system, Endobase III®, developed by Olympus Software, was introduced and from June 1996 onwards each gastrointestinal endoscopy performed in the centre was recorded with this system. Four experienced endoscopists performed all endoscopy procedures recorded in the database. The system enables standardized methods for report writing.[13] All data are coded with a specific gastrointestinal endoscopic terminology code (GET-C) which is an extension of the International Classification of Diseases 10th version (ICD-10).[14]

All codes in the database starting with K25 and K26, coding for gastric and duodenal ulcer, were included in this study. Furthermore, a search was performed for the word 'ulcer' in all reports of upper gastrointestinal endoscopies in the database. These reports were reviewed for the diagnosis of gastric and duodenal ulcers. Many patients with a gastric ulcer underwent a follow-up gastroscopy after a few weeks. These follow-up endoscopies were excluded from the analysis; so all included cases were newly diagnosed ulcers in a previously uninvestigated dyspeptic population.

Patient characteristics such as age, gender and indication for the endoscopy were retrieved from the database. Furthermore, the Forrest classification and *H. pylori* status were investigated. All found ulcers were classified according to the Forrest classification.[12] From 2001 onwards, the program enabled entering the Forrest classification into the database, which was done for all peptic ulcers. Ulcers entered before 2001 were re-classified using the Forrest classification based on the reports and available endoscopic images.

The *H. pylori* status was assessed with a rapid urease test (CLO-test) on gastric biopsy specimens.

Data were analysed in Statistical Package for the Social Sciences (SPSS), version 11.5 (SPPS, Chicago, IL). Regression of incidence of ulcers over the years was plotted together with the observed incidence of ulcers in percentage per year. Data are described by means and standard deviations (SD) or 95% confidence intervals (CI). Two-sided p values < 0.05 were considered to be statistically significant. Student's t-test and linear regression analysis were used to compare groups and linear relations.

Results

In total 20,006 upper gastrointestinal endoscopies were accessible for analysis, 10,784 (53.9%) of which were performed in women. The mean age of the patients was 55.6 years with a standard deviation (SD) of 17.9 years. The total number of endoscopies performed yearly, increased gradually over the 10 years from 1800 to 2200 per year.

Duodenal ulcers were found in 696 (3.5%) of the investigated patients, gastric ulcers in 487 (2.4%) patients. The majority of ulcer patients was male, 57.6% of duodenal and 51.5% of gastric ulcer patients.

Duodenal ulcer patients were significantly younger than gastric ulcer patients. The mean age of duodenal ulcer patients was 57.4 years (95% confidence interval (CI) 55.9 – 58.9), gastric ulcer patients had a mean age of 66.3 years (95% CI 64.9 – 67.7) ($p < 0.001$). The distribution over age groups is shown in **Figure 1**. From 1996 to 2006 the mean age of the ulcer patients increased; for duodenal ulcer patients by 0.992 years per year (95% CI 0.44 – 1.4) ($p<0.001$); for gastric ulcers patients by 0.274 years per year, but not statistically significant (95% CI – 0.34 – 0.89) [**Figure 2**].

Classification according to the Forrest system [**Table 1**] demonstrated that gastric ulcers showed signs of bleeding (Forrest 1 and 2) less frequently than duodenal ulcers ($p < 0.001$). Forrest-3 ulcers (no signs of recent bleeding) were seen in 77.3% of

Figure 1 *Ulcers in different age groups*

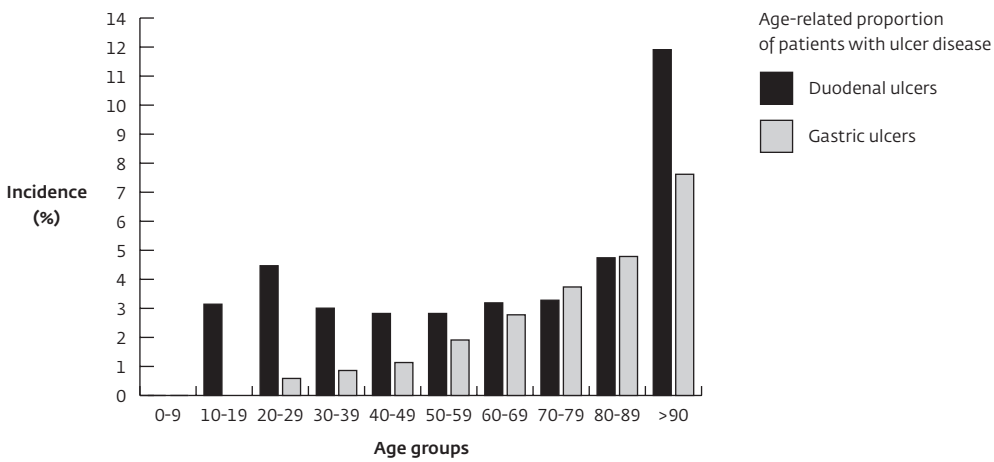
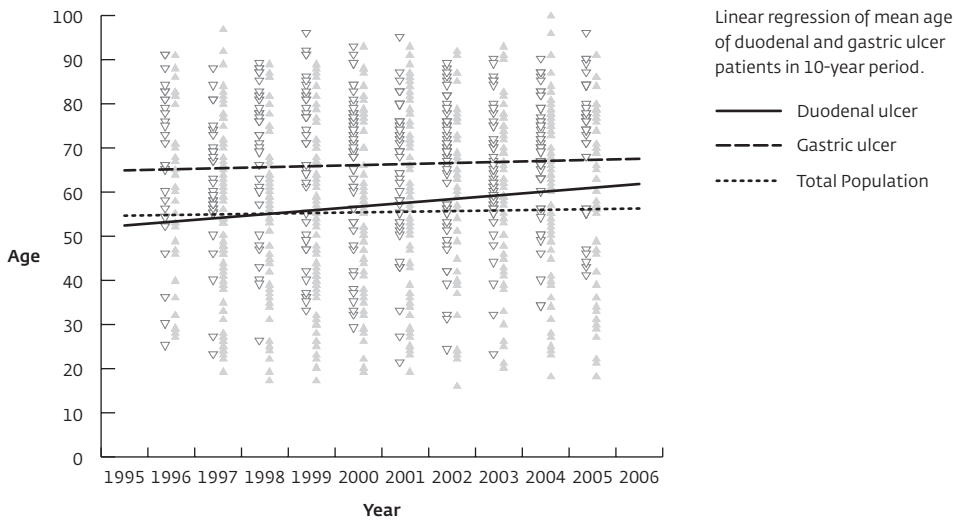


Figure 2 *Change in the mean age of duodenal and gastric ulcer patients*



The mean age of the duodenal ulcer patients increased with 0.992 years per year (95% CI 0.44-1.4) ($p<0.001$) compared to a non-significant increase of 0.274 years per year for gastric ulcer patients (95% CI −0.34-0.89)

Table 1 *Number and classification of duodenal and gastric ulcers*

	Duodenal Ulcers		Gastric Ulcers	
	Number	**Percentage**	**Number**	**Percentage**
Forrest 1a	15	2.2	1	0.2
Forrest 1b	30	4.3	18	3.7
Forrest 2a	39	5.6	14	2.9
Forrest 2b	37	5.3	7	1.4
Forrest 2c	37	5.3	23	4.7
Forrest 3	538	77.3	424	87.7
Total	696	100.0	487	100.0

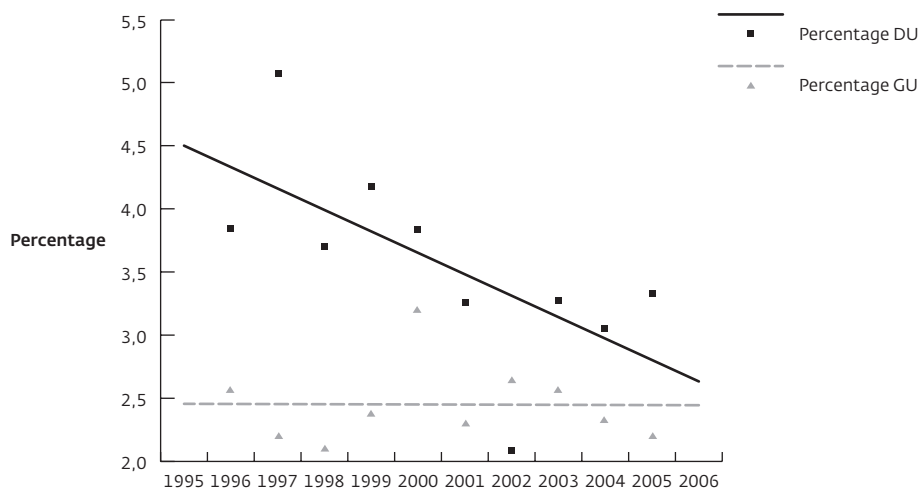
Number of duodenal ulcers and gastric ulcers according to Forrest classification

the duodenal ulcers and 87.0% of the gastric ulcers. Active bleeding (Forrest 1) was seen in 6.5% of all duodenal ulcers and 3.9 of all gastric ulcers and signs of bleeding, i.e. a visible vessel (Forrest 2a), an overlying clot (Forrest 2b) or a hematin-covered base (Forrest 2c) were diagnosed in 16.2% of the duodenal ulcers and 8.4% of the gastric ulcers.

Complicated ulcers, defined as Forrest 1 and 2, were more frequently seen in elderly patients, with a mean age of bleeding duodenal ulcer patients of 69.7 years (95% CI 66.8–72.7) versus 54.3 years (95% CI 52.8–55.9) ($p<0.001$) for non-bleeding duodenal ulcer patients. For bleeding gastric ulcer patients the mean age was 71.6 years (95% CI 67.6–75.5), compared to 65.6 years (95% CI 64.1 – 67.1) for uncomplicated ulcer disease ($p = 0.077$). Of the patients with complicated ulcers, 60.4% and 63.4%, for duodenal and gastric ulcers respectively, were older than 70 years of age. The gender distribution was not different for various Forrest-classified ulcers, nor was the gender distribution in patients with complicated ulcers different from that in patients with uncomplicated ulcers. For both groups the majority of patients were males (57.7% and 54.5%, respectively; $p = 0.395$).

In patients with complicated ulcer disease *H. pylori* infection was assessed in 22.6%, with a positive result in 37.1% of the tested patients.

Figure 3 *Regression of incidence of ulcers over 10 year period (% of all endoscopies)*



Trends in the incidence of duodenal (DU) and gastric ulcer (GU) disease

The incidence of gastric ulcers remained stable over the ten years observation period. In contrast, duodenal ulcers showed a decreasing incidence, with a linear regression coefficient of -.169 (p= 0.040) [**Figure 3**]. This decline was due to a decline in the incidence of uncomplicated ulcers only. The incidence of complicated duodenal and gastric ulcers increased over this 10-year period, as shown in Figure 4. This increase was more explicit for duodenal ulcers.

