

From the Department of Neurobiology, Care Sciences and Society,  
Center for Family and Community Medicine,  
Karolinska Institutet, Stockholm, Sweden

# **Computer decision support systems for opportunistic health screening and for chronic heart failure management in primary health care**

Eva Toth-Pal



**Karolinska  
Institutet**

Stockholm 2007

All previously published papers were reproduced with permission from the publisher.

© Eva Toth-Pal, 2007  
ISBN 978-91-7357-435-8

# Abstract

There are growing demands for effective management of chronic diseases and preventive services in primary health care (PHC). Computer decision support systems (CDSS) have been shown to improve the quality of care, but they are still underused. Further knowledge is needed about the obstacles and facilitators related both to the CDSSs and to the process of implementing them in order to benefit from their full potential.

A computer generated on-screen physician reminder program for opportunistic health screening was designed and implemented at a PHC centre (study I). The program was completely integrated with the electronic patient record system (EPR) and the battery of screening tests was adjusted to the individual patient on the basis of previous diagnoses, treatments and test results for seven screening areas. Of 914 patients over 70 years of age, 602 (66%) participated in the screening. The rates for pathological findings ranged from 2-23% and new diagnoses were found in 1-4%.

In a controlled study (study II) the results from the health screening in study I were compared with corresponding data from 1989 patients at three neighbouring PHC centres. There was a significant increase (13-75%) in tests performed on the participants and in pathological test results for systolic blood pressure and serum cobalamin, and an increase in new diagnoses was found for cobalamin deficiency.

The influence of a guideline-based CDSS on five general practitioners' (GPs) management of 48 of their own patient cases of chronic heart failure was explored in a descriptive questionnaire study (study III). The CDSS was accessible on the Internet without connection to the EPR. The results showed that the GPs' confidence in the diagnosis changed in 25% of the cases, and they considered further investigations in 31% of the cases and medication changes in 19%. The support from the CDSS perceived by the GPs seemed to be substantial in 35% of the cases.

The implementation process of the CDSS used in study III was followed in a qualitative study (study IV). Different methods for data collection were used; repeated interviews with the GPs, observations of patient visits, patient interviews, and detection of usage. The results of a qualitative content analysis showed that GPs' attitudes and characteristics constituted different profiles that seemed to be associated with the degree of acceptance of the CDSS. Those profiles were related to conceptions about the GPs' professional role and their attitudes towards the computer's function in disease management and in decision making. Additional barriers were insufficient level of computer skills and time constraints in everyday work.

In conclusion, a computer-reminder program, completely integrated with an electronic patient record system, seems to be an effective method for increasing the delivery of preventive services in PHC. The system may be particularly clinically useful in screening areas that have thus far not been satisfactorily implemented, and when introducing new screening services. Applying a guideline-based CDSS for chronic heart failure may have a significant influence on GPs' disease management. It is possible to identify groups of GPs with definable needs during the implementation of a CDSS, thereby making it easier to meet those needs with individually tailored interventions.

*Key words:* computer decision support systems, primary health care, electronic patient records, clinical guidelines, opportunistic health screening, chronic heart failure, qualitative method

# List of publications

This thesis is based on the following papers, which will be referred to by their Roman numerals.

- I. Toth-Pal E, Nilsson G, Furhoff A-K. Computer generated physician reminders in opportunistic health screening in primary health care: design, implementation and preliminary evaluation. *The Journal on Information Technology in Healthcare* 2003; 1:235–247
- II. Toth-Pal E, Nilsson GH, Furhoff A-K. Clinical effect of computer generated physician reminders in health screening in primary health care – a controlled clinical trial of preventive services among the elderly. *International Journal of Medical Informatics* 2004; 73: 695-703
- III. Toth-Pal E, Wårdh I, Strender L-E, Nilsson GH. A guideline-based computer decision support system's influence on general practitioners' clinical considerations on chronic heart failure. Submitted manuscript
- IV. Toth-Pal E, Wårdh I, Strender L-E, Nilsson GH. Implementing a clinical decision support system in practice: a qualitative analysis of influencing attitudes and characteristics among general practitioners. Submitted manuscript

# Contents

Abstract .....	3
List of publications .....	4
List of abbreviations .....	6
Introduction .....	7
PHC in Sweden .....	7
EPR systems .....	7
Screening and prevention.....	8
Management of chronic diseases.....	10
Computer decision support systems .....	11
Exploring the use of CDSSs in clinical practice .....	13
Aims .....	14
General aim .....	14
Specific aims .....	14
Materials.....	15
The EPR systems.....	15
The CDSSs .....	17
Setting and subjects.....	18
Methods.....	20
Study I.....	20
Study II .....	22
Study III.....	23
Study IV.....	23
Analysis .....	25
Ethical approval.....	26
Results .....	27
Study I.....	27
Study II .....	27
Study III.....	29
Study IV.....	33
Discussion .....	41
The CDSSs .....	41
The EPR systems.....	44
The use and effect of the CDSSs .....	45
Screening and prevention.....	47
The management of chronic diseases .....	48
PHC .....	49
Conclusions .....	52
Forthcoming research .....	53
Appendix .....	54
Acknowledgements.....	55
Summary in Swedish – Sammanfattning på svenska .....	56
References .....	59
Publications.....	71

# List of abbreviations

ACE	Angiotensin converting enzyme
ATC	Anatomic therapeutic chemical (classification system)
B-Hb	Blood haemoglobin
BNP	Brain natriuretic peptide
BP	Blood pressure
CDSS	Computerised decision support system
CHF	Chronic heart failure
ECG	Electrocardiogram
EPR	Electronic patient record
ESR	Erythrocyte sedimentation rate
GP	General practitioner
ICD	International statistical classification of diseases and related health problems
MQL	Medical Query Language
NYHA	New York Heart Association
PHC	Primary health care
S-THS	Serum thyrotropin
VAS	Visual analogue scale

# Introduction

This thesis addresses the issue of screening services designed for elderly patients and the management of chronic heart failure in primary health care (PHC) in a computerised environment. The main scientific fields involved are PHC and decision support. The methodologies used in the studies are computerised decision support and its implementation, opportunistic screening, data retrieval by means of database querying, statistical analysis, interviewing and qualitative content analysis. The focus is on general practice, computer generated physician reminders in electronic patient record (EPR) systems, and guideline-based computer decision support systems.

## PHC in Sweden

Swedish PHC is organised in group practices (henceforth called PHC centres), where general practitioners (GP) work together with other health professionals including district nurses, assistant nurses, secretaries, and frequently also with biochemical analysts at local laboratories. Swedish GPs are specialists in family medicine and it is assumed that they serve the basic medical needs of patients of all ages. During recent decades the health care system has undergone continuous and rapid development. We have seen an increase in specialisation and more advanced diagnostic and therapeutic methods in hospital care, and the management of chronic diseases has been transferred to PHC. Swedish PHC is expanding and is regarded as a fundamental part of current health care with the commission to detect, investigate and treat all common diseases and health problems as long as they do not require the specific resources of specialist care. The care of elderly people, who often have several chronic diseases and complex medical problems, constitutes a substantial part of the GPs' workload. One of the main functions of PHC is prevention of diseases. The main focus of disease management and preventive work in PHC is the individual patient.

## EPR systems

The development and increasing use of EPR systems has resulted in significant changes in the process of health care. The EPR is much more than just medical documents stored in a computer, as it organises patient data in a more efficient and versatile way than is the case with paper records. EPR systems have a recognised potential to improve the quality of care by providing rapid access to reliable medical information due to their ability to automatically review the records and generate patient-specific reminders to support clinical decision making, and to retrieve aggregated data for quality assessment and clinical research (Laux 2005; Shortliffe 1999; Sujansky 1998; Sönksen 1996).

To reach those goals and make use of the full potential of EPR systems, several requirements have to be met, some of which are partially conflicting. On one hand, the structure of the EPR systems has to be systematic and well-organised in order to enhance data retrieval (McDonald 1988); on the other hand, the user-friendliness of the EPR systems and the amount of time required to activate their tools is crucial regarding the extent to which they are going to be used by physicians (Bodenheimer 2003; Elson 1995b). It has also been shown that using EPRs improves the recording of data regarding chronic diseases (Mitchell 2003) and influences physicians' reasoning and the way they organise data (Patel 2000).

During the past decade, EPR applications have become increasingly common in PHC in most developed countries. Sweden is one of the countries where the use of EPR systems amongst GPs is now almost universal (Nilsson 2002b). Figures show that over 90% of Swedish primary care physicians were using EPR systems by 2002, compared to 80% in Australia (Henderson 2006), 58% in the United Kingdom and 17% in the US (Bodenheimer 2003).

## Screening and prevention

Screening is a powerful method in prevention and in early detection of diseases in the population. Prevention is defined as proactive measures taken before a medical event occurs. Depending on when this measure is taken during the process of disease development, we distinguish between primary and secondary prevention. Primary prevention refers to complete prevention of disease in susceptible individuals or populations through promotion of health, and to specific protection, as in immunisation. Secondary prevention refers to early detection and postponement of progression or complications of existing disease. Screening is often used in secondary prevention, and is usually applied broadly to an unselected population. The requirements for an effective screening test are that the test must be 1) capable of detecting the condition in a preclinical stage, 2) clinically relevant (able to detect a condition for which intervention at a preclinical stage can improve outcome), 3) accurate (high sensitivity and specificity), 4) acceptable to patients (non-invasive), and 5) widely available and inexpensive (Beck 1999; Swee 1991).

### *Recommendations*

Several well-conducted studies have demonstrated the benefits of many preventive interventions in terms of survival and morbidity. Some countries such as the US and Canada have long traditions of national recommendations for preventive services directed to the adult population that also include screening tests (CTF 1979; USPSTF 1996). In most Western countries there is consensus about the importance of guidelines for early detection and management of diseases with a strong impact on public health such as cancer and cardiovascular diseases. The rapid increase in the number of elderly people in these countries makes it increasingly important to provide appropriate preventive care for this age group (Weiler 1989a). Despite numerous reports in the literature on preventive medicine

and screening, recommendations regarding older people are conflicting (Frame 1999; Goldberg 1997; Scheitel 1996). The goal of prevention in the elderly should focus on early detection and treatment of incipient or existing problems not only in order to reduce premature morbidity and mortality, but also to maintain optimal function and quality of life as long as possible (Kligman 1992; Klinkman 1992). Screening for and management of hypertension is one of the few preventive measures that have proved valuable in most studies (Zazove 1992).

### *Implementation in clinical practice*

GPs have a strategic position with respect to providing screening and preventive care due to their accessibility to the patient population and their long-term relationship with patients. GPs also have positive attitudes and beliefs about providing these services (Schellhase 2003; Stange 1992). Further, it has been shown that patients receiving regular care by a family physician are also more likely to receive recommended preventive services (Flocke 1998; McIsaac 2001; Steven 1998). The use of visits to the physician as opportunities for preventive services has been widely recommended, especially for age groups with frequent visits, and this is well accepted by patients (Stange 1998a).

Insight into the implementation of screening and prevention in PHC is limited. Research in different countries has, however, documented substantial discrepancies between evidence-based guidelines and what is done in practice (Hudon 2004; Kottke 1997; Lopez-de-Munain 2001; Mandelblatt 1995; Shea 1996). Some investigations show that preventive activities recommended by groups of experts are often difficult to integrate into medical practice (Hudon 2004). Numerous constraints influence the provision of these services including physician, patient, and health system factors (Hensrud 2000). Different strategies have been tested in order to improve the delivery of preventive services in PHC, and it has been shown in the literature that several types of interventions are effective to some extent. It has been concluded that there is a need for more detailed studies evaluating the various elements of interventions, the obstacles to change, and cost-effectiveness (Hulscher 2002).

### *Screening of the elderly in Swedish PHC*

There are no established screening schedules for elderly people in Sweden. Nevertheless, there is increasing awareness among GPs concerning the importance of regular check-ups for the elderly focusing on chronic diseases, e.g. diabetes and hypertension, and most elderly individuals have regular contact with their GP. There are only a few studies systematically assessing the extent of preventive activities in Swedish PHC (Haglund 1989). The extent of screening activities for elderly patients in PHC today is unknown. In a population study in the 1980s approximately 45% of the elderly had some unknown disorder despite regular contacts with health care services (Landahl 1990). As mentioned above, different

circumstances have created a great demand for tools that can facilitate screening activities in everyday clinical work in PHC.

## **Management of chronic diseases**

The number of individuals in the society having some chronic disease is increasing. According to a recent study every fourth European citizen are being treated for chronic disease (Watson 2007). The majority of patients with chronic diseases are managed within PHC in Sweden. This puts high demands on GPs regarding effectiveness in handling information about recommendations and relevant research findings within the broad field of medicine. As GPs have to make several decisions during each patient encounter, there is a need for decision support (Tierney 2001). Clinical practice guidelines are widely accepted as support for evidence-based, high-quality practice. They have been developed in order to facilitate the dissemination of research evidence and the standardisation of clinical practice. It has been shown that clinical practice guidelines have the potential to improve the quality of care (Grimshaw 1993). Although GPs have a positive attitude to clinical guidelines (Olesen 1997; Watkins 1999), their adoption into everyday clinical practice is still not satisfactory (Davis 1997; James 1997).