The rapid urease test (CLO-test) on biopsy specimens taken during endoscopy for the presence of *H. pylori* was performed in 20.5% of gastric ulcer patients and 36.4% of the duodenal ulcer patients. In 34.0% of the tested gastric ulcer patients and 56.5% of the tested duodenal ulcer patients the test results were positive for *H. pylori*. The overall incidence of CLO-positive tests declined significantly from 57.7% in the period 1996-2000 to 45.1% in the period 2001-2006 (p=0.02).

Discussion

The investigated population consists of patients referred for endoscopy, for a major part based on either serious recurring complaints, alarm symptoms or older age, according to the 1996 Dutch General Practitioners' Guideline on Dyspepsia.[15] Thus, the investigated population is not a cross section of the total population and incidences from this investigation are not fully comparable with findings concerning total populations. Trends over time are however clear. We found a decreasing incidence of duodenal ulcer and a stable incidence of gastric ulcer. This suggests a further amplification of the trend observed from 1980 onwards, implying a decreasing incidence of both gastric and duodenal ulcer, with only a slight decline for gastric ulcer incidence.[8] Our data suggest that the former, already slighter, decline in gastric ulcer incidence has stopped by now, whereas duodenal ulcer incidence is still further decreasing. This leads to a situation in which, similar to 100 years ago, gastric ulcer again becomes more common than duodenal ulcer, whereas for the past 100 years, duodenal ulcer disease has been more common than gastric ulcer disease in Western countries.[1]

Other trends that we found were an increasing incidence of complicated ulcers for both duodenal and gastric ulcers, an increasing age at diagnosis for patients with duodenal ulcers and a declining incidence of *H. pylori* positive ulcers.

The overall decline of peptic ulcer disease is likely to be due to a combination of factors, including the introduction of acid suppressive medication, a decreasing prevalence of *H. pylori* in subsequent birth cohorts, and the development of eradication treatment for *H. pylori*-positive ulcer patients preventing chronic relapsing ulcer disease. The introduction of newer NSAID's and a tendency for prescription of lower doses of aspirin for patients with cardiovascular disease may also have contributed to the changing epidemiology of ulcer disease.

The Forrest classification can predict the risk of re-bleeding from peptic ulcer disease and is therefore an important tool to select patients for endoscopic treatment.[16-17] In this study a minority, 12.3% of the gastric and 22.7% of the duodenal ulcers, were complicated by bleeding. As in other studies[10] bleeding ulcers were more frequently seen in older patients and in men.

While we observed a decreasing incidence of ulcers, there was a rise in the proportion of complicated ulcers, an observation in line with data presented in other studies.[8-9] The incidence of complicated ulcers rose in the investigated period in both gastric and for a greater part in duodenal ulcers [**Figure 3 and 4**]. The decline of duodenal ulcers in particular can even be attributed completely to a decrease of uncomplicated Forrest 3 ulcers.

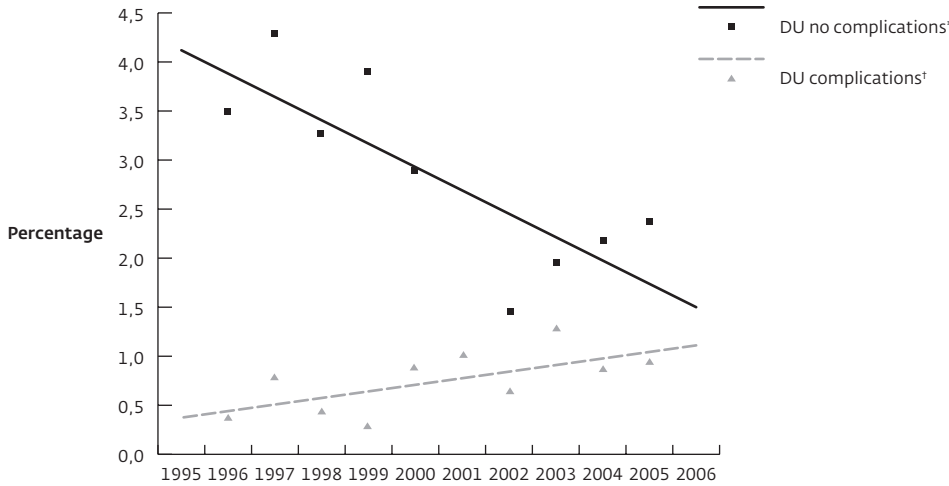
The changes in the proportional distribution of ulcers of complicated versus non-complicated ulcers in the investigated period may be influenced by more accurate description of ulcers in endoscopic reports in the recent years. The endoscopy report program Endobase III®, which was used for this study, enabled more detailed standardized report writing as a result of improvements in the program from 2001 onwards. So, in the updated version of the program the need for free text was minimized. This may have influenced the description of the ulcer classification. We support the suggestion from other publications showing a stable incidence or slight increase of ulcer bleeding compared to overall peptic ulcer disease. It was suggested that the use of NSAID's are the main cause of this change.[8, 10-11] The high proportion of negative CLO-tests in bleeding ulcers supports the hypothesis that bleeding ulcers are more often related to NSAID use, although it may also partly be due to low sensitivity of this test in upper gastrointestinal bleeding patients.[18] Adherence to guidelines to prevent NSAID-related upper gastrointestinal events is low in the Netherlands as well as in the USA.[9, 19] This might be an important cause of the opposite trends in the incidence of complicated versus uncomplicated peptic ulcer patients.

Both ulcer types show an increase in incidence rate with growing age. Duodenal ulcers occur in our population at a younger age than gastric ulcers. The incidence of duodenal ulcers starts to rise at about 20 years of age, in contrast with 50 years of age for gastric ulcers. This again indicates an etiological factor for duodenal ulcers early in life, such as infection with *H. pylori*. These findings are not completely comparable to other studies which show an older age of duodenal ulcer patients than in this study.[10]

In 1996 an update of the Dutch General Practitioners Guidelines of 1993 on Dyspepsia was published.[15] In this 1996 guideline it was advised to diagnose *H. pylori* status by endoscopy biopsy, as only *H. pylori* infection in patients with ulcers should be treated. The role of *H. pylori* in other dyspeptic symptoms was stated as unclear.

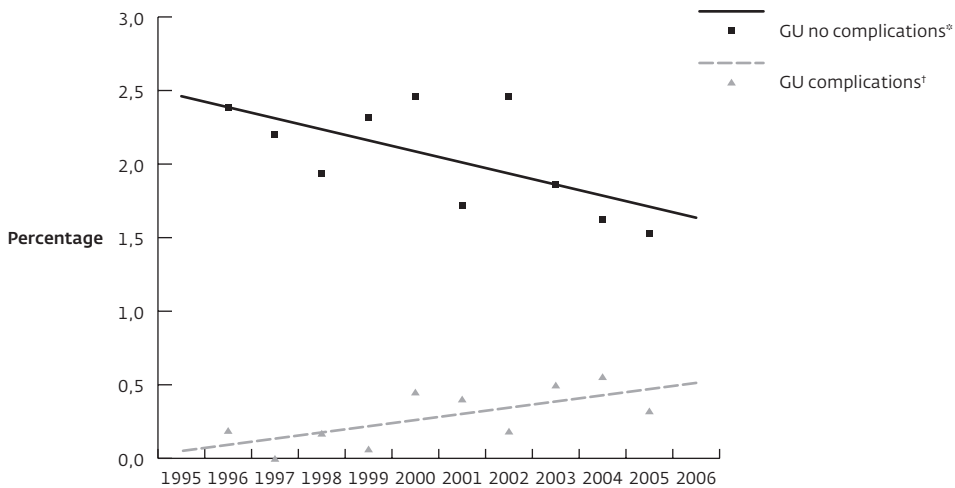
In 2004 a new multidisciplinary guideline for dyspepsia was published in the

Figure 4a *Trends in the incidence of complicated and uncomplicated duodenal ulcers (% of all endoscopies)*



Trends in the incidence of complicated and uncomplicated ulcers
* Duodenal ulcers without complications of bleeding (Forrest 3)
† Duodenal ulcers with complications of bleeding (Forrest 1 and 2)

Figure 4b *Trends in the incidence of complicated and uncomplicated gastric ulcers (% of all endoscopies)*



Trends in the incidence of complicated and uncomplicated ulcers
* Gastric ulcers without complications of bleeding (Forrest 3)
† Gastric ulcers with complications of bleeding (Forrest 1 and 2)

Netherlands by the quality institute for health services CBO and the Dutch general practitioners society.[20] In this guideline, an *H. pylori* test is recommended if there are persistent non-reflux-like complaints without alarm symptoms. If *H. pylori* is negative, treatment with PPI for 2-4 weeks is recommended. If symptoms persist or diagnostic certainty is desired, endoscopy is recommended. Because these guidelines were published in 2004 and the total number of endoscopies performed was still rising since this year, this guideline is not suspected to have influenced the incidence and complications of peptic ulcer disease in this study. However, it is possible that noninvasive testing for H pylori and the use of trials of therapy for dyspeptic patients have had a significant effect on the rate of performance of endoscopy in duodenal ulcer patients, resulting in an apparent decline in incidence.

A CLO-test was performed only in a small proportion of the patients. Other tests like the urea C^{13} breath test or serology may have been used in patients included in this study, in particular in case of bleeding. However those test results were not included in the endoscopy database and thus could not be analysed for this study.

From the results obtained we conclude that the incidence of uncomplicated peptic ulcer disease, especially for duodenal ulcers, declines in our Western population. This will soon bring us back to a situation where gastric ulcers are more common than duodenal ulcers. The incidence of complicated ulcer disease is however rising, which underlines the need to be more alert in providing patients using NSAID's with adequate gastroprotection to prevent ulcer disease and its complications.

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CHAPTER 8

Trends in the diagnostic yield of open access upper gastrointestinal endoscopy

SUBMITTED

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Abstract

PURPOSE We intended to compare the diagnostic yield of upper endoscopy procedures in patients referred by general practitioners, specialists and clinical referrals, in order to establish the effectiveness of open access endoscopy over time.

METHODS Cumulative 10-year data of an open access endoscopy unit were analyzed. Data of all patients referred for their first diagnostic upper endoscopy were analyzed, comparing diagnostic yield between different referring groups and trends over time.

RESULTS In 21,441 examinations eligible for analysis, 42% patients were referred by general practitioners, 38% by specialists and 20% were clinical referrals. The proportion of first line referrals increased from 35 to 45% ($p<0.001$). Pathology was found in 74% of the endoscopies, without a difference in diagnostic yield between referral groups. The proportion of positive endoscopies increased over the investigated period.