### ***Chronic heart failure***

Chronic heart failure (CHF) is a common condition, especially among the elderly, and is associated with high mortality and morbidity (McMurray 2000). The burden on the health care system resulting from the management of CHF is rising in parallel with the increasing proportion of elderly persons in the population. In Sweden, CHF is managed mainly in PHC. Its management is often complex and both over- and under-diagnosis are common (Khunti 2002; Nilsson 2002a; Olofsson 2007). In most countries there are well-established clinical guidelines, which are regularly updated, for the management of CHF. GPs' adherence to the guidelines has, however, been shown to be insufficient (Halling 2003; Stafford 2003). Lack of awareness of guidelines is one barrier to effective management of heart failure in PHC (Fuat 2003). CHF is therefore one of the fields where interventions leading to increased adherence to the clinical practice guidelines have a significant potential to improve the quality of care.

### ***Clinical practice guidelines***

Despite considerable investments in developing and implementing evidence-based clinical practice guidelines, they are still not optimally used by practitioners (Cabana 1999; Davis 1997; Gupta 1997; Hayward 1997). Investigating different kinds of interventions to enhance the effect of clinical guideline recommendations has led to the conclusion that simple passive dissemination of guidelines and conventional education are not effective (Bero 1998; Grimshaw 2001). Several studies have shown that guidelines are used more when they are presented in computerised form, when patient-specific advice is given, and when they are

integrated with clinical activities (Bouhaddou 1993; Elson 1995a; Grimshaw 1993; Lobach 1997).

## Computer decision support systems

A computer decision support system (CDSS) in the medical domain is any computer program that provides information to help health care professionals in medical decision making, e.g. by comparing patient specific data with an expert knowledge base. This information is most often in the form of alerts, reminders, advice or interpretation specific to a given patient at a particular time (Payne 2000; Wyatt 2000). CDSSs can be passive or active. Active systems generate information automatically without a preceding request, while passive systems require the user to trigger the process.

Integrating CDSSs with the EPR system makes it possible to create effective tools for quality improvement in everyday clinical work, e.g. during medical audit, in the process of drug prescribing and in research (Linnarsson 1993a; 1993b; Martens 2006). Many different CDSSs have been created and studied in a large variety of medical situations from simple alerting to potential drug interactions to interpreting results of laboratory tests, critiquing orders for medications, and in automated medical diagnostic programs, and electronic disease management programs based on guidelines. As these programs include patient specific information in the analysis, they can transform often-ignored guidelines into real-time patient specific management advice that improves the quality of patient care (Classen 1998). It has been shown in several studies that CDSSs can enhance clinical performance in different aspects of medical care, such as in drug dosing and prescribing habits, in preventive care, in adherence to disease management guidelines, in ordering laboratory tests, – but not convincingly in diagnosing (Austin 1994; Balas 1996; Elson 1995a; Hunt 1998; Tierney 2001). CDSSs also have the potential to facilitate implementation of new disease management strategies in everyday clinical work (Craig 2001; Garg 2005; Johnston 1994; Kawamoto 2005; Payne 2000).

### *Evaluation of CDSSs*

The majority of studies evaluating the effectiveness of CDSSs focus on their influence on the process of care (Balas 1996). Experiments have shown that decision support is more effective when comments are generated directly as data are entered into the record, rather than with delayed feedback (van Ginneken 2002). Patient outcomes are less often included and are considered to be insufficiently studied (Balas 1996; Hunt 1998; Johnston 1994). Only a small proportion of studies involve field tests of a CDSS in routine clinical settings with real patients, and despite their potential usefulness, only a few are in general use in clinical settings (Kaplan 2001a). Little is known about the obstacles resulting in this situation. Evaluation studies rarely use a naturalistic design with real patients, and studies focusing on what really happens when clinicians use CDSSs in their

everyday practice are still scarce. The most recommended method for evaluation has long been randomised controlled trials but a methodological pluralism (including both qualitative and quantitative methods) has also been advocated the recent years to broaden our understanding of clinical acceptance and use of informatics applications (Kaplan 2001b; Liu 2006).

### ***Computer generated physician reminders***

Computer reminders are probably the type of CDSS that is used most in medicine. The reminders provide notes or advice to the physician about important tasks that need to be done before an event occurs (Elson 1995a). They generate alerts by matching patient data in the EPR with information in a knowledge base. Relevant patient data are thereby returned to the physician at just the right time during the decision-making process, which will result in more well-founded decisions and improved quality of care. They have great potential to influence physician performance, since they provide decision support directly at the point of care, which has been demonstrated to be most effective (Hunt 1998). Computer reminders have been extensively studied and proved to have a positive effect on both clinical performance and patient outcomes (Balas 1996; Johnston 1994; Martens 2006). Common fields of application are implementation of medical care guidelines (Lobach 1997) and preventive care, e. g. screening services and immunisation (Austin 1994; Frank 2004; Ornstein 1991; Rosser 1992; Rosser 1991; Yarnall 1998). The most positive results have been shown in preventive care. One study even concluded that the results are so convincing in some areas, i.e. tetanus immunisation, that further studies would be unnecessary and probably unethical (Austin 1994).

In studies conducted in PHC, patient-specific reminder systems have also been found to be highly effective both in terms of patient outcomes (Figar 2004; Lobach 1997) and in delivery of preventive services (Austin 1994; Feldstein 2006; Rosser 1991; Steen 1999). Despite these unambiguous results, such decision-support systems are not yet in routine use in most countries.

### ***Computer reminders in screening and prevention***

Computer generated clinical reminder systems are an effective strategy for promoting preventive procedures (Austin 1994; Heller 2004; Shea 1996). Several studies have shown positive effects in the areas of vaccination, breast and colorectal cancer screening, and cardiovascular risk reduction. However, the computer reminders in most of these studies are not fully integrated with the EPR system, and produce printed forms to fill in or require extra data to be entered by the user. The outcome measures are most often limited to analysis of the number of patients tested, and analysis of obstacles to change is rarely addressed. Assessments of clinical outcomes in terms of number of pathological tests, new diagnoses and interventions, and the long-term effect of these outcomes, have also received little attention.

### ***Guideline-based CDSSs***

In their original printed form, clinical practice guidelines often comprise extensive and complex text that needs interpretation before it can be applied to individual patient cases. Adapting clinical guidelines to the computer environment shortens this process and saves time for clinicians (Duff 1998; van Wijk 2001). It also makes it possible to adjust the guideline recommendations to the individual patient at the point of care (Elson 1995b). For those reasons, expectations have been high regarding the effect of computerised guidelines on the quality of care (Ramnarayan 2006). The results of studies performed in clinical settings have, however, been variable and only a few could show improved adherence to guideline recommendations and better patient care (Hetlevik 1998; Sequist 2005; Shiffman 1999; Subramanian 2004; Tierney 2005). Further, implementation of computerised clinical practice guidelines has turned out to be a challenging issue, with many unsuccessful interventions documented in the literature (Eccles 2002; Rousseau 2003; Schellhase 2003; Tierney 2003).

### **Exploring the use of CDSSs in clinical practice**

Understanding the reasons behind the fact that CDSSs are rarely used in clinical practice could be of help in finding tools that facilitate their further dissemination (Kaplan 2001a; Kaushal 2003). Obstacles to a wider use of CDSSs can probably be attributed to several factors, i.e. the usability of the CDSS itself, the attitudes of end-users, and a probable influence on the clinical situation. The majority of studies focus on usability, while assessments of the two latter factors in everyday clinical settings have received little attention. Some important barriers found in an interview study of GPs were limited computer skills, shortage of time during consultation, problems with interpreting the recommendations given, and the GPs' concerns about patient reactions (Short 2004). Another study analysing videotaped consultations with GPs using computerised medical records suggests that more complicated programs such as a CDSS require the GP's full attention and cannot be relegated to the background, and this can lead to a risk of disturbances in the consultation (Booth 2004).

In order to obtain increased understanding of factors influencing the implementation and acceptance of CDSS tools, we probably also need to examine why clinicians may or may not use CDSSs and change their practice behaviours (Kaplan 2001b). The process of using CDSSs in clinical practice comprises several facets (Ammenwerth 2003a). There are both detectable and invisible interactions going on between the user/provider, the patient and the computer that influence the outcome (Gibson 2005). It is desirable to combine different methods in order to get as complete a picture of those facets as possible. A combination of different research strategies using both qualitative and quantitative methods is also advocated by some researchers (Ammenwerth 2003b).

# Aims

## General aim

The general aim of these studies was to explore the usage and effect of CDSSs in prevention and in the management of CHF in primary health care. We also wanted to assess the implementation process and elucidate obstacles and facilitating factors related to wider use of CDSSs in clinical practice.

## Specific aims

The specific aims of studies I and II were to test the hypotheses that:

- using a computer reminder program incorporated into the EPR system makes it possible to integrate a health screening program for the elderly into the everyday work of the PHC centre,
- a health screening program organised in this way is well accepted by GPs and patients, and
- when the reminder program is used, the participating patients benefit from the health screening, as the targeted diseases are diagnosed and treated sooner.

The specific aims of study III were:

- to explore the influence of a CDSS on GPs' confidence in the diagnosis and their considerations about investigations and medications in patients with chronic heart failure, and to explore to what extent the GPs perceived using the CDSS as a support.

The specific aim of study IV was:

- to explore the attitudes and individual characteristics of the GPs that influence the implementation process of a CDSS in clinical practice.

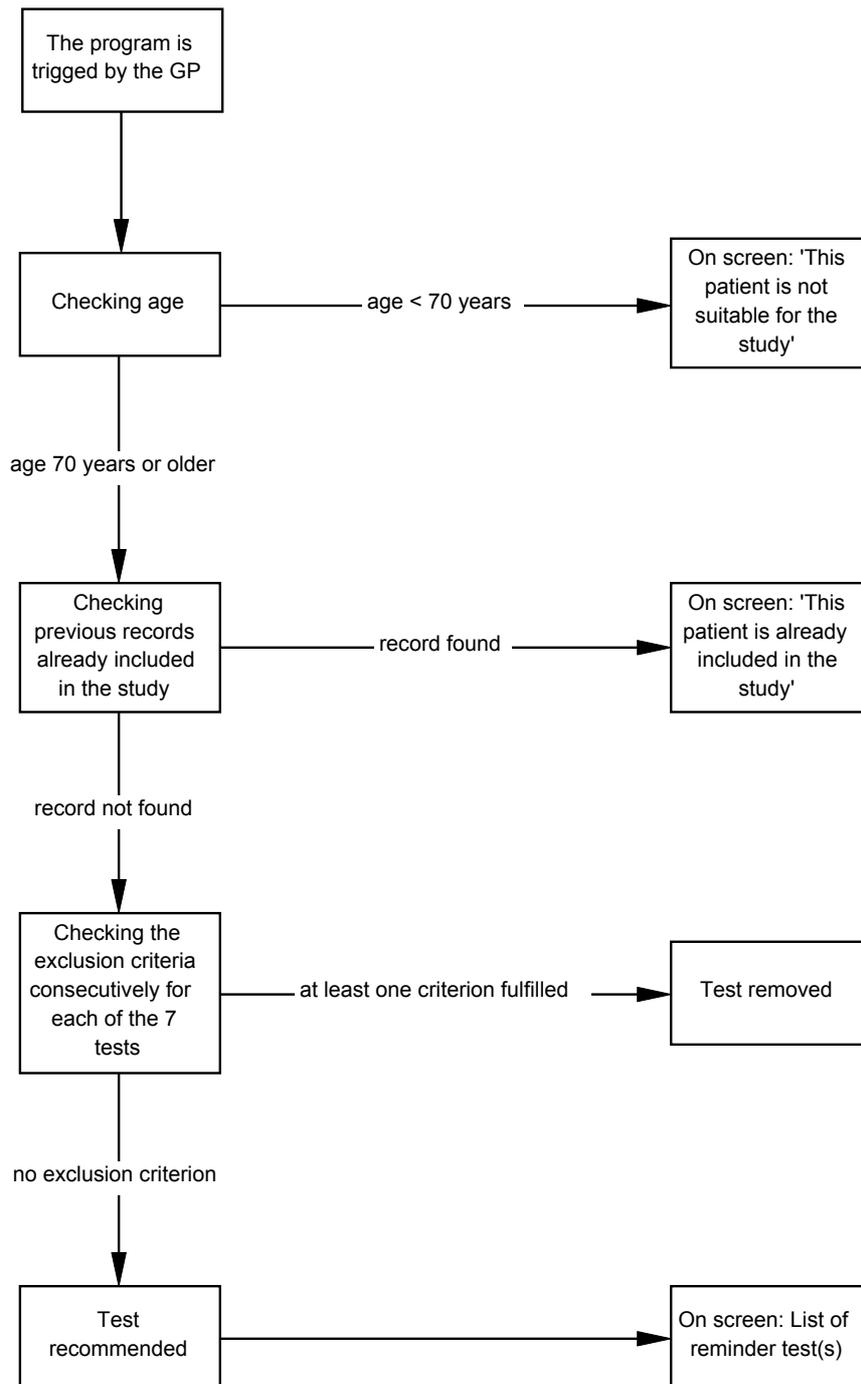
# Materials

## The EPR systems

There were two different EPR systems used in these studies. The text-based version of Swedestar was used in studies I and II and ProfDoc (Journal III) was used in studies III and IV. Both EPR systems included the complete medical record without any paper records.

Swedestar<sup>®</sup> is an EPR system with a well organised database where each medical action, such as a diagnosis, physical examination, drug prescription or laboratory test, is represented as a separate unit (Linnarsson 1987; Linnarsson 1993c). The controlled vocabulary of the system is organised in a data dictionary where each element or term corresponds to a unique code. The EPRs are structured as problem-oriented records, which means that there is a controlled association between a specific problem on the problem list and the different categories of medical data. The terms for diagnoses and medications are mapped to the International Classification of Diseases (ICD-9) and the Anatomic therapeutic chemical classification system (ATC), respectively. With this EPR system at least one diagnosis must be recorded at each visit. Classification and coding of diagnoses is done by the GPs and included in their dictated encounter report. A secretary enters data into the EPR based on dictation from the GPs. All laboratory tests are ordered by the GPs using paper order forms. The staff at the local laboratory routinely record the laboratory tests that are taken in the EPR. Each single event in the EPR may be directly searched with the aid of an integrated computer program using Medical Query Language (MQL) (Webster 1987).

ProfDoc<sup>®</sup> is a Windows based EPR system that does not support problem-oriented documentation. It comprises separate parts for encounter notes, laboratory list, diagnosis list, documents (e.g. referrals and investigation results) and a patient scheduling system. All parts can be reached within the system, but are not interconnected regarding the data contained in each of them. Data can be viewed only in the part where it has been recorded. Each part has a chronological structure, which means that older registrations are more laborious to access and searching possibilities within the system are limited. Diagnoses are coded according to ICD-10. The registration of a diagnosis in each encounter note is recommended but not mandatory.



**Figure 1.** Flowchart for the reminder program when searching the electronic patient records of patients to be included in the study and tests to be recommended.

## The CDSSs

### *The reminder program (study I)*

The CDSS used in study I was a reminder program for health screening (henceforth called the reminder program). It consisted of a set of 17 MQL-queries that adjusted a predefined battery of screening tests to the individual patient. The complete battery of screening tests consisted of seven tests (see under Methods, Table 2). The reminder program was completely incorporated within the EPR and could be triggered by the user when reading the patient's medical record. The reminder program searched the EPR, first checking the patient's age and any previous inclusion in the study (Figure 1). If the patient was 70 years or older and had not yet been included in the study, the search continued by the checking of diagnoses, medical treatments and previous test results. The reminder program removed a test from the list if the EPR already included: 1) the concerned diagnosis, 2) specified medical treatments (cobalamin or levothyroxin prescription the past 18 months), or 3) performance of the test in question in the past 6 months (12 months for cobalamin, thyrotropin and breast examination) and the result was not pathological. A list of recommended tests for the individual patient was then presented on the screen within a few seconds.

### *The guideline-based CDSS (studies III and IV)*

The CDSS (EviBase®) used in studies III and IV was a web-based application written in Swedish (EviBase) and freely accessible on the Internet. It comprised four separate modules, all with the same basic structure (Persson 2000). In these studies we used the diagnostic and the treatment modules for the management of CHF (henceforth called the CDSS). The CDSS was based on three evidence-based clinical guidelines (one Swedish and two European) published earlier in paper form (Läkemedelsverket 2000; the European Society of Cardiology 1995; 1997). The two modules could be used independently of one another. Both contained a form with check boxes for patient data that the user had to fill in manually. There was no connection between the CDSS and the EPR, which meant that no patient data could be collected automatically. The result sheet appeared on screen immediately and was printable on demand. After closing the window or starting a fresh form, no data from the previous case were stored.

In the diagnostic module the form for patient data contained boxes with symptoms and signs, examination results and aetiological factors. The result sheet gave a suggestion on the probability of CHF with five alternatives: 1) "CHF is present", 2) "asymptomatic dysfunction", 3) "suspect CHF", 4) "CHF is not present" and 5) "Not possible to calculate" (when neither presence of symptoms nor echocardiography results were entered in the form). Further, the result sheet contained comments on the entered patient data, their impact on the probability of CHF, and suggestions for further investigations. Since the principal diagnostic investigation recommended by the guidelines is echocardiography, if the box

“ejection fraction missing” was marked in the form, the result sheet always included a suggestion to perform an echocardiogram. A blood test, brain natriuretic peptide (BNP), or an exercise test could also be suggested as a complement.

In the treatment module there was an assumption that CHF was present. Suggestions were given on suitable drugs for additional treatment. The form for patient data comprised checklists for: 1) functional classification according to the New York Heart Association (NYHA), 2) related medical conditions, 3) medications already prescribed, and 4) any drugs not tolerated by the patient. The result sheet gave suggestions on groups of drugs suitable for adding to those already prescribed. Furthermore, there was a list of the advantages and disadvantages of all the theoretically usable drugs in the present case, listed in order of importance. The user could repeat the inquiry for additional suggestions on the same case up to a maximum of five repetitions.

Thus, in addition to the tangible suggestions on how to proceed in the present case, the result sheet for both modules also provided information on the most important rules underlying the calculation of each suggestion. In this way the CDSS also functioned simultaneously as an aid in further education.

## Setting and subjects

### *Studies I and II*

Studies I and II were performed at four PHC centres in a suburb of Stockholm that provided health care for about 32,000 inhabitants. All four PHC centres were using the same kind of EPR (Swedestar) as the sole medical record.

One of the four PHC centres was chosen for recruiting participants and carrying out a computer supported health screening for the elderly (study I). This PHC centre had 7,715 inhabitants in its catchment area and of those, 1,207 (15.6%) were over 70 years of age. Five GPs and one trainee doctor were working at the PHC centre at the time of the study. The control patients were selected from the other three PHC centres, where 12 GPs and two trainee doctors were working (study II). All the GPs were specialists in family medicine with 5-15 years of experience in primary care, and there were no differences in age and experience between the GPs who carried out the screening and the others. Four of the five GPs at the intervention PHC centre and 10 of 12 at the three control centres were females.

The health screening was allocated to one of the two PHC centres that had been using the EPR longest and that had the smaller number of patients over 70 years of age. The EPR system at the intervention PHC centre and at one of the control PHC centres had a common database, as they were located in the same building. This system had been in use since 1984. The other two PHC centres, which were situated in different parts of the municipality, each had its own database, and had used the EPR system for a shorter period (since 1989).

**Table 1.** Summary of design, data sources and methods used in the studies

	<b>Study I</b>	<b>Study II</b>	<b>Study III</b>	<b>Study IV</b>
<b>Design</b>	Intervention (opportunistic screening) with a follow-up using a computerised reminder program	Intervention (opportunistic screening) with a control group and a follow-up using a computerised reminder program	5 GPs assessed the records of 48 authentic patient cases using a CDSS for the management of chronic heart failure	Observation of the implementation process for a CDSS application at a PHC centre
<b>Data collection</b>	April 1993 – December 1994	April 1993 – December 1994	February 2005	March 2005 – January 2006
<b>Subjects</b>	Patients over 70 years of age at one PHC centre (914 individuals)	Patients over 70 years of age at four PHC centres (914 + 1989 individuals)	5 general practitioners at one PHC centre	5 general practitioners at one PHC centre
<b>Data sources</b>	The database of the EPR at the PHC centre	The databases of the EPR at the PHC centres	The GPs' answers to the questionnaire Printouts of the CDSS' recommendations and patient data registered by the GPs	Transcriptions of interviews Notes from field observations Log-files from the CDSS' server
<b>Methods</b>	Mainly quantitative  Opportunistic health screening	Mainly quantitative  Opportunistic health screening	Mainly quantitative  Questionnaire	Both qualitative and quantitative Interviews Observations User log-files

### *Studies III and IV*

Studies III and IV were performed at a PHC centre in a northern suburb of Stockholm serving approximately 6500 inhabitants. The PHC centre had used EPRs as the sole medical record since 1994. The present EPR (ProfDoc) was introduced in 1999 and included patient records only from that time and thereafter.

Six female GPs worked at the PHC centre including the author. The remaining five participated in the study. They had between 3-27 years of clinical experience in PHC, and had been working at this clinic for between 2-25 years. All the GPs had been using EPRs in their everyday practice for more than five years and the desktop computers in their offices had rapid Internet connections. None of the GPs had more than an average interest in computers either privately or in their profession. Before this study, no CDSSs had been used on a consistent basis at the PHC centre.

## Methods

A summary of the design, data sources and methods used in the studies is found in Table 1.

### Study I

In study I we designed and applied the computer reminder program in an opportunistic health screening. The intervention lasted 20 months (April 1993 to December 1994), and a follow-up was done after a 20-month period in which the reminder program was not used (February 1995 to September 1996).

For inclusion in the intervention, each patient had to fulfil two criteria: 1) an age of 70 years or older, 2) having made a visit to a GP during the study period, not including emergency visits. Patients with more than one visit during the study period could be included at any of the visits, but only once. A total of 914 patients fulfilled the two inclusion criteria. For ethical reasons we excluded patients who could not give informed consent because of dementia (24 patients) or who had a concomitant severe illness at the time of the visit (12 patients). There were 51 (5.6%) patients who declined to participate. A further 224 (24%) patients were excluded because the GPs did not have enough time during the visit to give the necessary information and recruit the patient to the study without a negative effect on the consultation. One patient was excluded for administrative reasons. The remaining 602 patients participated in the health screening (participants).

Seven screening areas and related tests addressing different diseases and health problems were chosen to be included in the complete screening battery (Table 2).

**Table 2.** Screening areas and the corresponding seven tests included in the complete test battery used in study I.

Screening area	Test
1. Hypertension	Blood pressure (BP)
2. Breast cancer	Breast examination
3. Diabetes	Blood glucose
4. Anaemia	Blood haemoglobin (B-Hb)
5. Elevated ESR	Blood erythrocyte sedimentation rate
6. Cobalamin deficiency	Serum cobalamin (vitamin B-12)
7. Hypothyroidism	Serum thyrotropin (S-TSH)

The seven areas were strategically selected in order to obtain a mixture of manual (1–2 above) and laboratory procedures, and established (1–4 above) and new screening areas (6 and 7 above).

The GPs who implemented the screening were given a brief introduction prior to the study. All data were registered in the EPR without any separate protocols. The everyday clinical routines were completely unaltered during the study, save for the additional note in the records about participation of the eligible patients. For patients 70 years or older who were not taking part, the GP described the reason for non-participation, either spontaneously or later at the request of the investigator. The reminder program was voluntarily triggered at the time of the encounter. The presented list of recommended tests was solely advisory. The GP decided which tests should be done. The test findings were handled by the GPs in accordance with standard clinical routines.

One brief interview was conducted with the GPs about three months after the start of the study. This concerned the ease of use of the reminder program and other issues regarding how the study was proceeding. Specific questions and problems were also discussed within the team on several other occasions.

The outcome data were collected using several MQL queries searching the database of the PHC centre. The records of the patients included in the study were first retrieved to be further analysed by the evaluation queries. There was one evaluation query for each screening test. The logical structure of those queries was similar to that of the reminder program. The most important difference was that the evaluation programs retrospectively examined all the retrieved records for the whole study period, while the reminder program examined one patient's record at a time, directly at the moment of the encounter.

The first step in each evaluation query was the same as in the computer reminder program for the screening test in question, i.e. it reconstructed the recommendations by the reminder. The result of this step was a list of patients whose records did not have the diagnosis in question, or the corresponding medication (for hypothyroidism and cobalamin deficiency), before the study, i.e. patients for whom the test would have been recommended as a screening test. The complete EPRs of those patients were then analysed and the results were presented as the number of patients who 1) had undergone the test, 2) had a pathological test result, or 3) had a new diagnosis – and for cobalamin deficiency and hypothyroidism, appropriate pharmacological treatments (cobalamin and levothyroxin) – recorded at least once during the study period. The follow-up data comprised the number of patients with additional new diagnoses and prescriptions recorded after the intervention.

In the evaluation programs we used the same ranges for pathological results as in daily clinical work, in accordance with the laboratory's recommendations. However, for S-cobalamin we used two limits, <110 pmol/l for pathological results, and 110– 200 pmol/l for borderline values.

## Study II

Study II was designed as a controlled study where we compared the findings from the patients participating in the health screening in study I (participants) with corresponding data in control patients selected from the other three PHC centres (see under Setting and subjects). There were 1989 patients at the control PHC centres who fulfilled the same two inclusion criteria as in study I (controls). We compared the number of pathological test results, new diagnoses and medications in participants and controls for five of the seven conditions included in the health screening in study I.

First we selected the medical records of the controls by searching the databases of the control PHC centres for patients who fulfilled the two inclusion criteria. Those retrieved records were then analysed using the same MQL queries as in study I regarding the following five conditions and related tests:

1. Hypertension – Blood pressure
2. Diabetes – Blood glucose
3. Anaemia – Blood haemoglobin
4. Cobalamin deficiency – Serum cobalamin (vitamin B-12)
5. Hypothyroidism – Serum thyrotropin

In study II we also collected baseline data on how commonly the screening tests were used at the PHC centres before the study. We retrieved the records for patients who fulfilled inclusion criteria 1) and 2) at the four PHC centres during a 20-month period two years earlier (April 1991 – December 1992). We analysed

those records according to the same procedures as above (first excluding all patients who had had the diagnosis) to determine the number of patients who had had the test performed at least once.

### Study III

Study III was a descriptive study with the five GPs applying the CDSS for the management of CHF to the medical records of their own patient cases and then answering a questionnaire about their considerations in each case.