CONCLUSIONS The high yield of diagnostic upper endoscopies in all referral groups warrants open access upper gastrointestinal endoscopy.

Introduction

Open access endoscopy is defined as the performance of endoscopic procedures requested by referring physicians without prior clinical consultation of the endoscopist.[1] This form of referral for endoscopy is extensively available in both the United States and Europe.[2] Open access endoscopy is commonly offered for esophago-gastro-duodenoscopy (EGD), flexible sigmoidoscopy, and in some centers for colonoscopy.

Open access upper gastro-intestinal endoscopy has had a major impact on the workload for endoscopy units in the last two decennia.[3] A rise in number of endoscopies of 25% was seen from 1999 to 2004 in the Netherlands, leading to a total of 1137 upper endoscopies per 100.000 persons per year with a mean waiting time of 3.1 weeks between request and procedure.[4] The rise in upper endoscopies led to discussion about possible overuse of diagnostic endoscopy capacity. Several studies published between 1997 and 2001 have shown that endoscopies indicated by gastroenterologists had higher diagnostic yields than those requested by non-gastroenterologists.[5-8] There are however only limited data on the findings of endoscopic procedures in patients referred by general practitioners in an open access endoscopy system.[1] Furthermore, little is known about trends in diagnostic yield of open access upper gastrointestinal endoscopy over time in different referral groups that might have been caused by the decreasing prevalence of *Helicobacter pylori* over the last decades, the widespread use of proton pump inhibitors since their introduction in the late 1980's and introduction of guidelines for gastroprotection in NSAID users since the late 1990's. If these measures should have led to a decrease in the yield of open access endoscopy, it can be questioned whether open access procedures are justified in view of scarcity of endoscopic capacity. We therefore studied the diagnostic yield of upper gastrointestinal endoscopy in an open access endoscopy unit in three different referring groups. Findings in patients referred by general practitioners (first line) were compared with patients referred by specialists (second line) and patients referred during hospital admission (clinical patients). The trends in incidence of diagnoses in a ten-year period were assessed, with special emphasis on reflux esophagitis as a common disorder in all age and referral groups.

Methods

The Ikazia hospital in Rotterdam, the Netherlands, offers an open access endoscopy service, including esophagogastroduodenoscopy (EGD), to both general practitioners and hospital medical staff serving a population of approximately 150.000 persons. Data from all consecutive upper gastrointestinal endoscopies performed

in our centre from July 1996 until July 2006 was included in the study. Endoscopic examinations performed in this clinic are recorded in a computerized endoscopy report system, Endobase III®, developed by Olympus Software, since June 1996, after a 12-month development period. By linking the Endobase system and the hospital information system (HIS), patient characteristics are imported from the HIS and the report and digital endoscopic images are sent to the HIS.

Four experienced endoscopists performed the endoscopies and used the program with the standardized reports and text blocks for description of the endoscopic findings.[9] All methods of report writing are automatically coded with a specific gastrointestinal endoscopic terminology code (GET-C), developed as an extension of the International Classification of Diseases 10th version (ICD-10).[10] In this way all endoscopic data were collected in a similar way and stored within the database.

We compared the diagnostic yield of the endoscopies referred by general practitioners versus those referred by medical staff from the outpatient clinic and patients from within the hospital. Only patients who underwent the examination for the first time were included. All follow-up and surveillance endoscopies for specific conditions such as Barrett's esophagus, celiac disease and ulcer disease were left out of the analysis.

Demographics and details of the diagnoses were recorded. If the diagnosis reflux esophagitis was made, a classification was made; before 2000 esophagitis was classified according to the Savary-Miller classification (grades I-IV)[11] and from 2000 onwards according to the LA-classification (grades A-D).[12] Before 2000 reflux esophagitis was re-classified. For comparison, the Savary-Miller scores were recoded in LA classification grades. Although these classifications cannot be compared completely, we chose to recode the Savary-Miller scores I to IV consecutively into LA grades A to D.

The data were exported from Endobase to be evaluated statistically in Statistical Package for the Social Sciences (SPSS), version 14.0 (SPPS, Chicago, IL). Regression of incidence of diagnosis over the years was plotted in percentage per year. Data are described by means and 95% confidence intervals (95% CI). Two-sided p values < 0.05 were considered to be statistically significant. Linear regression analysis were used to compare groups and linear relations.

All findings were classified into the following specific groups: normal, esophagitis, hiatal hernia, gastritis, duodenitis, gastric ulcers, duodenal ulcers, esophageal neoplasm, gastric neoplasm, duodenal neoplasm, varices, therapeutic interventions, and 'miscellaneous'.

Diagnoses with clinical consequences (including cancer, esophagitis, hiatus hernia of great dimension, varices, ulcers, erosive gastritis and/or duodenitis,

esophagitis and Barrett's esophagus) were considered to be 'major pathology', other positive endoscopic diagnoses (mild gastritis or duodenitis, small hiatal hernia) were considered as 'minor pathology'.

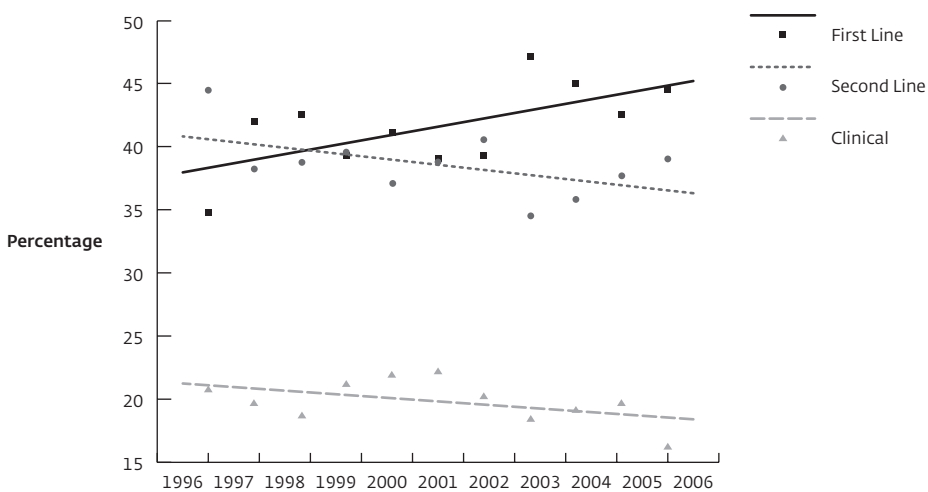
In the ten year study period time-trends for different diagnoses were investigated.

Results

A total of 22,268 esophago-gastro-duodenoscopies (EGD) were performed by 4 endoscopists from July 1996 until July 2006. In total 827 endoscopies were excluded from the analysis because they were follow-up endoscopies for Barrett's esophagus (575), celiac disease (13), ulcer disease (129) or malignancy (110). Thus, the data of 21,441 examinations were eligible for analysis.

Of all patients, 42% were referred by a general practitioner, 38% by a specialist, and 20% were patients referred while being admitted to the hospital [**Table 1**]. Over the years, the proportion of patients referred by general practitioners increased from 35 to 45% with a linear regression coefficient of .615 (p=0.036); the proportion of referrals by specialists and the proportion of referrals at hospital admission declined significantly [**Figure 1**].

Figure 1 *Regression of proportion of referrals to open-access endoscopy unit in time.*



Trends in distribution of patients referred by First Line (general practitioner), Second Line (specialist) and Clinical patients.

Of all patients referred for EGD a small majority (54%) was female, which was more pronounced in the specialist referrals [**Table 1**]

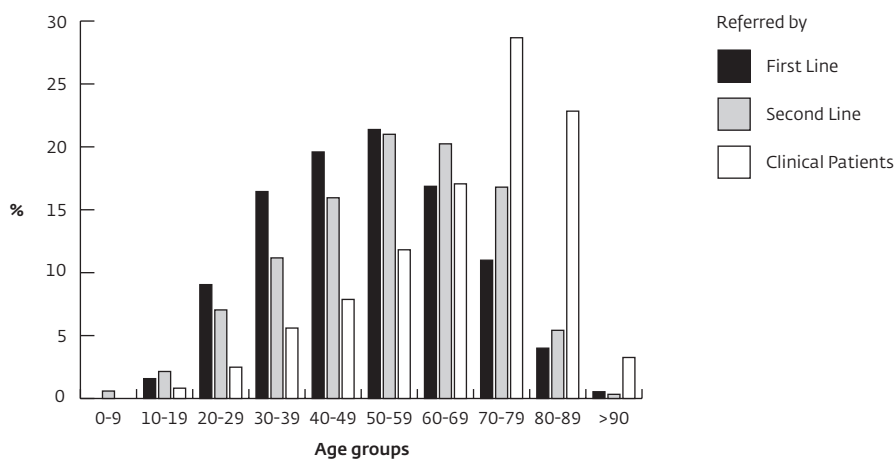
Table 1 *Patient characteristics in different referral groups*

		First line referrals	Second line referrals	Clinical referrals	Total
		Number (%)	Number (%)	Number (%)	Number (%)
Number of endoscopies		8971 (41.8)	8197 (38.2)	4273 (19.9)	21441
Gender	Male	4297 (47.9)	3492 (42.6)	2018 (47.2)	9807 (45.8)
	Female	4674 (52.1)	4705 (57.4)	2255 (52.8)	11634 (54.2)
Mean age		51.2 Range (14-96)	54.7 Range (0-96)	67.1 Range (8-104)	55.7 Range (0-104)

The mean age of all patients was 55.7 years. Patients referred by general practitioners were significantly younger with a mean age of 51.2 (95% CI 50.9 – 51.6) years compared with 54.7 (95% CI 54.3 – 55.1) years for specialist referrals and 67.1 (95% CI 66.6 – 67.6) years for admitted patients ($p<0.05$ for first and second line versus clinical patients) [**Figure 2**].

This age difference was related with different diagnosis distributions between referral groups.

Figure 2 *Age distribution in patients referred by general practitioners, by specialists and at hospital admission.*



Pathology was found in 15,820 patients (74%). The referral groups differed slightly but significantly with respect to the prevalence of pathology, with the highest diagnostic yield (75%) in the first line referrals, 73% in the specialist referrals, and 74% in the admitted patients ($p = 0.001$). Females were more likely to have a normal endoscopy (30%) than male patients (22%) ($p < 0.005$). The diagnostic yield of endoscopy increased in the last ten years from 59% to 79% ($p < 0.0001$) for the comparison of first versus last year).

The first line and second line referrals both showed an increase over time in positive endoscopies both with major and minor pathology. Endoscopies performed in hospital-admitted patients showed an increase in pathology with clinical consequences, but a stable prevalence of minor pathology [**Figure 3**].