We identified the medical records of all patients who had the diagnosis “heart failure” (ICD-code: I50-) registered during the last five years (2000-2004) by searching the database of the EPR system. Thereafter we selected those who were still being treated for their CHF problems at the PHC centre. Forty-eight patients fulfilled those criteria. For each case we then identified the encounters in their medical records where the diagnosis or symptoms associated with CHF were noted and selected one of the latest of those encounters. We allocated each case exclusively to the GP who had seen the patient at that encounter.

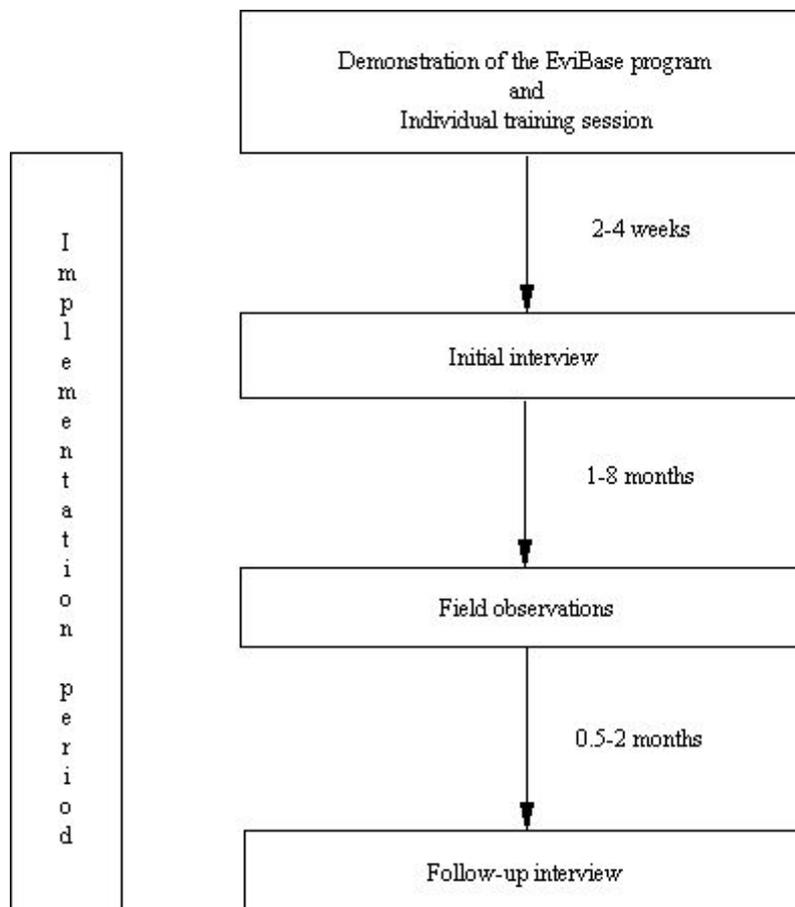
The GPs were asked to carry out an assessment of the selected cases using both modules of the CDSS (9-11 cases per GP). They were instructed to perform as if the selected encounter were taking place now, and for every case to fill in a questionnaire directly after using the CDSS (see Appendix). There were five paragraphs in the questionnaire regarding: 1) whether the GP would consider further investigations, 2) whether her confidence in the diagnosis increased, decreased or was unchanged, 3) whether she would consider some changes in medications and if so what kind, 4) the overall support from the CDSS perceived by the GP in the present case (marked on a 100 mm visual analogue scale (VAS), where 0 mm was marked “no support at all” and 100 mm was marked “the maximum support I can imagine”), 5) the GP’s comments on the assessment of the present case. The GPs were also asked to collect all the print-outs of the result sheets from the CDSS.

### Study IV

Study IV was mainly a qualitative descriptive study where we followed the implementation of the CDSS for the management of CHF by performing repeated individual interviews with the GPs, observations of authentic patient visits, and patient interviews.

The implementation period lasted from February 2005 to January 2006. After each GP had completed the assessment of the selected CHF cases in study III, they were encouraged to use the CDSS in their everyday clinical work whenever they found it suitable. We documented each GP’s performance during the implementation period in three steps: 1) individual interviews with each GP at the beginning of the implementation period (initial interviews), 2) field observations of authentic patient visits where the CDSS was used, 3) individual interviews with each GP at

the end of the implementation period (follow-up interviews) (Figure 2). Further, there was a log function linked to the database of the CDSS that registered each occasion of usage during the implementation period.



**Figure 2.** Flowchart of the data collection during the study. As it was planned that each GP would follow these steps in the given order, the length of the Implementation period varied among the GPs (9.5-11.5 months).

Both the initial and follow-up interviews were semi-structured with open-ended questions and followed a check-list of topics to be covered (question guide). The interviews were conducted, audio taped, and transcribed immediately after each session by the author. They took place at the GP's own office and lasted between 1-2 hours. After transcription the text was read through by the interviewer and an

independent co-researcher and thereafter discussed to attain a preliminary interpretation that identified important question areas, which were used to revise the question guide for the next interview. The initial interviews focused on the GPs' perceptions of the CDSS, their experiences of computer use in general, and their involvement in the management of CHF. The main topics in the follow-up interviews were the GPs' experiences using the CDSS in practice, their views on information retrieval for clinical decision making, and their preferences regarding a good CDSS. There were three additional areas that emerged in the preliminary analysis of the initial interviews that were added to the interview guide at the follow-up: 1) shortage of time, 2) the GPs' conception of professionalism in their work, 3) the CDSS as representing a way of structuring data for the decision process that differed from what the GPs were used to.

After the initial interviews the GPs were asked to select patient visits, where they considered it appropriate to use the CDSS, that could be observed. The observer took handwritten notes using a predefined guide that focused on how the GP handled the computer and communicated with the patient at the same time, and noted usage of both the EPR and the CDSS. In addition, the observer documented her reflections about the consultation situation. If the patient agreed to be interviewed after the visit, a few questions were asked about the patient's 1) general perceptions of the visit, 2) views about the GP using the computer during this consultation, and 3) general attitudes towards computers in healthcare.

The notes and reflections from each observation were transcribed and the findings served as a base both for later observations and for selecting question areas for the question guide in the follow-up interviews that were performed when all observations were completed.

## Analysis

### *Qualitative content analysis*

All qualitative data in study IV were analysed using qualitative content analysis. Qualitative content analysis deals with description and interpretation of text that can originate from different types of qualitative data, for example interviews or observations (Berg 2006). The technique comprises the following steps: 1) condensing and coding of text, where codes are generated from the data themselves, 2) organising codes into categories that must be comprehensive and at the same time mutually exclusive, 3) finding patterns, or threads of meaning, through codes and categories that constitute themes. While codes and categories represent the manifest content of the data, themes are the expression of the latent content (Graneheim 2004).

We performed both a manifest and a latent content analysis during the data collection, and then directly after each interview set (initial and follow-up) was completed and transcribed. First we condensed the text, identifying and selecting

important meaning units. The meaning units were then labelled with codes and grouped into subcategories and categories. The codes, subcategories and categories were continually refined and compared with each other in order to obtain exclusivity within each of them. The results were then discussed and revised together with an independent co-researcher who had also read all the original transcripts. In order to explore individual characteristics influencing acceptance of the CDSS, we grouped the categories with regard to whether they illustrated differences or similarities between the GPs. Finally, 16 category headings were generated and under these all data were accounted for. There were six categories describing similarities and 10 describing differences. In the categories illustrating differences, we looked for patterns describing the attitudes and characteristics of each GP, and these patterns were called the GP's "profile". To detect any sign of change during the implementation period, analyses of the initial and follow-up interviews were not compared until both analyses were completed. We also looked for underlying meanings and threads throughout the codes and categories, and these constituted the sub-themes and the main theme.

In analysing the notes from the field observations we looked for differences and similarities in the GPs' behaviour, following the same procedure as for the interviews. The patient interviews were roughly divided into positive and negative comments.

### ***Statistics***

In studies I, II and III the data were analysed manually or using the Excel<sup>®</sup> software program and are presented as the number (and proportion) of patients with a specific finding in each group. For comparisons between the groups we used 95% confidence intervals for the differences in proportions. Whenever the value 0 is outside the confidence interval the observed difference is regarded as being statistically significant at a level of less than 5%.

### **Ethical approval**

Studies I and II were approved by the Committee on Ethics in Research at the Karolinska Hospital. Every participating patient gave informed consent after receiving both verbal and written information about the study. Studies III and IV were approved by the Regional Ethical Review Board in Stockholm. The participating GPs and patients were given both written and verbal information about the study before giving their informed consent. Their participation in each part of the study was voluntary.

# Results

## Study I

### *Implementation*

According to the GPs' reports on ease of use, one brief introduction was sufficient. The most commonly stated reason for why patients who fulfilled the inclusion criteria were not included in the study was lack of time during the visit. Of the 602 participants, 65% were women, and the largest age group was 70-74 years (38%). Of those patients for whom a screening test from the complete test battery was selected as appropriate, the tests were eventually performed in between 92.9 and 97.6% of cases.

### *Pathological test results and new diagnoses*

The proportion of patients with a pathological test result and new diagnoses were calculated (N=914) (Table 3). Pathological results for the screening tests ranged between 1.9% (S-TSH) and 22.8% (hypertension). New diagnoses were found in between 1.4% (anaemia) and 4.1% (cobalamin deficiency). Additional new diagnoses at follow-up were found in 0.2–1.2%. The examination results for breast palpation are not known. There were two patients with a new diagnosis of breast cancer during the study period and one additional patient at follow-up.

## Study II

Among the controls, there were 64% women, and 40% were in the age group 70-74 years. There were no significant differences regarding age and sex distribution between the non-participants, the participants and the controls. Comparing the number of patients with the diagnoses or medical treatments before the study for the five conditions addressed in study II, we found a difference between participants and controls only for previously diagnosed cobalamin deficiency, which was lower in the participants (3.5% versus 6.5%)

### *Test rates, pathological test results and new diagnoses*

The baseline data for the test rates two years earlier showed differences between the PHC centres. The percentage of eligible patients who had undergone the test in question was significantly lower at the PHC centre where the health screening was performed for four of the five tests. The lowest rate was found for S-cobalamin (11.1%). During the study period the tests were performed in between 92.9–97.6% of the participants for whom the screening test was recommended (Table 4). In the controls the corresponding variation was much wider, with test rates ranging between 20.2% (S-cobalamin) and 84.3% (blood pressure) in the patients for whom the screening test would be appropriate if the same criteria were applied

**Table 3.** Selection and test rates and clinical outcomes in the study group (N = 914) for the seven screening areas, presented as number of patients, with percentages in parentheses.

	Hypertension		Diabetes		Anaemia		Elevated ESR		Cobalamin deficiency		Hypo-thyroidism		Breast examination <sup>5</sup>	
Participating	602	(65.9)	602	(65.9)	602	(65.9)	602	(65.9)	602	(65.9)	602	(65.9)	390	(66.8)
Selected for screening	415	(45.4)	529	(57.9)	566	(61.9)	602	(65.9)	581	(63.6)	548	(60.0)	379	(64.9)
Tested	405	(44.3)	493	(53.9)	539	(59.0)	584	(63.9)	550	(60.1)	509	(55.7)	-	-
Pathological finding	208/100 <sup>1</sup>	(22.8/10.9)	26 <sup>2</sup>	(2.8)	42 <sup>3</sup>	(4.6)	112	(12.3)	148 <sup>4</sup>	(16.2)	17	(1.9)	-	-
New diagnosis	36	(3.9)	14	(1.5)	13	(1.4)	-	-	37	(4.1)	14	(1.5)	2	
New diagnosis during follow-up	11	(1.2)	2	(0.2)	7	(0.8)	-	-	11	(1.2)	5	(0.6)	1	

<sup>5</sup> only in women, n=584 <sup>1</sup> High systolic (>160 mmHg) and diastolic (>90 mmHg) blood pressure, respectively

<sup>2</sup> Blood glucose  $\geq$ 6.7 mmol/l fasting or  $\geq$ 8.0 mmol/l not fasting

<sup>3</sup> Hb<130 g/l in men and Hb <120 g/l in women

<sup>4</sup> S-cobalamin < 200 pmol/l

as for the participants. The largest difference between the groups was found for the S-cobalamin test for which the test rate was 74.5% higher in the participants. For blood pressure and B-Hb the differences between the groups were much smaller, at 13.3% and 12.9%, respectively.

The rates for pathological test results were significantly higher in the participants than the controls for systolic blood pressure (50.1% and 38.0%, respectively) and for S-cobalamin regarding both pathological (3.3% and 1.1%, respectively) and borderline (22.2% and 3.9%, respectively) values. During the study there was a significantly higher frequency of new diagnoses of cobalamin deficiency in the participants (6.4% and 3.4%, respectively). After the study there was no longer any difference in the frequency of the diagnosis of cobalamin deficiency between the participants and the controls.

For the participants, the frequency of new diagnoses during the follow-up was lower for diabetes (0.4% and 1.1%, respectively) and for anaemia (1.2% and 2.4%, respectively).

## Study III

### *The diagnostic module*

The mean age of the patients was 81 years and 60% of them were men. In 15 (31%) of the 48 CHF cases there was no echocardiogram result found in the EPR. The echocardiogram showed an impaired heart function in 20 (42%) cases. The CDSS gave suggestions on 1-3 further investigations in 21 (44%) cases (echocardiography in 15 cases and BNP test in 8 cases).