Table 2 shows the most frequent endoscopic findings for the different referral groups and the total population. In 4943 (23%) of the endoscopies, patients had more than one diagnosis during their first endoscopy procedure, with two diagnoses in 4037 patients (19%), three diagnoses in 811 patients (4%), and four diagnoses in 95 patients (0.4%).

Figure 3 *Trends of upper gastrointestinal endoscopy diagnoses (negative, positive with major pathology or positive with minor pathology) over a ten years period in patients referred by general practitioners, by specialists and at hospital admission.*

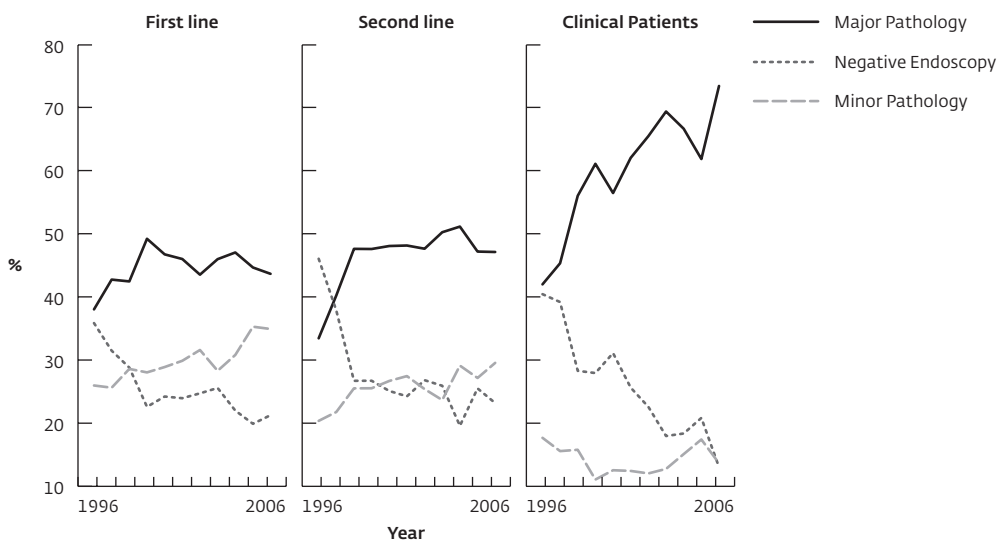


Table 2 *Incidence of diagnoses in different referring groups*

Diagnosis	First Line (8971)		Second Line (8197)		Clinical Patients (4273)		Total (21441)	
	n	%	n	%	n	%	n	%
Normal	2250	25.1	2257	27.5	1114	26.1	5621	26.2
Hiatal Hernia	2507	27.9	2009	24.5	644	15.1	5160	24.1
Esophagitis	1867	20.8	1171	14.3	444	10.4	3482	16.2
Gastritis	2236	24.9	1751	21.4	646	15.1	4633	21.6
Duodenitis	900	10.0	573	7.0	340	8.0	1813	8.5
Gastric Ulcer	169	1.9	148	1.8	240	5.6	557	2.6
Duodenal Ulcer	319	3.6	148	1.8	286	6.7	753	3.5
Barrett's esophagus	380	4.2	328	4.0	116	2.7	824	3.8
Neoplasm Esophagus	69	0.8	39	0.5	48	1.1	156	0.7
Neoplasm Stomach	60	0.7	49	0.6	96	2.2	205	1.0
Neoplasm Duodenum	2	0.0	11	0.1	13	0.3	26	0.1
Varices	16	0.2	76	0.9	99	2.3	191	0.9
Therapeutic interventions	153	1.7	760	9.3	525	12.3	1438	6.7
Miscellaneous	961	10.7	1070	13.1	685	16.0	2716	12.7

Reflux esophagitis was seen in 16% of all patients, 55% of these were grade A, 24% grade B, 12% grade C, 5% grade D and 4% grade D with complications. Reflux esophagitis was more frequently seen in first line-referred patients than second line and clinical patients and no clear trend was observed over time [**Figure 4**].

Reflux esophagitis was diagnosed more frequently in men, this predominance was more pronounced for grades A and B than for grades C and D esophagitis [**Figure 5**].

Milder types of reflux esophagitis were most prevalent in age groups of 30-59 years.

Newly diagnosed Barrett's esophagus was seen in 4% of the patients, rising with age [**Figure 6**]. There were no significant differences between the referring groups with respect to the prevalence of Barrett's esophagus.

Upper gastrointestinal malignancies were found in 387 patients (2%), 205 patients were diagnosed with adenocarcinoma of the stomach and 156 patients were diagnosed with esophageal cancer [**Table 2**]. The proportion of patients who were

Figure 4 *Incidence of reflux disease in different referring groups during a ten years period.*

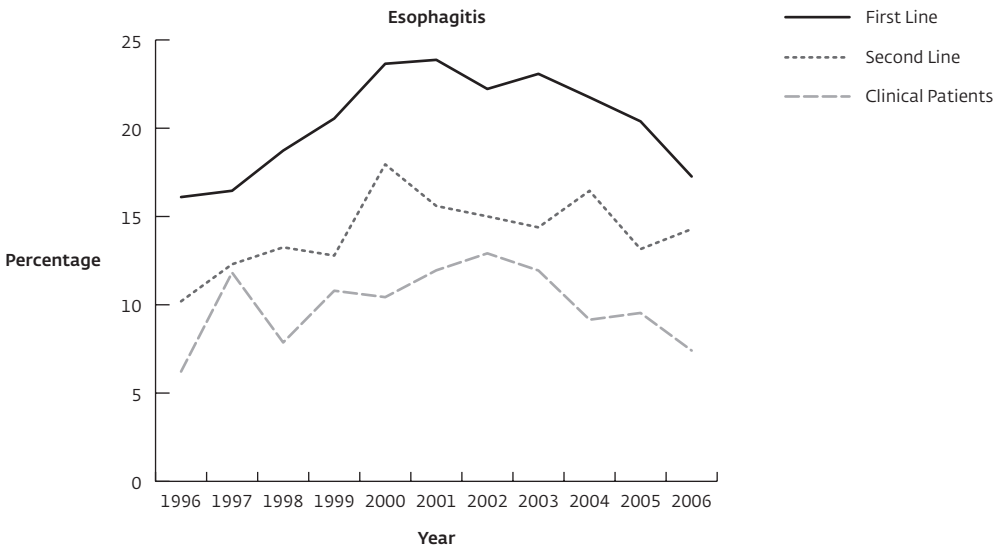


Figure 5 *Trends in incidence of reflux esophagitis with LA classification for males and females.*

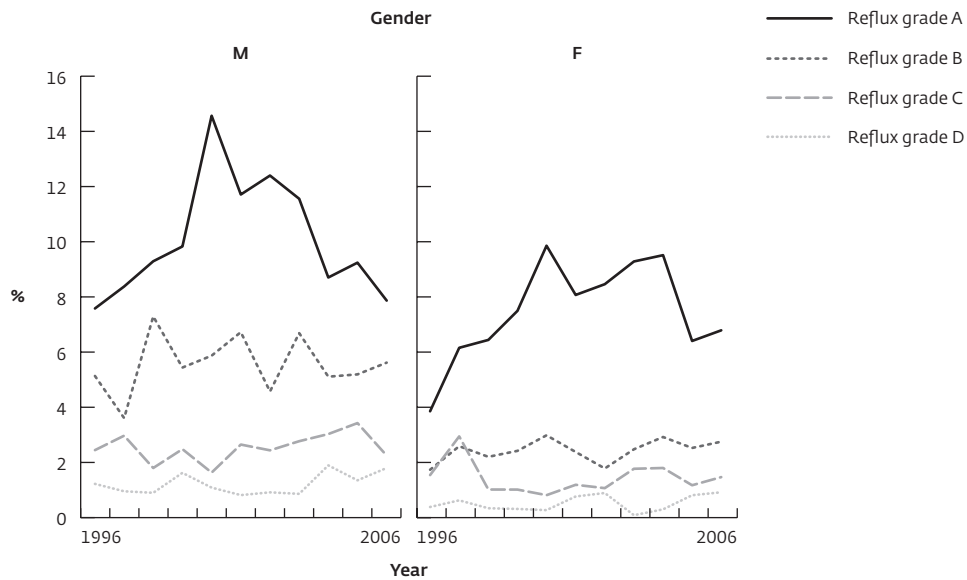


Figure 6 *Incidence of reflux esophagitis with LA classification and new diagnosed Barrett's esophagus for different age groups.*

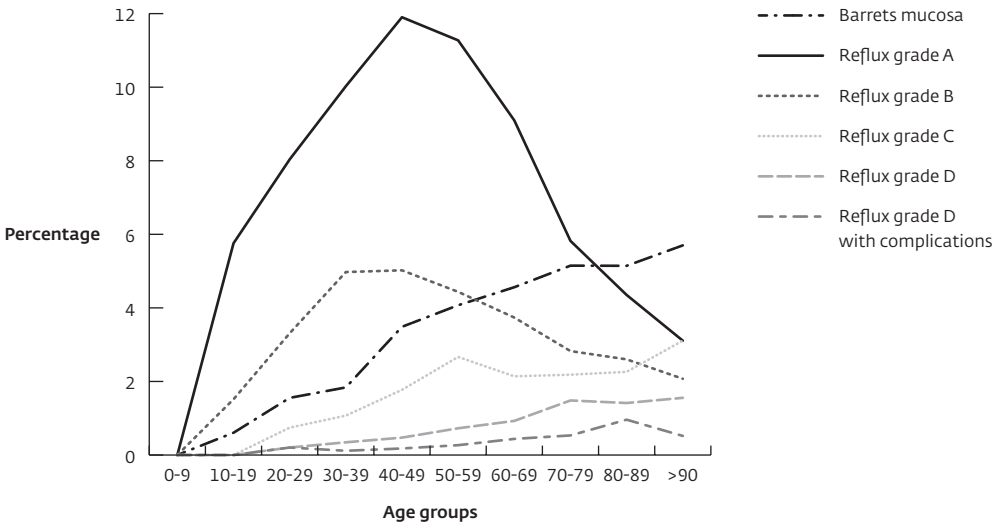
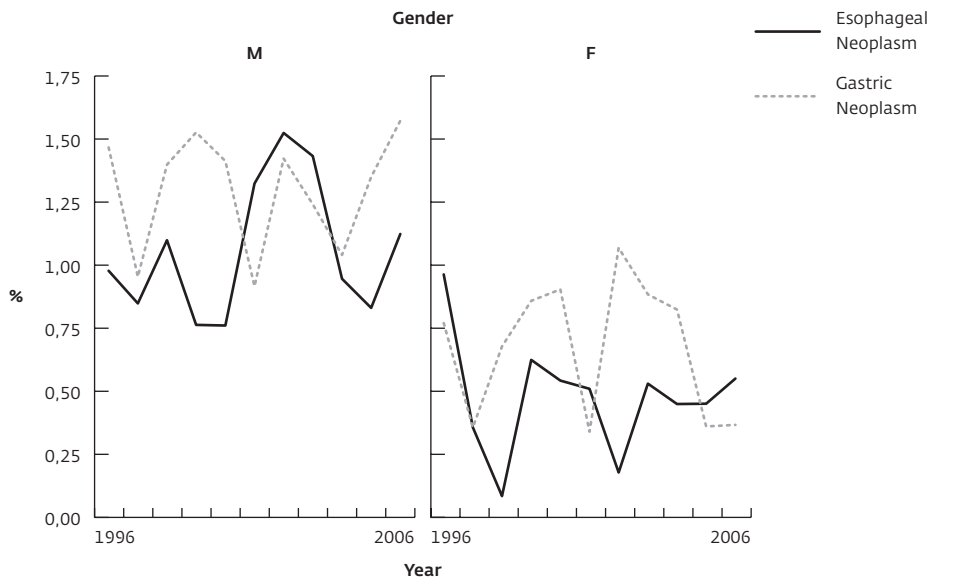


Figure 7 *Trends in incidence of esophageal and gastric neoplasms for males and females.*



diagnosed with cancer was the highest in the hospital group, accounting for 4% of all the endoscopies performed in this group, but proportions in patients referred by the first line and the second line were not different (1.2 and 1.5%). Cancer of the esophagus and stomach were more frequently diagnosed in men than in women, without a significant change over time [**Figure 7**].