The GPs' responses to the questionnaire showed that their confidence in the diagnosis was influenced by the CDSS in 12 (25%) cases, with equal numbers of increased and decreased confidence. The GPs considered further investigations in 15 (31%) cases (31 investigations in total of which 14 were echocardiography).

### *The treatment module*

In 25 (52%) of the cases the patients were prescribed between 1 and 3 drugs of the type used for CHF. Only 8% had no such drugs registered. Diuretics were most common (85%), followed by Beta-blocking agents (58%) and angiotensin converting enzyme (ACE) inhibitors (44%).

ACE inhibitors were the additional medication most frequently suggested by the CDSS (23%), and the GPs considered making changes in medications in 9 (19%) cases. The most frequently considered change was addition of ACE inhibitors (in 5 cases). In 20 (42%) cases the CDSS could not find any suitable additional medication at all.

**Table 4.** Tests and clinical outcomes for the five study areas, presented as number of patients, percentages and differences with 95% confidence intervals (CI).

	Participants number (%)	Controls number (%)	Difference (95%CI)
All patients (=N)	602 (100)	1989 (100)	-
Women	390 (64.8)	1265 (63.6)	1.2 (-3.2; 5.6)
<b>Hypertension</b>			
Eligible (=n)	415 (100)	1442 (100)	-
Tested	405 (97.6)	1215 (84.3)	13.3 (10.9; 15.7)*
High systolic BP (>160 mmHg)	208 (50.1)	548 (38.0)	12.1 (6.7; 17.5)*
High diastolic BP (>90 mmHg)	100 (24.1)	343 (23.8)	0.3 (-4.4; 5.0)
New diagnosis	36 (8.7)	121 (8.4)	0.3 (-2.8; 3.3)
New diagnosis during follow-up	11 (2.7)	38 (2.6)	0.1 (-1.7; 1.8)
<b>Anaemia</b>			
Eligible (=n)	566	1893	-
Tested	539 (95.2)	1557 (82.3)	12.9 (10.5; 15.4)*
Pathological finding <sup>1</sup>	42 (7.4)	150 (7.9)	-0.5 (-3.0; 2.0)
New diagnosis	13 (2.3)	47 (2.5)	-0.2 (-1.6; 1.2)
New diagnosis during follow-up	7 (1.2)	46 (2.4)	-1.2 (-2.3; -0.1)*
<b>Diabetes</b>			
Eligible (=n)	529 (100)	1744 (100)	-
Tested	493 (93.2)	1169 (67.0)	26.2 (23.1; 29.2)*
Pathological finding <sup>2</sup>	26 (4.9)	62 (3.6)	1.3 (-0.7; 3.4)
New diagnosis	14 (2.6)	55 (3.2)	-0.6 (-2.1; 1.1)
New diagnosis during follow-up	2 (0.4)	20 (1.2)	-0.8 (-1.5; -0.1)*
<b>B-12 deficiency</b>			
Eligible (=n)	581 (100)	1859 100	-
Tested	550 (94.7)	376 (20.2)	74.5 (71.9; 77.0)*
Pathological finding <sup>3</sup>	19 (3.3)	20 (1.1)	2.2 (0.7; 3.7)*
Borderline finding <sup>4</sup>	129 (22.2)	73 (3.9)	18.3 (14.8; 21.8)*
New diagnosis <sup>5</sup>	37 (6.4)	64 (3.4)	3.0 (0.8; 5.1)*
New diagnosis during follow-up <sup>5</sup>	11 (1.9)	50 (2.7)	-0.8 (-2.1; 0.5)
<b>Hypothyroidism</b>			
Eligible (=n)	548 (100)	1836 (100)	-
Tested	509 (92.9)	595 (32.4)	60.5 (57.4; 63.5)*
Pathological finding <sup>6</sup>	17 (3.1)	32 (1.7)	1.4 (-0.2; 2.9)
New diagnosis <sup>7</sup>	14 (2.6)	38 (2.1)	0.5 (-1.0; 2.0)
New diagnosis during follow-up <sup>7</sup>	5 (0.9)	29 (1.6)	-0.7 (-1.6; 0.3)

<sup>1</sup> Hb<130 g/l in men and Hb <120 g/l in women

<sup>2</sup> Blood glucose >=6.7 mmol/l fasting or >=8.0 mmol/l not fasting

<sup>3</sup> S-cobalamin < 110 pmol/l

<sup>4</sup> S-cobalamin=110-200 pmol/l

<sup>5</sup> Diagnosis of cobalamin deficiency or treatment with cobalamin

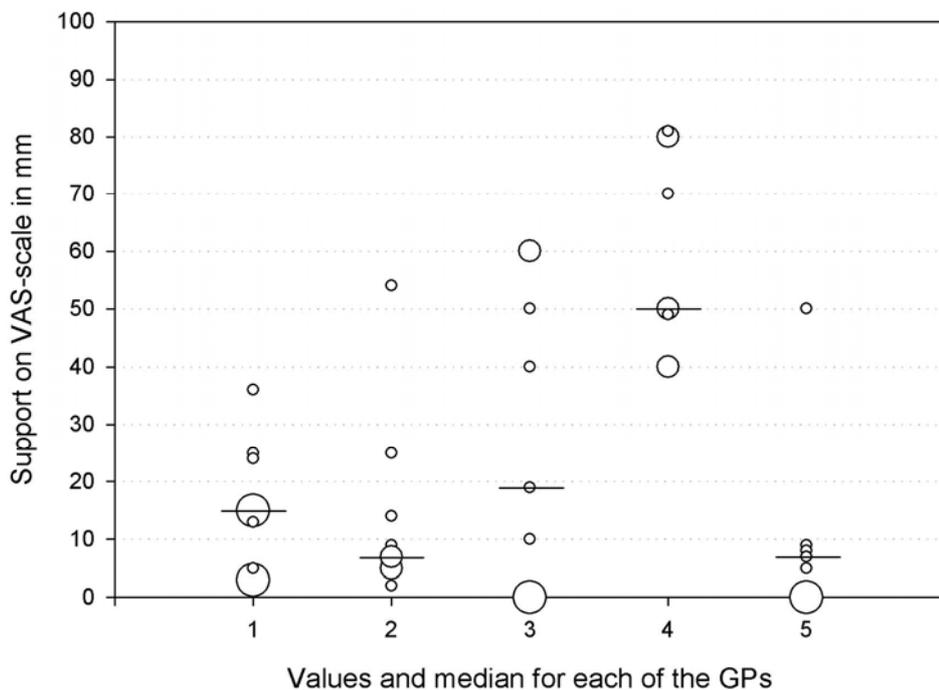
<sup>6</sup> S- thyrotropin > 5.0 mIU/l

<sup>7</sup> Diagnosis of hypothyroidism or treatment with levothyroxin

\* Statistically significant difference at a level of less than 5%

### *The perceived support*

The mean rank value for the support perceived by the GPs was 15 mm (range 0-81 mm) (Figure 3). In 6 cases the perceived support was marked as 0 (by 2 GPs). The individual values for four of the GPs fell into two intervals with a gap between, one below 40 mm and the other 40 mm and above. Therefore we regarded a value equal to or above 40 mm as representing substantial support. According to this interpretation the perceived support was substantial in 17 (35%) of the cases, and there was only one GP who had no value in this range. We could not see any association between years of clinical experience and perceived support, except that the GP with the shortest clinical experience seemed to perceive generally greater support than the others.



**Figure 3.** Distribution of the marks for perceived overall support reported by the GPs on a 100 mm visual analogue scale. The smallest dots represent 1 mark, the medium dots 2 marks and the largest dots 3 marks each.

### *The GPs' considerations versus the CDSS' suggestions*

We grouped the GPs' considerations about investigations according to the CDSS' diagnostic suggestions (Table 5). When the suggestion was "suspect CHF" or "not possible to calculate", the GPs considered investigations in 67% of the cases whereas they did so in 23% of the cases when the suggestion was "CHF not present" and in 14% -15% when the diagnosis was confirmed by the CDSS. Of the 31 investigations considered by the GPs, 14 were in agreement with the CDSS'

suggestions. The GPs considered 10 of 15 suggestions for echocardiography and 2 of 8 S-BNPs. There was agreement between the GPs' considerations about changes in medications and the CDSS' suggestions in 4 of the 10 considered changes.

The CDSS' suggestions on the diagnosis		Changes in the GPs' confidence in the diagnosis		Proportion of cases where the GP considered further investigations	
		More confident	Less confident	n	%
		n	n	n	%
"CHF is present"	(n=13)	1	1	2 of 13	15
"Asymptomatic dysfunction"	(n=7)	1	0	1 of 7	14
"Suspect CHF"	(n=12)	3	2	8 of 12	67
"CHF not present"	(n=13)	1	3	3 of 13	23
" Not possible to calculate"	(n=3)	0	0	2 of 3	67
<i>All cases</i>	<i>(N=48)</i>	<i>6</i>	<i>6</i>	<i>16 of 48</i>	<i>33</i>

**Table 5.** Changes in the GPs' confidence in the diagnosis and the GPs' considerations regarding further tests in relation to the CDSS' diagnostic suggestions (N=48).

### *The GPs' comments*

The GPs wrote comments on 29 cases falling into two main categories; one dealt with the CDSS itself and one with its use in the clinical situation. Among the comments on the CDSS itself, three mentioned that the check boxes for electrocardiogram (ECG) in the diagnostic module did not cover all possible pathological variations. Two comments concerned the fact that the CDSS did not accept a certain drug combination that was prescribed in line with existing local routines. The GP had to withdraw one of the drugs in order to proceed. In one of those cases the GP chose to quit the treatment module instead. Two comments described the program suggesting treatment that had already been input as existing medication for the patient. This turned out to be a program error that occurred when the user carried out an unintended action, and it was corrected later by the constructors.

Among the comments dealing with the clinical situation, eight described circumstances overshadowing a potential CHF, so that the GP did not find it justified to consider the CDSS' suggestions (patients who had died since the last visit, had other severe conditions or were very old and without symptoms). In seven cases the GP intended to await the results from the investigations before making any decisions on medications. In four cases there was an assenting comment to the program's suggestions (e.g. "Very appropriate in this case to perform a new echocardiogram now"). Two comments mentioned that the patient also visited a cardiologist and in one comment it was stated that the patient would not accept more drugs.

## Study IV

We did not reveal any substantial differences regarding the GPs' attitudes and characteristics in the two interview sessions. Instead, the follow-up interviews confirmed and elaborated the findings from the initial interviews. The results are presented according to the similarities and the differences that were found.

### *Similarities in attitudes and characteristics*

We found six categories concerning similarities:

#### *Management of CHF at the PHC centre:*

- Management of CHF represents only a small part of the GPs' everyday concerns

#### *Computer use in medicine:*

- Computers have a theoretical potential to improve the quality of medical care but their design is still not optimal
- Computerisation in PHC has resulted in added administrative duties
- The EPR is fairly good except for some cumbersome features, but it requires quite a lot of time during each visit

#### *Common opinions about the CDSS:*

- Concise and fairly easy to use after the initial training
- Applying it to the records of the selected patient cases (in study III) was beneficial
- It rarely failed to run properly, but some of the recommendations were not in agreement with local guidelines
- Having to fill in forms with patient data is a drawback

#### *Finding answers to medical questions:*

- Discussion with colleagues is of positive value and is often the first choice

- Clinical guidelines provide very important support
- The reliability of information from different sources is not dependent on the kind of source per se, but rather on whether the sender of the information is known and considered reliable

*Focusing on the patient during the consultation:*

- Offering enough time and focusing on the patient during the consultation are of top priority
- Computer usage has to be minimised while the patient is telling his/her story
- It is important, irrespective of shortage of time, not to let the patient feel there is any hurry

*Feeling stressed and rushed during the workday:*

- Feeling stressed and rushed is common and constitutes an important obstacle in updating skills and knowledge adequately and in implementing new working methods
- Easier to run the CDSS after clinic hours when there is less stress

***Differences in attitudes and characteristics***

When looking for underlying meanings and threads in the categories illustrating differences between the GPs, we found three sub-themes (Table 6) and one main theme (see below) that finally led us to an understanding of the GPs' acceptance of the CDSS. Within the sub-themes and the main theme we could distinguish three different profiles (called "Profiles 1, 2 and 3"). The distribution of individual GPs in the Profiles turned out to be the same in both interview sessions. The only difference between the results from the initial and the follow-up interviews was that most of the GPs had a clearer opinion about the CDSS at the follow-up.

Demographic characteristics such as age and years of experience as a GP did not, on their own, seem to determine the distribution of GPs into the different Profiles. All GPs had a personal computer at home, but the frequency of usage was very moderate and varied from no usage at all to several times a week.

Profile 1 was characterised by feeling unskilled and inexperienced in computer use and being stressed by new tasks. Decision making in practice was based mainly on pre-existing knowledge. The CDSS was not considered as beneficial, in practice, to the decision making process. Computer use in clinical work was mainly seen as a burden, "a necessary evil".

Profile 2 felt quite inexperienced in computer usage, but sufficiently competent to improve if necessary. Profile 2 described being keen on having up-to-date information on the management of CHF. The most important prerequisite for proper decision making was considered to be possession of thorough

**Table 6.** Description of the GPs' Profiles within the sub-themes (A, B, C) found in the initial and follow-up interviews

	<b>A/ The GP and the computer: attitudes and skills</b>	<b>B/ Problem solving in disease management</b>	<b>C/ Decision making and the computer</b>
<b>Profile 1</b>	<ul style="list-style-type: none"> <li>• Limited computer skills, no time to learn more</li> <li>• Feelings of stress associated with a new task on the computer</li> <li>• A feeling of being forced to use the computer (EPR) in everyday work</li> <li>• No confidence in managing EviBase</li> </ul>	<ul style="list-style-type: none"> <li>• Not especially involved in CHF management</li> <li>• Mostly asks colleagues if problems arise</li> <li>• Clinical guidelines are good, but not used much in the decision making situation</li> </ul>	<ul style="list-style-type: none"> <li>• Has to rely completely on own capacity to make the right decisions.</li> <li>• Computers do not have any practical role in decision making today.</li> </ul>
<b>Profile 2</b>	<ul style="list-style-type: none"> <li>• Computer usage infrequent outside work.</li> <li>• Improving computer skills is given low priority</li> <li>• Information retrieval on the Internet takes too much time and has low accuracy</li> <li>• Nevertheless convinced about own ability to manage EviBase</li> </ul>	<ul style="list-style-type: none"> <li>• Has an interest in the management of CHF and is keen on updating regularly</li> <li>• Looks for information in books or from colleagues if problems arise</li> <li>• Reads and updates clinical guidelines regularly (in printed form)</li> </ul>	<ul style="list-style-type: none"> <li>• Decision making is based on active and careful reasoning by the GP.</li> <li>• Clinical guidelines are important in updating one's knowledge, whereas the role of the computer is secondary and not well-defined.</li> <li>• CDSSs processing patient data are less reliable, as it is not possible to follow the underlying process.</li> </ul>
<b>Profile 3</b>	<ul style="list-style-type: none"> <li>• Uses the computer quite regularly outside work</li> <li>• Uses opportunities that arise during the workday to practice computer skills</li> <li>• Considers the computer as an important tool and regularly seeks medical information on the Internet</li> <li>• No problem managing EviBase</li> </ul>	<ul style="list-style-type: none"> <li>• Does not have a special interest in the management of CHF but is keen on learning more</li> <li>• Gets information both from colleagues and from the Internet if problems arise</li> <li>• Clinical guidelines are essential and are used both in printed and on-line versions</li> </ul>	<ul style="list-style-type: none"> <li>• Effective decision making requires constant improvement in the GP's knowledge, and computer support can facilitate that</li> <li>• Approves of both the kind of CDSS that processes patient data and the kind that presents general clinical guidelines, as they complement each other</li> <li>• Still endeavouring to overcome instinctive resistance to changing working habits</li> </ul>

knowledge. The CDSS was given some credit for confirming decisions, but it was not beneficial enough to be incorporated in their own practice. Filling in forms on the computer with patient data felt very cumbersome and annoying.

Profile 3 regarded the computer as just like any other tool for work that requires practice and time to master. The time devoted to practicing on the computer was very limited, but there was a feeling of being skilled enough to solve new tasks fairly well. In Profile 3 a kind of acceptance of the CDSS seemed to be attained, and this Profile was alone in giving a balanced picture of the program, as both its disadvantages and advantages were mentioned at the same time. Nevertheless, it was thought to be difficult to use a CDSS in routine work unless extra efforts were made to change working habits.

### ***The main theme***

The main theme we found during the analysis was:

*Giving CDSSs a role as a supporter of knowledge and decision making in the GPs' professional practice*

The main theme subsequently emerged during the analysis of both the initial and follow-up interviews. It turned out to permeate all the sub-themes and categories. The Profiles' descriptions of different aspects of the main theme reflected the GPs' medical practice philosophy and their way of approaching the use of a CDSS in practice (Table 7.).

Profile 1 described the CDSS as inferior to the GP in that it could not process all facets of the patient's problems. For that reason the CDSS could not be incorporated into the decision making situation. Further, there was a distinct difference between Profiles 2 and 3 in their thoughts on how the GP should handle knowledge in order to obtain the aims of good professionalism.

Profile 2 described a rather traditional view of the GP, saying that professionalism requires the GP to have all necessary, up-to-date knowledge in his/her head in the decision making situation, and to apply it to the individual patient by means of active and independent reasoning. Having to use computer support was thought to lead to the risk of being deprived of the very essence of the GP's profession: active and independent reasoning.

The description of the GP's role in Profile 3 was focused instead on the interaction between the GP and the patient, where the GP was seen as more like a coach who gathers all needed information for the decision making process, and does not necessarily have it all in his/her head. Searching for complementary information from all kinds of sources was considered natural. The computer could provide assistance in this process and thereby support independent reasoning.

**Table 7.** Description of the GPs' Profiles within the main theme (D) and attitudes towards the CDSS (E).

<b>D/ Giving CDSSs a role as a supporter of knowledge and decision making in the GPs' professional practice</b>	<b>E/ Attitudes towards the CDSS</b>
<p><b>Profile 1</b></p> <ul style="list-style-type: none"> <li>• Describes the GP's profession as taking care of all aspects of patients' problems, not only the presented symptoms</li> <li>• CDSSs can not provide any support, as they are unable to take all aspects of the patient's situation into consideration</li> <li>• Seeking information with the patient present is OK but not on the computer</li> </ul>	<ul style="list-style-type: none"> <li>• No acceptance attained. Feelings of resistance toward the CDSS</li> <li>• No experienced need of support for CHF</li> <li>• It is too stressful to use the CDSS with the patient present</li> </ul>
<p><b>Profile 2</b></p> <ul style="list-style-type: none"> <li>• Describes the GP's profession as acquiring all necessary knowledge to be able to give patients as optimal treatment as possible</li> <li>• When relying on CDSSs in decision making, the GP risks being deprived of independent reasoning</li> <li>• The CDSS can at its best confirm the GP's decision</li> <li>• Seeking information with the patient present is avoided, except perhaps contacting colleagues.</li> </ul>	<ul style="list-style-type: none"> <li>• Partial acceptance attained. Feelings of some resistance toward the CDSS</li> <li>• The CDSS's usefulness is limited, as it did not actually alter any medical decisions in practice. It could have some value as a reminder about new methods</li> </ul>
<p><b>Profile 3</b></p> <ul style="list-style-type: none"> <li>• Describes the GP's profession as providing patients with guidance and making them well-informed and active with the aim of attaining rapport and agreement on decisions</li> <li>• CDSSs can supplement the GP's knowledge, improve disease management methods and support independent reasoning</li> <li>• Seeking information with the patient present is completely natural irrespective of the source used</li> </ul>	<ul style="list-style-type: none"> <li>• Acceptance attained. No feelings of resistance toward the CDSS</li> <li>• The CDSS provides support in further professional education and in individual patient cases</li> <li>• It is stressful but still possible to use the CDSS with the patient present</li> </ul>

### *Attitudes towards the program and influences between themes*

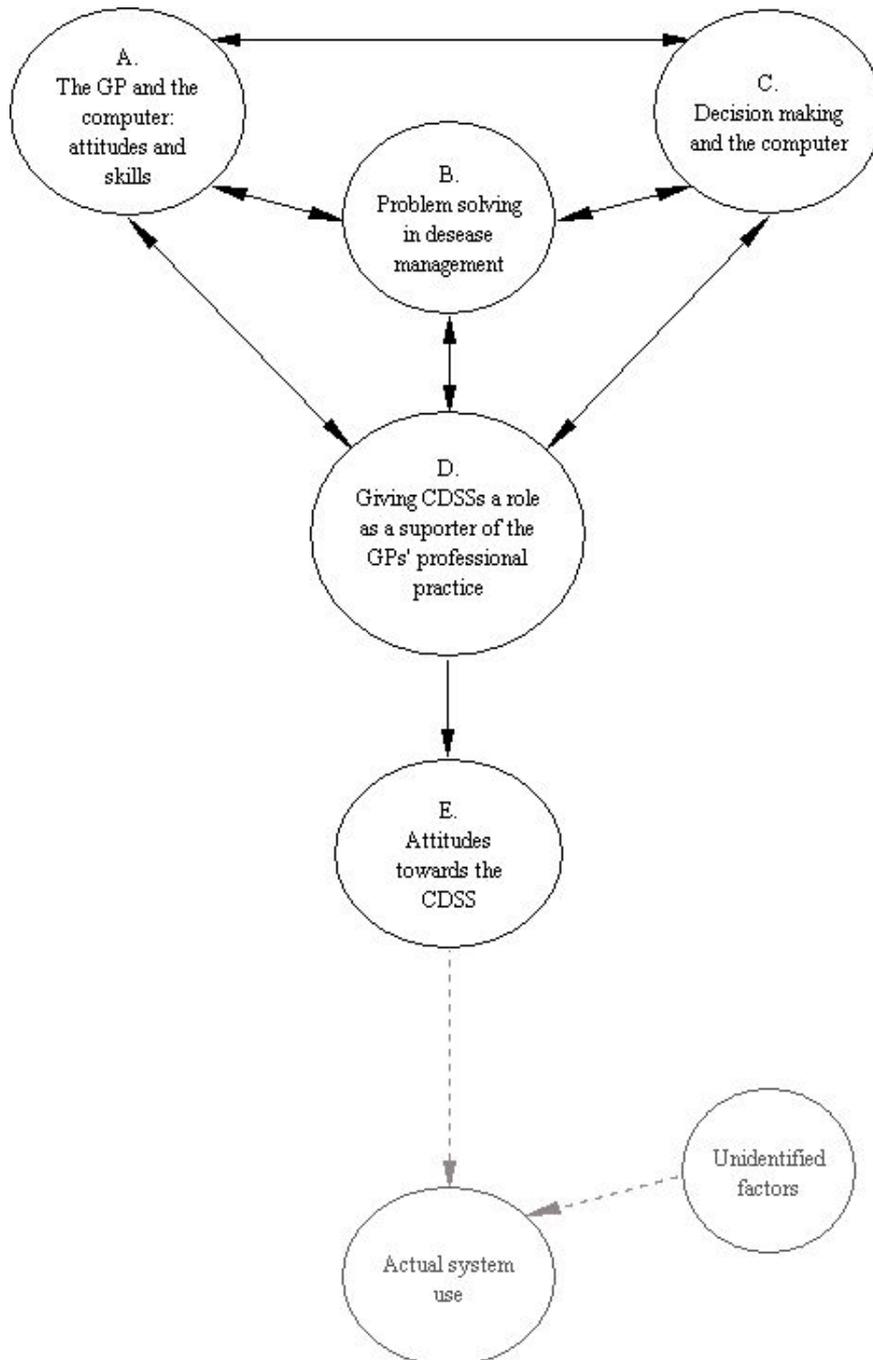
The views and attitudes that emerged in the follow-up interviews regarding the CDSS turned out to be different in the three Profiles. They seemed to attain different degrees of acceptance, with Profile 1 maintaining full resistance and Profile 3 attaining reasonable acceptance (Table 7). Most of the GPs had on some occasion used Internet sites presenting general clinical guidelines, but none had used a CDSS that processed patient specific data. In comparing their experiences from those Internet sites with the CDSS used here, only Profile 3 reported considering the benefits of the CDSS to be of the same value. It was also only in Profile 3 that usage of the CDSS during patient visits was described as practicable, although still stressful.

We could discern influences between the different sub-themes (A, B and C), the main theme (D) and attitudes towards the CDSS (E). There seemed to be reciprocal relations between each of the sub-themes and the main theme, which in turn determined the attitudes towards the CDSS program (Figure 4).

### *Field observations*

Of the eight field observations performed, six were done during patient visits. On two occasions the CDSS was used after the visit and on one occasion the GP was not able to run the program due to missing data. There were no observations in Profile 1.

When opening the CDSS, all GPs made some explanatory comments to the patient. When filling in forms with patient data, the GPs alternated in their strategies for gathering the information, obtaining it either from the EPR or from the patient. That made it difficult to determine the exact amount of time that was devoted to this task, but it varied between 1-5 minutes per module. In only four of the observations were both modules run. With respect to directing their focus of attention during the visit between the patient and the computer, the GPs chose a strict sequential division of time between the two, or changed their focus from one to the other either for short periods or almost simultaneously. This was part of each GP's individual way of working and was not related to the Profiles. In all visits, however, the GP tried to get a few minutes alone with the CDSS while the patient was occupied with something else (e.g. getting dressed or having an ECG done in another room). None of the patients gave any sign of being disturbed and did not comment on the use of the CDSS.



**Figure 4.** Influences between the sub-themes (A, B, C) and the main theme (D) describing the attitudes and characteristics of the GPs in the different Profiles and acceptance of the CDSS (E). Further influence on actual system use and additional influencing factors are not assessed in the present study.

There were some differences between the Profiles:

1. When filling in the forms with patient data, Profile 2 tried to avoid changing to the EPR, whereas Profile 3 seemed to alternate more freely.
2. When receiving the program's recommendations, Profile 2 simply stated that nothing new had come to light. Profile 3 read the recommendations and the comments and took them into account when deciding on further actions, but did not always follow the recommendations.

### ***Additive results***

Five of the six patients whose visits were observed consented to an interview. All reported being very satisfied with their visits and not experiencing any disturbance because their GP was using the computer or the CDSS. All patients described positive expectations regarding computers in medicine in general, and only one had some worries about risks. All patients were positive about their GPs using a computer with respect to benefits for themselves. Computer support in the GP's work was seen as a more powerful instrument by the patients than by the GPs themselves. One patient expressed the opinion that a proficient GP should rely on experience rather than using computer support in decision making.