In 2716 patients (13%) miscellaneous conditions were diagnosed, either as main or as additional diagnosis, including angiodysplasia, achalasia, conditions related to previous surgery, diverticula, Mallory-Weiss lesions, other causes of esophagitis, stenosis, Schatzki rings and webs in the esophagus.

Therapeutic interventions were performed in 1438 patients (7%), including dilatations of peptic stenosis and anastomotic strictures after surgery, balloon dilatation for achalasia, as well as haemostasis in bleeding ulcers, treatment of bleeding and non-bleeding varices, placement of endoprostheses in the esophagus, placement of gastrostomy catheters and placement of feeding tubes in the duodenum and jejunum.

Discussion

Open access endoscopy has led to increasing numbers of upper gastrointestinal endoscopy procedures and longer waiting times, with the proportion of upper endoscopies referred by general practitioners increasing by about 10% to 45% of all referrals in the investigated hospital.

It has been suggested that open access endoscopy might shorten the time to endoscopy, and thus enable diagnosis of upper gastrointestinal malignancies in an earlier state with a better survival.[13] This was however not confirmed in other studies, and the usefulness of first line referral was doubted. Open access endoscopy did even lead to longer waiting times for all referred groups.[3, 14]

In the investigated endoscopy practice patients could be referred by general practitioners from 1988 onwards. From 1996 onwards data were collected in an Endobase system, which allowed comparison between groups and over time. By doing so, we found that the proportion of referrals by general practitioners increased and the proportion of clinical patients and referrals by specialists declined in the last ten years.

With an increase of first line referred patients a reduction in diagnostic yield of overall performed endoscopies was hypothesized. Overall the diagnostic yield of upper endoscopy was high with only 26% of the investigations without any abnormalities. This yield of upper endoscopy is higher than in other studies.[6-8, 15-16] In the past the diagnostic yield was described to be higher in specialist referred patients.[8]

Our results show a remarkable rise of diagnostic yield in all referral groups, suggesting that the selection for this procedure has improved. In both first and second line referrals the positive endoscopies with clinical consequences accounted for about 45-50% of all endoscopies. Besides, endoscopies with minor pathology and even normal endoscopies can influence the subsequent management of patient, avoiding unnecessary therapies.[17-18] Malignancies were seen more frequently in clinical patients than in other referred patients. As malignancies were seen more frequently in the older population, this might explain the stronger association between clinical referrals and cancer. Another explanation is that complications of malignancies like bleeding and obstruction are reasons for endoscopy at hospital admission.

The male-female ratio of patients is comparable to that in other studies. No clear explanation was found for the surprising higher proportion of female patients in the group referred by specialists. The age of patients was different between the three referring groups with hospital patients being almost 15 years older than patients referred by general practitioners. This has a major impact on the distribution of diagnoses between the three referral groups.

In this article we concentrate on reflux esophagitis. Reflux esophagitis is common and was diagnosed in a great proportion of the patients (16%). Although women and men are reported to have generally similar patterns of endoscopic severity in gastroesophageal reflux diseases,[19] we found reflux disease to be more frequent and more serious in men than in women. The highest incidence of reflux esophagitis was seen in the patients referred by general practitioners. This could be explained by the fact that patients referred by the general practitioner probably used less acid suppressive medication or for a shorter period than patients referred by a specialist or from out of the hospital. The highest incidence of reflux esophagitis was seen in the patients referred by general practitioners. Reflux esophagitis is a condition that can be treated by the general practitioner himself, after endoscopic confirmation of the diagnosis. If a general practitioner should suspect another diagnosis, the patient would rather be referred to the specialist and not for first line endoscopy. In the investigated ten years period, the incidence of reflux disease increased in all referring groups and for all grades of severity.

Grade A reflux esophagitis was diagnosed most frequently, accounting for about 55% of all the newly diagnosed reflux esophagitis patients. The incidence of esophagitis declined from 2004 onwards, especially in the first line referrals [**Figure 4**]. This was seen especially in the mildest grades of reflux (A and B) [**Figure 5**]. After an initial rise in reflux esophagitis, the number stabilized and even declined. this might have to do with a discussion, ending in changed Dutch Guidelines for general practitioners on the diagnosis and treatment of upper GI symptoms in 2004,[20]

implying a proton pump inhibitor (PPI) test treatment with for 2-4 weeks is recommended in suspected gastroesophageal reflux disease without alarm symptoms. If reflux symptoms persist or diagnostic certainty is desired, endoscopy is recommended. Due to this guideline a higher proportion of referred patients will use PPIs before their first endoscopy. PPI showed in a meta-analysis a healing rate of 11.7% per week.[21] This may explain the declining incidence of endoscopically proven esophagitis in the last 3 years. In this short period of 2 to 4 weeks particularly mild esophagitis will be reduced. Adherence to gastroprotective agents in NSAID's users increased from 11.3% in 1996 to 44.6% in 2005 in a study performed in the same area as this population, probably leading to a decrease in esophagitis.[22]

The peak incidence of the mildest reflux esophagitis grades (A and B) around 30-59 years and the raising incidence of grade C and D with rising years of age are in correspondence with other studies.[23]

Newly diagnosed cases of Barrett's esophagus were seen in 4% of all patients. The incidence of Barrett's esophagus increased gradually with growing age [**Figure 6**]. This can be explained by the fact that development of Barrett's esophagus is the result of longstanding reflux of gastric content into the esophagus.[24]

Our data show that the use of a standardized report system with an extended coding system is suitable for analyzing trends in endoscopic data. The diagnostic yield is high in all investigated referring groups. Despite discussion in the past about incorrect referral and the rise of proportion of referrals by general practitioners for upper gastrointestinal endoscopy it seems that the yield of first line diagnostic upper endoscopy is comparable with specialist referrals. We conclude that the claim of the first line on the scarcity of endoscopic capacity is still justified and that this service of open access endoscopy should be continued.

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CHAPTER 9

Summary and discussion

Samenvatting en discussie

Summary and Discussion

Gastrointestinal endoscopic investigations with flexible endoscopes started in the 1960. Since that time endoscopic investigations changed from an innovative technique to visualize the gastrointestinal tract to a routine investigation for patients with complaints of the gastrointestinal tract. Besides diagnostic investigations endoscopy is progressively used for therapeutic interventions and screening, especially colorectal carcinoma screening.

A report has to be made from the investigation to inform the referring doctor about the findings, therapy and advice. Besides this it is important to know in forthcoming endoscopy the findings en therapy of former investigations. Reporting is therefore an essential part of the endoscopic investigation. As an imaging method with numerous repetitive manoeuvres as well as findings, gastrointestinal endoscopy reports are particularly suitable for electronic storage and processing.

Standardization and coding of endoscopic reports makes it suitable for research, and quality measurements. Quality indicators that are in development will contain aspects of endoscopic reporting or items that can be retracted from the database that is build by the report system.

To be able to retract data from the database of the report system it is important to have standardized reporting and database building. Fur this purpose a working group was formed, called TRANS.IT, with 3 university and seven district hospitals. The aim of this working group was to create uniformity and consensus on gastrointestinal endoscopic reporting. The second purpose of this working group was to establish a coding system for gastrointestinal endoscopic findings and terminology to be able to analyze data anonymously. To create a report system that is suitable for every endoscopists we generated three different ways of report writing. These different ways can be chosen independently after each examination.

Firstly standard reports were created, consisting of a complete report, describing the results of the whole investigation based on one or a combination of diagnoses. Secondly, we constructed text blocks, by which a report is built up selecting different text-blocks for separated parts or different diagnoses. With the combination of these text-blocks a complete report is generated. Thirdly, the newest way to compose a report is using structured data entry. In this way a sentence and subsequently a report is built up selecting different aspects of a finding in a specific part.

In all these different ways allowed for reporting of endoscopic findings according to international classifications. The medical context of the reporting was discussed in the TRANS.IT working group and consensus was obtained. The three different ways of report writing are coded in the same way en stored in the database.

In this way forthcoming new quality measurements can commonly be retracted from the system.

In **Chapter 2** the first two ways of report writing are described and discussed. Standard reports are mainly used to report examinations without abnormalities and examinations with frequently seen abnormalities. In cases of more rare findings or a combination of diagnoses the use of text blocks is more suitable. With these two ways of report writing, 90 % of the reports can be composed within a short period of time. For the remaining part structured data entry is advised. This way of report writing describes the findings very punctual, but is more complex and takes more time.

The implementation of new techniques is often criticized. Change from handwritten to standardized computerized reporting is generally thought to require more time for report composing. Physicians often insist to keep their usual way of working, especially when a new way of working not directly results in obvious gain of time or quality aspects. We therefore studied in **Chapter 3** time aspects of three different ways of report writing. Computerized reports were compared to dictated reports and handwritten reports. The time needed to compose the report and send it to the referring physician was in computerized reports 86 seconds, compared to handwritten reports 113 seconds and dictated reports 65 seconds with additional time for the typist of 172 seconds. This showed that standardized computerized reporting consumed similar time than the other methods. The main advantage of computerized reporting is the possibility to capture and store endoscopic images and the structured way of storing the data of the endoscopy performed for forthcoming research, quality indicators or management information.

Starting with computerized systems demands an investments in hardware, and software including construction of necessary links between the system and the hospital information system. One of these links is a connection between the report system and the financial department. Computerized systems are known to record investigations more accurate, leading to billing benefits. Besides direct financial benefits computerized system also showed to improve quality aspects. In **Chapter 4** a study on costs for the above mentioned three different ways of report writing (computerized, dictated and handwritten) was performed. Computerized reporting was shown to be the most expensive way of reporting because of high initial costs. After five years, at the moment that the initial investments are depreciated, the costs per report were comparable with those of the two other ways of report writing. In a cost-benefit analysis already after three years the computerized system show a positive financial benefit.

In the computerized system, besides standard reports and text blocks also structured data entry is allowed. For every examination the endoscopist is free to choose one of the three ways of report writing. To be able to compare the results of the

investigations, the reports need to be coded in a similar way. For this reason a coding system had to be developed. It was chosen to extend a widely used coding system, the International Classification of Diseases, 10th version, of the World Health Organization (WHO). In **Chapter 5** this extension is described. The WHO defined rules to extend the ICD-10. In this way adaptations are possible to be coded and in the same time the generated code is retraceable to its original ICD-10 code. With the extension made in this Gastrointestinal Endoscopic Terminology Code (GET-C) for gastrointestinal endoscopic findings and terms it is possible to generate codes for all items that are recorded during endoscopy. With new developed techniques and diagnosis, this GET-C is consecutive adapted to correctly code new endoscopic terms. These data can anonymously be exported to another database to compare data between different endoscopy units and countries.

The automatically recorded codes are stored in the database of each hospital. Within the TRANS.IT project research is being performed on the anonymous data. Therefore a central database was created with the anonymous data of all investigations in the participating hospitals. Within the project it was agreed to use standard reports and text blocks although the report maker could use free text or adjust the report. Obviously, this could potentially influence the correctness of the automated terminology coding. In **Chapter 6** a multicentre study is described to assess to what extent automatically generated GET-C codes are in agreement with the actual text of the endoscopy report. A total of 500 colonoscopy reports were selected randomly on a total of 2500 examinations from 5 different hospitals and evaluated on indication, endoscopy findings, therapeutic interventions. Indications were correctly coded in 92% of the reports. Correct coding of endoscopic findings varied between 42 and 93% per hospital. This great variation was explained by incorrect use of the reporting system, in particular the selection of a standard report and consecutive adding or deleting diagnosis by free text, resulting in a incorrect code. The incorrectness of the coding was also scored for clinical relevance, resulting in 89% of all the investigations to be clinically correctly coded. These result warrant further improvement in requirements for composing reports and training of endoscopists for using the system to enhance the correctness of the database. We intend to induce better recording of endoscopy data by showing each hospital and individual endoscopists their data, compared to the anonymous results of other hospitals. The result of this benchmarking has be evaluated in the future by a new study on the correctness of coding in the TRANS.IT group.

In the Ikazia Hospital, Rotterdam, the computerized system was used from 1996 onwards. It was possible to study the endoscopic data over a ten year period. Trends in different diagnoses were analyzed. In **Chapter 7**, we studied the incidence of gastric and duodenal ulcer disease over time. In a 10 year period a total of 20,006 endoscopies were performed in previously uninvestigated dyspeptic patients. Gas-

tric ulcers were diagnosed in 2.4% of the cases. Duodenal ulcers were diagnosed in 3.5 % of the patients and this incidence declined in this 10 year period. A further decline of duodenal ulcer incidence with a stable incidence of gastric ulcer disease will soon lead to a situation similar to 100 years ago in which gastric ulcer is more common than duodenal ulcer disease in the Netherlands. The overall decline of ulcer disease is attributed to be due to several factors, including widespread use of acid-suppressive medication, a decreasing prevalence of *H. pylori* and eradication of this bacterium in new ulcer patients, thus preventing recurrence.

In **Chapter 8** different referring groups and their yield of upper gastrointestinal endoscopy were compared over time. In an open access endoscopy unit patients were referred by general practitioners, specialist and clinical referrals. In total 21,441 first diagnostic upper endoscopies were eligible for analysis. The proportion of patients referred by their general practitioner raised from 35 to 45% in 10 years. Abnormalities were found in the majority (74%) of the investigation without differences in diagnostic yield between the referral groups. The percentage of patients with abnormalities increased over the period.

Gastro-esophageal reflux diseases was the most common diagnosis, observed in 16% of the patients. Men were affected more often and had more severe grades of esophagitis than women. The highest prevalence of reflux disease was seen in patients referred by general practitioners. This may be explained by the fact that these patients used less acid suppressive medication or for a shorter period than patients referred by a hospital physician. After an initial rise in reflux esophagitis, the number stabilized and even declined. In 2004 a new guideline for general practitioners was published on the diagnosis and treatment of upper gastrointestinal symptoms. This guideline recommended use of proton pump inhibitor (PPI) for 2-4 weeks as initial approach to patients with new onset dyspepsia. If reflux symptoms persist, endoscopy is recommended. This can be the explanation of a decline in incidence of reflux diseases in the last years of this study.

In the past there has been discussion about incorrect referral and the rise in referrals by general practitioners. Our data show a high diagnostic yield in all referral groups, justifying open access endoscopy in our setting.

Conclusions

In this thesis different studies are described on standardization and coding of gastrointestinal endoscopy reports. Good report writing of endoscopic investigations is of major importance for the treatment, screening and follow-up of patients. With standardization, reports will fulfill all recommended items for complete endoscopy reports.

New computerized medical systems request a great initial financial investment for the program as well as for the connection with other hospital systems. Besides these financial investments, efforts has to be made by users of the system. Therefore the report system has to be quick, easy to learn, and suitable for use in busy daily practice. Studies in this thesis showed comparable costs and even financial benefits after initial investments and also a quick system compared to other ways of report writing.

Because of automatically coding of recorded findings the developed system creates a extensive database suitable for research. The created GET-C coding system facilitates in anonymously recording of these data. At the same time items appropriate for quality indicators can be or are already stored in the system. The system has showed to be capable to investigate diagnostic yield and trends of endoscopic examinations described in this thesis.

In the future these systems become essential for monitoring of quality, quality improvement, and management of endoscopy units.

Samenvatting en discussie

In 1960 werd gestart met gastrointestinale endoscopische onderzoeken met flexibele endoscopen. Sinds die tijd zijn endoscopische onderzoeken veranderd van een techniek om het maag-darmkanaal in beeld te brengen, in een routine onderzoek bij patiënten met maag- en darmklachten. Naast diagnostische onderzoeken wordt endoscopie in toenemende mate gebruikt voor therapeutische ingrepen en screening, van voornamelijk dikke darmkanker.

Van het endoscopisch onderzoek moet een verslag worden gemaakt om de verwijzende arts te informeren over de bevindingen, de verrichte therapie en het advies. Daarnaast is het belangrijk om de bevindingen en therapie van eerdere onderzoeken in de toekomst opnieuw te kunnen inzien. Rapportage is daarmee een essentieel onderdeel van het endoscopisch onderzoek. Als beeldvormend onderzoek met vaak voorkomende bevindingen en verrichtingen zijn gastrointestinale endoscopie verslagen bijzonder geschikt voor elektronische vastlegging en verwerking.

Standaardisatie en codering van endoscopische verslagen maakt het geschikt voor onderzoek en tevens voor kwaliteitsmetingen. Kwaliteitsindicatoren die in ontwikkeling zijn zullen aspecten bevatten van endoscopische verslaglegging. Daarnaast kunnen sommige indicatoren worden verkregen uit de database die wordt opgebouwd door het verslagleggingsysteem.

Om gegevens op de juiste manier te kunnen achterhalen uit de database van het verslagleggingsysteem is het van belang om een gestructureerde verslaglegging en opbouw van deze database te hebben. Hiervoor werd een werkgroep gevormd, TRANS.IT genaamd, met 3 universitaire ziekenhuizen en zeven perifere ziekenhuizen. Het doel van deze werkgroep is het creëren van uniformiteit en consensus voor gastrointestinale endoscopische verslaglegging. Het tweede doel van deze werkgroep is om een codering systeem te ontwikkelen voor gastrointestinale endoscopische bevindingen en terminologie zodat gegevens anoniem opgeslagen en geanalyseerd kunnen worden. Om een systeem te ontwikkelen dat voor elke endoscopist makkelijk te gebruiken is, zijn er drie verschillende vormen van verslaglegging gecreëerd binnen het gebruikte programma. Deze verschillende vormen van verslaglegging kunnen onafhankelijk van elkaar, door de endoscopist bepaald, gekozen worden na afloop van het onderzoek.

Ten eerste zijn standaard verslagen gecreëerd, bestaande uit een volledig verslag, waarin de resultaten van het hele onderzoek op basis van een of een combinatie van diagnosen is samengesteld. Daarnaast de mogelijkheid om een verslag te maken met tekstblokken. Hiermee wordt een verslag opgebouwd door het selecteren van verschillende tekstblokken corresponderend met verschillende diagnosen en verschillende anatomische delen van het onderzoek. Ten derde, de laatst ont-

wikkelde manier om een verslag samen te stellen, met behulp van gestructureerde data invoer. Op deze manier wordt een zin uit het verslag opgebouwd door het selecteren van een specifieke endoscopische bevinding, waarvan vervolgens verschillende items dienen te worden geselecteerd.

Bij al deze verschillende vormen van verslaglegging, worden de bevindingen beschreven volgens internationaal geaccepteerde classificaties van gastrointestinale endoscopische afwijkingen. De medische inhoud van deze verslagen wordt besproken binnen de TRANS.IT werkgroep en hierover wordt consensus verkregen. De drie verschillende vormen van verslaglegging worden op dezelfde manier gecodeerd en in de database vastgelegd. Op deze manier is het mogelijk om alle onderzoeken te vergelijken, kwaliteitsindicatoren te kunnen meten en eventueel toekomstige kwaliteitsmetingen uit het systeem te halen.

In **hoofdstuk 2** worden de eerste twee manieren van verslaglegging beschreven en besproken. Standaardverslagen worden voornamelijk gebruikt om onderzoeken zonder afwijkingen of onderzoeken met veel voorkomende afwijkingen te beschrijven. In het geval dat er zeldzamere afwijkingen of een combinatie van meerdere diagnosen worden gevonden, is het gebruik van tekstblokken beter geschikt. Met deze twee vormen van verslaglegging kan 90 % van de verslagen in een korte periode worden samengesteld. Voor de overblijvende onderzoeken wordt gestructureerde invoer geadviseerd, die veel nauwkeuriger kan worden samengesteld, maar daardoor ook meer keuzes vraagt en meer tijd kost.