During the study period, actual usage of the CDSS was detected by the server. The log-files showed that either of the two modules was triggered by some of the GPs on 38 occasions (not counting usage related to training, interviews and observations). There were, however, many clusters of marks made within very short time slots (1-5 minutes), implying that they were related to the same decision making situation. We chose to count each 5-minute slot as a separate occasion of usage. Then we calculated the number of such occasions per GP and found an average of four occasions per GP in Profile 3 and three in Profile 2, but none in Profile 1. Profile 2 tended to have a larger number of marks in those 5-minute slots (predominantly 4-7 marks) than Profile 3 (1 mark only on more than half of the occasions).

# Discussion

In these studies we assessed the use of two different types of CDSSs in the areas of health screening and management of chronic diseases in PHC. The CDSSs were different in construction/design, in the way they were accessed by users, and in their clinical purpose. Both CDSSs were used in authentic clinical environments with the aim of exploring their usage and clinical effect. We could therefore also gain some insight into the implementation process and elucidate some obstacles and facilitating factors regarding wider use of CDSSs in clinical practice.

The construction of the EPRs used in the different studies also differed, which was of importance regarding what kind of CDSSs could be used in that computing environment and regarding the outcomes of the studies. This mixture of characteristics gives us a wider picture of the functioning, the usage and the effects of different CDSSs in PHC.

## The CDSSs

### *The reminder program (studies I and II)*

In study I we aimed at complete harmonisation of the health screening and the PHC centre's everyday work. This was facilitated by the reminder program being completely integrated within the usual EPR system. The most important requirement for the successful use of a computer reminder program is the everyday use of a highly structured EPR system with an integrated search module. Fulfilling this criterion, our approach could provide the main advantages of computer support: easy access to a large amount of patient-specific data, prompt processing of data, an easy-to-use interface (no need to change between databases), and no protocols to fill in.

The exclusion criteria to be used by the reminder program were difficult to design for some of the screening tests. We aimed to exclude those patients who already had the diagnoses in question, and this was possible for six of the seven areas. To take maximum advantage of the reminder program it was also necessary to find exclusion criteria for each of the tests and they needed to be able to be expressed appropriately for data programming. That would be the case if tests and prescriptions always clearly corresponded to specific diagnoses. We found such criteria for blood glucose, serum thyrotropin, and serum cobalamin. The criteria were more complex for the other screening tests, and for these we could not exclude all patients who had had the tests as part of a follow-up of medical treatment.

### *The CDSS for management of CHF (studies III and IV)*

The program itself was an advanced CDSS that not only translated clinical guidelines to patient-specific advice, but also provided descriptions of the rules in the guidelines and explanations for the suggestions, which has been shown to increase user acceptance.(Teach 1981) It also possessed three of the four most important features identified by a meta-analysis as being associated with improved clinical practice: provision of decision support at the time and location of decision-making, provision of a recommendation rather than just an assessment, and computer-based generation of decision support.(Kawamoto 2005)

There were 20 cases in study III where the CDSS did not find any suitable medication to add. This could indicate that those patients were already optimally treated, or that the cases were too complicated for the program. Nor was there any possibility of getting advice on adjusting the dosage of drugs already used, which also was commented on by one informant and considered a shortcoming of the CDSS (study IV). The result sheet only included instructions on the recommended dosage of the suggested drugs.

### *Strengths and limitations of the evaluation methods*

The evaluation strategy we used in studies I and II to compare all the data in the EPRs concerning the studied conditions of the participants and controls was chosen so that the research method would be completely computerised, without the need to fill in any separate protocols. The screening activities were integrated as a natural part of the GPs' work, owing to the support of the reminder program. Measured in this way, the differences in medical outcomes between the participants and the controls should reflect the benefits of the reminder program when it is actually used. Further, we measured clinical outcomes (new diagnoses and medications) in addition to test rates, and had a relatively long intervention-free follow-up period.

The results of the ESR tests and the data for breast examinations could not be fully processed. It was not possible to evaluate this data directly by MQL queries, and manual evaluation would have required a great deal of time. These difficulties show that evaluation solely by computer requires that the object of evaluation is definable in computer language, i.e. that it does not include any free text. Evaluation could be enhanced by making the structure of the EPR system even stricter, but this would make it less user-friendly in everyday clinical work.

The fact that we were not able to use a randomised controlled design in study II reduces our ability to link the results to the intervention. Randomising GPs would have involved a considerable risk of influence between the groups, and randomising patients would have resulted in bias problems. Instead, we chose the second best alternative: an intervention and control group design. It has been concluded by some researchers that randomisation is often difficult when studying the use of information systems in health care in real-world settings (Burkle 2001).

In study I, 24% of the eligible patients were excluded because of a shortage of time during the visit. This was an unforeseen circumstance when the study was planned, and it was not designed to collect information on the details regarding this situation. We could have explored this question with qualitative methods such as interviews or questionnaires, as the results of this study would have gained in richness through a combination of methods.

In study III the evaluation of the CDSS was performed on the medical records of real-life patients by the GPs who were taking care of them – imitating real clinical situations. Further, we asked the GPs for their immediate reactions and considerations directly after having assessed each patient case. Their answers can therefore be seen as very reliable, as there was no risk of a memory gap. However, we had a small sample of GPs, which restricted the possibilities for generalisation of the results. As we did not have any control group, we can not with certainty differentiate the effect of the CDSS from the effect of the GPs simply reasoning about the management of their CHF cases a second time. Another limitation is that the cases already had a previously stated diagnosis and ongoing treatment. The diagnostic module seemed to be most functional when used in new cases.

The purpose of using qualitative methods in study IV was to get a deeper understanding of the implementation process from the users' perspective. Qualitative methods are very appropriate in medical informatics when the aim is to illuminate the function of the information resource in its working environment from the viewpoint of users (Friedman 1997).

Qualitative studies usually use small sample sizes, as the aim is to maximize the depth and richness of the information instead of detecting its frequency of occurrence. We had only five informants in the study, and that can naturally be a limitation in that the results may not reveal all the important views of potential CDSS users in PHC. We combined several different methods in the data collection and analysis - repeated interviews with the GPs, observations, patient interviews, and detection of usage - which enriched the picture of the phenomenon studied. Integrating different methods in this way, which is called triangulation, increases the validity of the results (Ammenwerth 2003b). We also found good agreement between the data from the interviews, observations and patient interviews, thereby strengthening our confidence that we obtained quite a complete description of the implementation process. One technique often used in qualitative studies in order to collect as complete material as possible is to continue collecting data until saturation is reached, i.e. when no more new information comes to light. We were unable to use this technique, as the number of informants in the present group was limited right from the beginning, and we had no additional resources that would have allowed us to include several groups in the study. We chose instead to collect data by means of different methods, thereby describing different aspects of the phenomenon studied and reaching saturation of the collected material in this way.

We chose a purposeful sample in that the GPs in this study did not have more than an average interest in using computers in their work, which gave us the opportunity to study the difficulties during implementation where they are probably most prominent. The fact that all participants were women is a limiting factor for the transferability of the results. We can not comment on gender differences in attitudes. However, several earlier studies found no relation between gender and attitudes towards computers (Brown 1994; Jerant 2000)

The fact that the author, who also conducted all the interviews and observations, is a colleague of the informants and works at the same unit has both positive and negative implications. The researcher in qualitative studies is also an instrument and as such uses his/her background and pre-understanding in the collection and analysis of the data. These factors are therefore always of importance regarding the study results. The fact that in study IV the researcher was familiar with the work situation at the PHC centre could have resulted in her causing fewer disturbances, leading to a more relaxed atmosphere. In assessing the GP interviewing fellow GPs, Chew-Graham also found that when the informants knew that the interviewer was a fellow professional, the answers tended to be richer and more intuitive (Chew-Graham 2002). This collegial relation could, however, make it more difficult for the researcher to put her preconceptions aside and it could also reduce her possibilities to notice certain details. During the process of data collection and analysis, the continuous collaboration with a co-researcher, who is experienced in qualitative research methods and who had never met the informants or visited the PHC centre, ensured some compensation for these drawbacks.

## The EPR systems

The databases of the EPR systems in studies I and II (Swedestar) were the basis for both the reminder program that selected patients for the intervention, and for the MQL queries in the evaluation of the study results. Consequently, accurate recording of the diagnoses and prescriptions was essential to the study outcomes. Many elderly individuals have several diagnoses and prescriptions, and this information may therefore be less accurate, resulting in some unnecessary screening tests and an underestimation of the number of diagnoses and prescriptions. However, we have no indication of any difference between the participants and the controls in this respect. Information in the record indicating that a test has been performed may be regarded as highly reliable.

In study III the selection of patients with the diagnosis of CHF by searching the EPRs (ProfDoc) could have limited our possibilities to attain a maximum effect of the CDSS. It has previously been shown that when registration of diagnoses is not mandatory in the EPR, the number of registrations is lower. Other studies have also shown that finding patients with CHF by searching the problem list of the EPR is most often not sufficiently reliable. (Onofrei 2004) Inclusion of the cases where the GP did not think of the possibility of CHF or felt too uncertain to register the

diagnosis may have improved our results, as the CDSS can probably give most support in those cases.

Patient data had to be extracted manually from the records each time the GP had to fill in the CDSS form. There could be a risk that the data registered in the forms were not always completely correct due to human error. This would also be the case when the GPs used the CDSS in their everyday work. We did not, however, check for agreement between data in the forms and in the patient records.

## The use and effect of the CDSSs

### *The CDSS for screening*

In study I the main barrier to including all patients who fulfilled the criteria was the GPs' lack of time, although the reminder system was nevertheless used in the majority of encounters. As many as 66% of all patients who fulfilled the inclusion criteria made an active decision to participate in the screening, which is in line with other studies (McMenamin 1992; Yarnall 1998).

In study II we focused mainly on patient benefits from the computer supported health screening, and we found a statistically significant increase in laboratory and manual screening tests which was greater than, or in line with, that reported in previous studies (Hulscher 2002). Pathological test results were more frequent in cobalamin deficiency and hypertension. An increased rate of new diagnoses or treatments was seen only for cobalamin deficiency. We think that one reason there was no increase in new diagnoses of hypertension could be that the importance of treating systolic hypertension in the elderly was not yet generally disseminated in Swedish PHC at that time. In a population based screening in a Stockholm district in 1987 the prevalence of untreated hypertension (mostly systolic) was over 47% in the elderly over 75 years of age (Aguero Torres 1994). A smaller proportion of the participants as compared to the controls had a diagnosis of cobalamin deficiency or treatment prior to the study. Cobalamin deficiency was also the least established screening area two years earlier. Our interpretation of these results is that the effectiveness of the system is probably most prominent in less established screening areas.

### *The CDSS for management of CHF*

The finding that the GPs' confidence in the diagnosis changed in every fourth case after using the CDSS (study III) is in line with other studies assessing clinicians' confidence in their responses to clinical questions before and after using computerised evidence systems (Dreiseitl 2005; Westbrook 2005). In our study the GPs considered some additional investigations in 67% of the 15 cases where the diagnosis was uncertain ("Suspect CHF" and "Not possible to calculate"). This proportion was considerably lower (15%) in the cases where the CDSS' suggestions included a confirmed diagnosis and no further investigations ("CHF is present" and "Asymptomatic dysfunction"). This could reflect the CDSS'

influence on the GPs' considerations. Regarding the GPs' adherence to the CDSS' suggestions in each case, they considered fewer than every second suggestion but considered almost as many others. One reason for that could be that the CDSS did not take into account the date of the previously performed investigations, while the GPs probably did.

The proportion of cases where the GPs considered a change in medication was lower in our study than in findings reported by Subramanian showing adherence to treatment suggestions of a CDSS in 30% of the cases with a previously confirmed diagnosis of CHF (Subramanian 2004). The reason for this could be that the CDSS in our study presented suggestions on additional medications whenever it was possible to find one. The GPs, however, might have found that additional medication was not justified in the situation or might have preferred to await the results from the investigations they were considering. Many of the GPs' comments described this discrepancy, and we therefore think it would have been more efficient to use the two modules on separate occasions.

In study IV we found different profiles for GPs that seem to be associated with the degree of acceptance of the CDSS. The main theme in all the profiles was the ability to give the CDSS a role as a supporter of knowledge and decision making in the GP's professional practice.

In exploring attitudes towards the usage of the CDSS and computers in general, we looked for similarities and differences in the interviews with each of the informants. Although all of the GPs regarded computers and CDSSs as having the theoretical potential to improve the quality of medical care, they did not find them sufficiently flexible and convenient. All the GPs also reported experiencing that having to retrieve patient data from the EPR and filling in the forms of the CDSS was a burden.

In one perspective, the Profiles that were found can be seen as representing different stages ranging between non user and convenient user. Profile 1 views all computer work as a burden. Profile 2 only sees theoretical benefits from the CDSS, while Profile 3 sees it as a suitable tool. Other studies have similarly found three main groups when assessing physicians' views on computer aid in their work. Using a survey instrument, Dixon and Stewart stratified GPs into high, intermediate and low usage groups (Dixon 2000). Valenta and Wigger used a mixture of qualitative and quantitative methods (Q-methodology) and distinguished three groups of users needing different types of interventions during implementation: those needing only minimal training interventions, those needing additional computer training, and those needing motivational interventions as well (Valenta 1997).