De implementatie van nieuwe technieken krijgt vaak kritiek op de werkvloer. Bij het veranderen van verslaglegging van handgeschreven of gedicteerde verslagen naar gestandaardiseerde verslagen met behulp van een computer, is een vaak gehoorde klacht, angst voor de toenemende tijdsinspanning van de endoscopist. Artsen willen hierbij graag hun gebruikelijke manier van werken behouden. Vooral wanneer de nieuwe manier van werken niet direct resulteert in een concrete winst van tijd of kwaliteitsaspecten. We hebben daarom in **hoofdstuk 3** de tijdsaspecten van drie verschillende manieren van verslaglegging onderzocht en beschreven. Gecomputeriseerde verslagen werden vergeleken met gedicteerde en handgeschreven verslagen. De tijd die nodig is om het rapport samen te stellen en te versturen naar de verwijzende arts was in gecomputeriseerde rapporten 86 seconden, in vergelijking met handgeschreven rapporten 113 seconden en gedicteerde verslagen 172 seconden, waarvan 65 seconden tijd voor de typiste nodig was om een verslag te maken en te versturen. Dit maakt het samenstellen van het verslag met een gestandaardiseerd computer verslagleggingsystemen vergelijkbaar met andere vormen van verslaglegging. Het belangrijkste voordeel van gecomputeriseerde verslaglegging is de mogelijkheid om het verslag op ieder gewenst moment te kunnen inzien en de mogelijkheid om endoscopische beelden op te slaan en terug in te zien.

Daarnaast levert het gestructureerd opslaan van de gegevens van de endoscopie onderzoeken mogelijkheden voor wetenschappelijk onderzoek, kwaliteitscontrole en management informatie.

Het starten met gecomputeriseerde verslagsystemen vraagt een grote financiële investering voor hardware, software en verschillende koppelingen tussen het verslagsysteem en het ziekenhuis informatie systeem. Gecomputeriseerde systemen bewijzen wel onderzoeken nauwkeuriger te registreren, waardoor er factureringsvoordelen optreden en andere kwaliteitsaspecten verbeteren. In **hoofdstuk 4** wordt een studie beschreven over de kosten van de hierboven genoemde drie verschillende manieren van de verslaglegging (gecomputeriseerde, gedicteerde en handgeschreven verslaglegging). Een kosten-batenanalyse werd uitgevoerd tussen gedicteerde en gecomputeriseerde verslaglegging. Gecomputeriseerde verslaglegging blijkt de duurste manier van rapporteren te zijn vanwege de hoge investeringskosten. Na vijf jaar, als een groot deel van de investeringskosten zijn afgeschreven zijn de kosten per verslag vergelijkbaar met de twee andere manieren van verslaglegging. In een kosten baten analyse wordt al na drie jaar van het gecomputeriseerde systeem een positief financieel voordeel gezien.

In het gecomputeriseerde systeem, is naast standaard verslagen en tekstblokken, ook gestructureerde data invoer mogelijk. Na ieder endoscopisch onderzoek is de endoscopist vrij om een van de drie manieren van de verslaglegging te kiezen. Om de op verschillende manier vastgelegde resultaten te kunnen vergelijken, moeten de verslagen gecodeerd worden op een identieke manier. Hiervoor is een coderingssysteem ontwikkeld. Er werd gekozen om een veel gebruikt coderingsysteem, de International Classification of Diseases, 10e versie, van de World Health Organization (WHO) uit te breiden. In **hoofdstuk 5** wordt deze extensie beschreven. De WHO heeft regels gedefinieerd om de ICD-10 uit te breiden. Op deze manier zijn aanpassingen en uitbreidingen van de codes mogelijk waardoor specifieker gecodeerd kan worden maar tegelijkertijd de uitgebreide code eenvoudig te traceren is tot de oorspronkelijke ICD-10 code. Met de uitbreiding specifiek voor gastrointestinale endoscopische bevindingen en terminologie is het mogelijk om alle items die beschreven worden tijdens een endoscopie te coderen. Met de ontwikkeling van nieuwe technieken en de beschrijving van nieuwe diagnosen, wordt deze GETC aangepast om nieuwe endoscopische termen te kunnen coderen. Deze gegevens kunnen anoniem worden geëxporteerd naar een andere database om gegevens tussen verschillende endoscopie afdelingen te vergelijken.

De automatisch gekoppelde codes worden opgeslagen in de database van elk ziekenhuis. Binnen het TRANS.IT project zal onderzoek worden uitgevoerd op de anonieme endoscopische gegevens. Daarvoor is een centrale database gemaakt met de anonieme gegevens van alle endoscopische onderzoeken van de deelnemende ziekenhuizen.

Binnen het project is overeengekomen om de gestandaardiseerde vormen van verslaglegging (standaard verslagen, tekstblokken en gestructureerde invoer) te gebruiken. Het is in het programma tevens mogelijk om vrije tekst te gebruiken en het verslag na de selectie van de gestandaardiseerde verslaglegging voor uiteindelijke verzenden aan te passen. Gebruik van vrije tekst en aanpassingen na de selectie van gestandaardiseerde verslaglegging zou invloed kunnen hebben op de juistheid van de automatisch gegenereerde codering. In **hoofdstuk 6** wordt een multicenter studie beschreven die is uitgevoerd om te beoordelen in hoeverre automatisch gegenereerde GET-C codes in overeenstemming zijn met de feitelijke tekst van het endoscopie verslag. In totaal werden 500 colonoscopie verslagen at random geselecteerd uit een totaal van 2500 onderzoeken van 5 ziekenhuizen en werden deze codes en verslagen geëvalueerd op de indicatie, de endoscopie bevindingen en therapeutische interventies. Indicaties waren correct gecodeerd in 92% van de rapporten. Correcte codering van de bevindingen varieert tussen 42 en 93% per ziekenhuis. Deze grote variatie is te verklaren door onjuist gebruik van het systeem om een verslag samen te stellen, met name de selectie van een standaard verslag en vervolgens het verwijderen of toevoegen van bevindingen in het uiteindelijke verslag, resulterend in een onjuiste code. De onjuistheid van de codering werd eveneens gescoord op klinische relevantie met als resultaat dat in 89% van alle onderzoeken correct klinisch werd gecodeerd. Deze resultaten maken het nodig om richtlijnen voor het samenstellen van verslagen verder te verbeteren en daarnaast endoscopisten aanvullend bij te scholen voor het op de juiste manier gebruiken van het verslagleggingsysteem. Hierdoor kan de betrouwbaarheid van de database nog verder verbeteren. Hiervoor zullen verschillende ziekenhuizen en individuele endoscopisten hun gegevens gespiegeld krijgen aan de gemiddelde resultaten van de andere ziekenhuizen binnen de werkgroep. De resultaten van deze benchmarking zullen in de toekomst door een nieuwe studie over juistheid van codering binnen de TRANS.IT groep worden geëvalueerd

In het Ikazia Ziekenhuis, Rotterdam, wordt het gecomputeriseerde systeem gebruikt vanaf 1996. Het was mogelijk om de endoscopische gegevens over een periode van tien jaar te onderzoeken. Trends in de verschillende diagnoses werden geanalyseerd. In **Hoofdstuk 7** worden de incidentie van maag - en duodenum ulcera beschreven in de tijd. In een periode van 10 jaar werden in totaal 20.006 endoscopieën uitgevoerd bij eerder niet onderzochte patiënten met dyspeptische klachten. Maag ulcera werden gediagnosticeerd bij 2,4% van de patiënten. Duodenum ulcera werden gediagnosticeerd bij 3,5% van de patiënten en deze incidentie daalde in deze periode van 10 jaar. Met een verdere daling van duodenum ulcera en tegelijkertijd een stabiele incidentie van maag ulcera verwachten we in een situatie terug te komen waarin, vergelijkbaar met 100 jaar geleden in Nederland, maag ulcra weer vaker voorkomen dan duodenum ulcera. De totale daling van ulcera is waarschijnlijk

te wijten aan verschillende factoren, waaronder zuuronderdrukkende medicijnen, een daling van de prevalentie van H. pylori en de behandeling van deze bacterie.

In **hoofdstuk 8** worden de opbrengsten van oesofago-gastro-duodensocopieën van verschillende verwijzende groepen vergeleken in de tijd. In de onderzochte open acces endoscopie afdeling werden patiënten polklinisch verwezen door huisartsen en specialisten en daarnaast een groep klinische verwijzingen. In totaal kwamen 21.441 primaire diagnostische oesofago-gastro-duodenoscopieën in aanmerking voor het onderzoek. Het aandeel van de patiënten verwezen door hun huisarts steeg van 35 tot 45% in 10 jaar tijd. Afwijkingen werden gevonden in de meerderheid (74%) van onderzoeken zonder significante verschillen in de diagnostische opbrengst tussen de verschillende verwijzende groepen. Het percentage patiënten met afwijkingen steeg in de onderzochte periode.

Vooral gastro-oesofageale reflux ziekte werd gediagnosticeerd in een groot deel van de patiënten (16%). Mannen hadden vaker en ernstigere vormen van refluxziekte dan vrouwen. De hoogste incidentie van reflux ziekte werd waargenomen bij patiënten die werden verwezen door de huisarts. Dit kan worden verklaard door het feit dat deze patiënten minder zuurremmende medicatie gebruikten of deze medicatie voor een kortere periode gebruikten dan patiënten verwezen door een specialist of vanuit het ziekenhuis. Na een aanvankelijke toename in de incidentie van reflux ziekte, stabiliseerde en daalde deze incidentie in de laatste jaren van de studie. In 2004 werd een nieuwe huisartsenrichtlijn uitgebracht voor de diagnostiek en behandeling van gastro-intestinale symptomen. In deze richtlijn wordt een behandeling van 2-4 weken met een protonpompremmer (PPI) aanbevolen. Als reflux- symptomen aanhouden, wordt endoscopie aanbevolen. Dit kan een verklaring zijn voor de daling van de incidentie van reflux ziekte in de laatste jaren van deze studie zijn.

Enkele studies hebben de mogelijkheid van direct verwijzen voor een endoscopie in een openacces endoscopieafdeling bekritiseerd. Het zou leiden tot onjuiste verwijzing en stijging van het aantal verwijzingen voor een onderzoek waarvoor, door het tekort aan MDL artsen, reeds een wachttijd bestaat.

Onze onderzoeksgegevens tonen een hoge diagnostische opbrengst in alle verwijzende groepen, waardoor het in stand houden van een openacces endoscopie afdeling gerechtvaardigd is.

Conclusie

In dit proefschrift worden de verschillende studies beschreven over standaardisatie en codering van gastro-intestinale endoscopieverslagen. Goede verslaglegging van endoscopische onderzoeken is van groot belang voor de behandeling, het onder-

zoek en de follow-up van patiënten. Met standaardisatie, zullen de verslagen alle geadviseerde punten voor complete endoscopieverslagen kunnen vervullen. Nieuwe geautomatiseerde medische systemen vragen een grote financiële investering voor het programma evenals voor de verbinding met andere het ziekenhuissystemen. Naast deze financiële investeringen, moeten gebruikers van het systeem inspanningen leveren. Daarom moet het rapportsysteem snel, gemakkelijk te leren, en geschikt zijn voor gebruik in een drukke dagelijkse praktijk. De studies in dit proefschrift toonden vergelijkbare kosten en zelfs financiële voordelen na aanvankelijke investeringen en ook een snel systeem in vergelijking met andere manieren van verslaglegging.

Door het automatisch coderen van vastgelegde bevindingen bouwt het ontwikkelde systeem een uitgebreid database met endoscopie gegevens op, geschikt voor research. Het gecreëerde GET-C coderingsysteem maakt anonieme vastlegging van gegevens mogelijk. Tegelijkertijd kunnen gegevens benodigd voor kwaliteitsindicatoren worden opgeslagen in het systeem. Het systeem heeft aangetoond om opbrengst en trends van endoscopische onderzoeken te kunnen onderzoeken. In de toekomst worden deze systemen essentieel voor kwaliteitscontrole, kwaliteitsverbetering, en management van endoscopieafdelingen.

APPENDIX

Dankwoord

Curriculum Vitae

Dankwoord

Uithoudingsvermogen, moet je hebben om een promotie tot een goed einde te brengen. Maar niet alleen uithoudingsvermogen voor de promovendus. Zeker ook voor iedereen die direct of indirect aan de totstandkoming van dit proefschrift heeft bijgedragen. Ik ben daarvoor velen dankbaar, waarvan ik een aantal met name wil noemen.

Graag wil ik mijn promotor Ernst Kuipers bedanken. Beste Ernst, jij hebt zeker uithoudingsvermogen moeten hebben. Bijna 10 jaar geleden heb ik de mogelijkheid gekregen om bij jou in opleiding te komen tot MDL arts. Ik ben je hiervoor nog steeds dankbaar. Vanaf dat moment ben jij ook als promotor betrokken geraakt bij dit proefschrift. Je analytische en kritische benadering heeft dit proefschrift naar een hoger niveau gebracht. Je was altijd beschikbaar voor vragen en commentaar en ik ben erg onder de indruk van de wijze waarop en snelheid waarmee je weer een nieuw manuscript beoordeelde en van advies voorzag. Ik hoop dat na de afronding van dit proefschrift we op meerdere fronten kunnen blijven samen werken.

Heel bijzonder wil ik mijn co-promotor Rob Ouwendijk bedanken. Onze eerste contacten gaan ver terug. Als co-assistent interne geneeskunde ben ik in 1995 voor het eerst bij je gekomen in het Ikazia ziekenhuis. Ik heb daar ook voor het eerst kennis gemaakt met de afdeling endoscopie waardoor ik erg geïnspireerd werd. Aan het eind van mijn co-schappen zijn wij gestart met een onderzoeksproject. Hier is de eerste basis gelegd voor dit proefschrift. In eerste instantie is een elektronische vorm voor verslaglegging gecreëerd met het programma Endobase in het Ikazia ziekenhuis. Om deze te standaardiseren en te uniformeren hebben we het initiatief genomen tot het starten van het TRANS.IT project.

Ik dank je voor je uithoudingsvermogen en je stimulerende en enthousiastmerende begeleiding. Er waren momenten dat jij degene was die mij aan het werk bleef houden, altijd steunend en altijd geloof houdend in mij. Ik hoop dat de gesprekken die we hadden en de vriendschap die daaruit ontstaan is in de toekomst zullen blijven bestaan en dat we nog veel zullen samenwerken ondanks de afstand tussen ons beider werk- en woonlocatie.

Graag wil ik de leden van de leescommissie, Prof. dr. H.W. Tilanus, Prof. dr. C.H.J. van Eijck en Prof. J.F.W.M. Bartelsman, en de leden van de grote commissie bedanken voor hun bereidheid zitting te nemen in mijn promotiecommissie.

Een zeer belangrijk onderdeel bij de totstandkoming van dit proefschrift is het werk van de TRANS.IT groep. In eerste instantie wil ik hiervoor Gerard van Berge

Henegouwen bedanken. Vanaf het eerste uur behoor jij tot de initiatiefnemers van dit vernieuwende project op gebied van endoscopie verslaglegging in Nederland. Direct was je zeer enthousiast en een stimulator van zowel het project als de basis van dit proefschrift. Na jou emeritaat ben je steeds betrokken en actief gebleven binnen deze groep waarvoor veel dank.

Voor de ondersteuning van het TRANS.IT project ben ik dank verschuldigd aan Janssen-Cilag en Olympus Nederland. Beide bedrijven hebben met meerdere personen ondersteuning gegeven aan het slagen van dit project. Met name wil ik noemen, Otto Leensma, Mark Wolff en Renier van Dinter van Janssen-Cilag die tevens mij de gelegenheid hebben gegeven om een jaar volledig aan dit project te kunnen werken. Daarnaast wil ik Henk Braat en Gerard van der Hoorn van Olympus Nederland bedanken. Vanaf het begin zijn jullie betrokken geweest bij TRANS.IT en hebben de ondersteuning gegeven voor nieuwe ideeën vanuit de groep ter verbetering van het programma Endobase. Dank voor de prettige samenwerking en ik hoop dat die nog verder kan worden doorgevoerd.

Aan het TRANS.IT project hebben vanuit het Ikazia meerder mensen meegewerkt. Ram Soekhoe is met een nieuwe ontwikkeling binnen Endobase gestart. Beste Ram, dank voor je samenwerking en het onderzoek dat we samen hebben mogen uitvoeren waardoor naar voren kwam dat werken met computers wel aanpassing van de gebruiker vergt, maar ook veel voordelen kan opleveren. Sanna Mulder heeft na Ram de draad opgepakt en het TRANS.IT project verder ondersteund.
Beste Sanna, jij hebt gewonnen door je proefschrift reeds vorig jaar af te ronden waarvan een deel uit de database van Endobase kwam. Het was prettig en erg gezellig om met je samen te werken.

In een klein kantoortje in het Ikazia ziekenhuis waar het episch centrum van TRANS.IT was gelegen, heb ik veel samen gewerkt met Adrienne Zandbergen. Beste Adrienne, samen als onderzoekers in een perifeer ziekenhuis is heel bijzonder geweest. Jij op een heel ander gebied, maar toch ook raakvlakken. Ik dank je voor de gezelligheid en het klankbord dat je voor mij was.

Bij mijn werkzaamheden in het Ikazia heb ik veel praktisch steun gehad van het secretariaat. Wil en Mildred, ik wil jullie bedanken voor al die ondersteuning evenals de gezelligheid en afleiding tussen het werk door. Daarnaast wil ik het personeel van de endoscopieafdeling bedanken voor alle ondersteuning en gezelligheid. Vele uren heb ik bij jullie doorgebracht, vaak achter de computer, maar zeer regelmatig ook tijdens endoscopieën. Dank voor jullie gastvrijheid en bereidheid om geduld te hebben met weer een nieuwe versie van Endobase die moest worden uitgetest.

Ook wil het secretariaat in het Erasmus MC en met name Wendy bedanken. Wendy, tijdens mijn verblijf in het Erasmus MC en nu op afstand vanuit Arnhem heb jij de zaken rondom dit proefschrift zo geregeld dat het allemaal mooi op tijd is afgekomen.

Het secretariaat van de MDL in het Rijnstate ziekenhuis wil ik bedanken voor de ondersteuning in de laatste vier jaar. Een proefschrift afronden naast een volledige praktijk vraagt ondersteuning op vele vlakken, die ik van jullie altijd heb gekregen. Met name Karin wil ik bedanken voor de hulp bij de laatste afrondingen van dit proefschrift, die uiteraard vaak op het korte termijn gerealiseerd moesten worden.

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Mijn ouders wil ik danken voor hun steun. Jullie hebben je tijdens mijn middelbare schooltijd en ook tijdens mijn opleiding tot arts weleens afgevraagd of het helemaal tot een goed eind zou komen. De steun en het vertrouwen die jullie mij daar toch steeds weer in gaven, creëerde de mogelijkheid om me te ontwikkelen tot arts en onderzoeker; de basisvoorwaarden van dit proefschrift. Mijn broer Paul, wil ik bedanken voor het voorbeeld dat jij bent geweest door mij voor te gaan met jouw promotie. Dat heeft mij positief gestimuleerd.

Mijn allergrootste dank gaat uit naar Lonneke. Lieve Lonneke, de laatste tien jaar is er regelmatig een verandering van plannen geweest. Een avond die anders verliep, een vakantie die later startte, een weekend zonder mij. Op sommige momenten beleefde jij de druk van deze promotie nog meer dan ik. Desondanks heb jij me altijd de ruimte en de steun gegeven waardoor ik het heb kunnen afronden. Ik ben je daar ontzettend dankbaar voor. De vlag mag eindelijk uit! Ik hoop dat wij samen met Sabijn, Kees-Jan en Phillip nog heel lang gelukkig zullen zijn, jongens...

'het boekje is af'.

Curriculum Vitae

De auteur van dit proefschrift werd op 4 december 1970 geboren in Tilburg. In 1989 behaalde hij het eindexamen Atheneum aan het Theresialyceum in Tilburg. In hetzelfde jaar ging hij geneeskunde studeren aan de Erasmus Universiteit in Rotterdam. In 1995 behaalde hij het doctoraalexamen. Zijn co-schappen heeft hij voor een groot deel gevolgd in het Ikazia ziekenhuis te Rotterdam.

In 1997 behaalde hij cum laude het arts examen, waarna hij onderzoek ging doen op het gebied van endoscopische verslaglegging samen met dr. R.J.Th. Ouwendijk.

Zijn opleiding tot Maag-, Darm-, en Leverarts is hij gestart in december 1999, met de vooropleiding Interne Geneeskunde (opleider: Dr. R.J.Th. Ouwendijk) in het Ikazia ziekenhuis te Rotterdam, waarna hij van mei 2003 tot mei 2006 zijn opleiding voltooide in het Erasmus Medisch Centrum te Rotterdam (opleider: Prof. dr. E.J. Kuipers).

Van mei 2006 tot januari 2007 werkte hij als MDL-arts in het Erasmus MC en het Ikazia ziekenhuis te Rotterdam.

Vanaf januari 2007 is hij werkzaam als MDL-arts binnen de maatschap MDL van het Rijnstate ziekenhuis te Arnhem. Hij is gehuwd met Lonneke van Poppel en samen hebben zij een dochter Sabijn en twee zonen Kees-Jan en Phillip.

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