When assessing influences between the themes found in our study (Figure 4), we could see similarities when compared with the Technology Acceptance Model (TAM) described by Davis (Davis 1993). The TAM model presents a theoretical frame for technology acceptance where "Perceived usefulness" and "Perceived

ease of use” are determinants for “Attitudes toward using”, which in turn anticipate actual system use. In a comparison, our main theme (D) would match “Attitudes toward using”, while the sub-themes (B) and (C) would together represent “Perceived usefulness”, and sub-theme (A) would represent “Perceived ease of use”. The correspondence between those entities is, however, not total. In our analysis we could see an influence from (B) and (C) on (A), while in the TAM model there is no influence from “Perceived usefulness” on “Perceived ease of use”. This may be because in our study we did not narrow our focus to examine attitudes strictly restricted to the CDSS targeted in this study, but tried to capture as many aspects as possible influencing the GPs’ handling of a CDSS in everyday work. Our informants expressed greater readiness to practice computer skills when the perceived usefulness of the system was greater, and also when their level of computer skills was higher. The TAM model, initially a theoretical construct, has been validated in many studies of user acceptance of computer technology (Shengnan 2003).

## Screening and prevention

The fact that in study I a considerable proportion of the PHC centre’s patient population participated in the screening during the study period of 20 months (602 out of 1207) indicates that opportunistic screening of the elderly is a useful approach in PHC and well accepted by patients (McMenamin 1992; Yarnall 1998).

The selection of the screening tests for the test battery could be discussed. Our strategy was to mix different kinds of tests in order to assess the function of the reminder program in the health screening. Some of the screening tests were widely recommended and already well established, such as blood glucose, blood haemoglobin, blood pressure, breast examination (Andersson 1993; Beers 1991; Bitzen 1986; Hanson 1993; Weiler 1989b), and fulfilled the criteria described above in the Introduction section. Serum thyrotropin and serum cobalamin were also recommended by some authors, but were not yet established (Bulpitt 1990; Falkenberg 1983; Lantz 1990; McRae 1989; Nilsson-Ehle 1989; Pennypacker 1992; Stabler 1995). The reason for the inclusion of blood erythrocyte sedimentation rate was the simple fact that, despite previous negative reports (Gronlie 1991; Kirkeby 1989; Sox 1986), it was a very common test in PHC, and it was therefore of interest to investigate its value.

In study II we aimed to assess patient benefits of the screening program when actually used in everyday clinical work. The figures for the frequencies of new diagnoses were generally small, but the relative difference between the groups was nevertheless marked for cobalamin deficiency (6.4% and 3.4%, respectively). A smaller proportion of the participants as compared to the controls had a diagnosis of cobalamin deficiency or treatment prior to the study. This difference had disappeared after the study. Cobalamin deficiency was also the least established screening area with only a 20% test rate in the controls. The number of new diagnoses during follow-up was smaller than expected in two areas (diabetes and

anaemia). This may indicate that these diseases had actually been detected at an earlier stage. We believe that our results may be generalised to opportunistic screening in other screening areas.

The fact that the proportion of patients selected for each screening test was between 69–97% among the participants may indicate that the program is timesaving for the GP and that it may support avoidance of unnecessary tests, i.e. several screening tests were probably actually excluded. The fact that almost all recommended screening tests were performed indicates that our approach is feasible in everyday clinical practice.

## The management of chronic diseases

In studies III and IV the GPs expressed both a need of and a positive attitude toward clinical practice guidelines for chronic disease management in general. We could also see that using a guideline-based CDSS for the GPs' own patient cases seemed to influence the GPs' management of those cases. The overall perceived support by the GPs could also be regarded as substantial in more than every third case. Nevertheless, contacting colleagues was the most frequent way to seek answers to clinical questions in their everyday work. Ranking discussions with a colleague as highest in value in solving clinical problems has also been reported from other studies (Adams 2005; Coumou 2006). In addition, discussions with colleagues help put the problem into a relevant context and provide opportunities to solve organisational issues at the same time, which was also pointed out by our informants. The fact that the problem of CHF did not seem to be as important an issue from the GPs' disease management perspective as it is for society and the individual patient could also reflect a high work load and the proximity of cardiologists.

Further, another perceived shortcoming was that the CDSS could not give advice on the question of what was preferable, adjusting the dosage of already prescribed drugs, or prescribing an additional one. This could indicate that decision-making in chronic disease management is often complicated and that it is not always possible for a computer program to cover this process completely (Tierney 1995).

Regarding the CHF cases at the PHC centre, we could see that age and gender distributions as well as the prevalence of the related conditions and the proportion of patients who underwent echocardiography were similar to those reported for Sweden as a whole in a large international survey on the management of CHF in primary care (Cleland 2002). The total usage of ACE inhibitors or Angiotensin II receptor antagonists was also on the same level, but the usage of diuretics and beta-blockers was somewhat higher in our study.

## PHC

Our studies provide us with some insight into PHC in Stockholm and also give us information about the conditions that influence the usage and implementation of a CDSS in this environment.

The participating GPs in all the studies were fairly representative of GPs in Stockholm, as they were of average age, and their education and experience in PHC were also average, and none of them had above average experience in scientific studies or computer applications. They had used EPR systems for about ten years before the performance of the studies. There were, however, some differences between the GPs in the different studies. Those participating in studies I and II probably had an above average awareness of the importance of thorough recording in the EPR, as its database was highly structured and required entering data in a highly structured way, but also because data from the EPR were frequently used for audit and feed-back on patient care in the GPs' peer group. The GPs participating in studies III and IV did not use any data from the EPR for feed-back and were probably not more aware of the structure and content of the EPR than GPs in other PHC centres.

Time constraints in everyday clinical work emerged as an important factor in the studies. This was the cause of the unexpectedly high number of patients excluded in study I, despite the fact that the reminder program did not require extra work from the GPs. The figure might have been lower if the screening procedure had been a part of normal clinical routine and had not required the consent of each participating patient. Lack of time at the visit as a reason for non-participation has also been reported in other studies (Stange 1998b; Yarnall 1998). One possible approach would have been only to select and enrol patients in the study during the visit, and to allocate the screening to a separate occasion. We chose instead to integrate the whole screening process into everyday clinical practice, as we wanted to assess the possibility of facilitating preventive work in existing work schedules. In study IV the GPs reported some reservations about the use of the CDSS because it took time to fill in the forms. In the interviews they also described that shortage of time and a high workload were generally important disturbing factors in adopting new methods and technology. Similar findings have been seen in other studies (Short 2004). Shortage of time did not seem to be a determining factor, but was rather an accentuating factor in the attained level of acceptance in the different Profiles (study IV).

We also saw positive attitudes on the part of the patients regarding the use of computers in health care in general, as well as regarding the use of CDSS during their visits (study IV). The health screening with computer support (study I) also seemed to be well accepted by the patients, as only 51 (8.5%) declined participation.

As working conditions in the PHC centres did not differ much from those in PHC centres in other districts, we believe that the results are generalisable to PHC in other parts of Stockholm.

### *Obstacles and facilitating factors related to CDSS use in PHC*

The results from these studies have also elucidated some factors regarding CDSS use in PHC that can influence their effectiveness and the degree to which they will be accepted by the users.

Integration of the CDSS in the EPR is considered by many authors as an important factor for greater effectiveness and better acceptance (Elson 1995a; Nies 2006; van Wijk 2001). This was confirmed in study I, since the fact that the users experienced the reminder program as a completely harmonised part of the EPR was probably a crucial factor in its impact on screening performance. The CDSS used in studies III and IV was not integrated into the EPR, which meant that the user had to change screens and fill in the forms manually. This was also pointed out as a drawback by the users and is a well-known disadvantage of Internet-based applications. There are, however, both prerequisites for and consequences of such a complete integration between the CDSS and the EPR. Such an application requires a highly enough structured database in the EPR for the CDSS to automatically find all data needed for its functioning, and requires a local application of the CDSS, meaning more resources for programming and support. As we could see in study I, not all of the data (i.e. breast examination results) could be processed by the computer. Internet-based CDSS applications, on the other hand, are easily accessible without any need of local applications and with a smaller risk of disruptions due to technical problems, which have also importance for whether a system is going to be used or not. A portable CDSS system that provides compatibility with all the different kinds of EPRs used in PHC might represent the ideal solution, combining the advantages of the two described systems.

CDSSs also need to be adjusted to some extent to local disease management traditions (Ref). This is normally the case with systems that are designed locally, but they often lack general applicability to other settings. This was the case with the reminder program (study I), which could not have been easily transferred to other PHC centres. The Internet-based CDSS (studies III and IV) was easily accessible from any setting but, on the other hand, it lacked some local adjustments, as it did not accept a drug combination commonly used at this PHC, leading to mistrust on the part of the users.

Whether a CDSS should be triggered automatically or voluntarily by the user, is also a subject for debate. It has been shown in some studies that automatically triggered reminders are more effective (Nies 2006). On the other hand, other studies show that such automated reminders can be seen as disturbances in the workflow and are often omitted (Sequist 2005). All the GPs in study IV stated that they would not like to have the CDSS they used to be automatically triggered due

to the time constraints and stress they were already experiencing. This was also the reason for that several of the GPs also pointed out the importance of limiting the number of CDSSs used at same time. Both high workload and preferences for limiting the number of simultaneously used CDSSs have been seen in other studies assessing barriers to the utilization of CDSSs (Saleem 2005; Sequist 2005). Further, we know from the GPs' comments in study IV that certain circumstances in the clinical situation were perceived as limiting the usability of the CDSS (e.g. very old age or the presence of other severe conditions) which has also been seen in other studies (Keeffe 2005; Leslie 2006). For optimal effect in everyday clinical work, we believe it is advantageous to let the GP freely decide when to use the CDSS.

It has also been shown that problems can be created in situations when patient focus and computer use are in competition for the limited time of the visit, (Booth 2004). The GPs in study IV reported giving definite priority to the former, and consequently perceived difficulties in operating the CDSS during the visit. Those GPs who used the CDSS during observed consultations also seemed to work hard to find effective strategies for solving this problem. None of the patients gave any sign of being disturbed, which was also reported by the GPs in the follow-up interviews, in contrast to their expectations of patients' reactions reported in the initial interviews. Interestingly, the GPs who had expressed being worried that patients could feel neglected, were the ones who nevertheless carried out patient visits using the CDSS program, in contrast to those who did not have such worries. Our interpretation is that these expectations per se do not constitute a decisive barrier. However, during the design and implementation of a CDSS, it is crucial to ensure that it will fit into the workflow of the users.

The way in which we implemented the guideline-based CDSS (study IV), with the aim of achieving its routine use, was not successful, as its actual usage remained very limited. For this reason we could only study the acceptance of the CDSS based on the GPs' statements in the interviews. From acceptance to actual usage, further steps are required, each with its own obstacles and facilitators. The implementation strategy used here - consisting of a demonstration and a short training session, and leaving the rest to the users - is today the most frequently used way of implementing new computer methods in PHC in Sweden. Using this approach in an ordinary everyday environment gave us a good opportunity to assess the complicating factors, but no possibility to demonstrate the success factors. Our hypothesis is, however, that counteracting the complicating factors that were found would facilitate implementation.

Some of the barriers we found in study IV have been recognised previously, such as an insufficient level of computer skills and time constraints in everyday work. In addition, there were barriers related to the individual GPs' attitudes and characteristics that were based on conceptions about their professional role and their attitudes towards the computer's function in disease management and in decision making. In order to attain a higher acceptance of CDSSs, more effort

must be focused on these aspects in the planning and realization of CDSS implementation. Our findings can facilitate identifying groups of GPs with definable needs during the implementation of a CDSS and make it easier to meet those needs with individually tailored interventions.

Obstacles and facilitating factors in the implementation of a CDSS seem to be closely related to the actual setting where it is intended to be used, the exact purpose of the CDSS, the background and needs of the users in question, and the workflow at the setting. These factors have to be thoroughly studied and taken into account before implementing a CDSS at a new site.

## Conclusions

Using a computer reminder program completely incorporated into the EPR system made it possible to integrate a health screening program for elderly patients into the everyday work of the PHC centre (study I). A health screening program organised this way was well accepted by the GPs and patients, and when the reminder program was used the participating patients benefited from the health screening, as the targeted diseases were in many cases diagnosed and treated sooner (study II). The program was especially useful in screening areas that have thus far not been satisfactorily implemented, and when introducing new screening services. The health screening program was, however, still underutilised from the patient and societal perspectives, mainly due to the GPs' time constraints.

Applying a guideline-based CDSS for the management of CHF (study III) influenced the GPs' confidence in the diagnosis, their considerations about investigations, and their considerations about medications in a substantial part of their own patient cases. The GPs also perceived the support from the usage of the CDSS as important in one third of the cases. Therefore, applying a CDSS based on evidence-based guidelines to the medical records of patients with CHF in primary care may have a significant influence on GPs' disease management.

In exploring the implementation process (study IV), we found several attitudes and characteristics among GPs that could be seen as three different profiles that influence the implementation of a CDSS in clinical practice. Important contributing factors turned out to be the GPs' individual computer skills and their attitudes towards the computer's function in disease management and in decision making. Future implementation strategies and research in the area need to take all these factors into consideration.

## Forthcoming research

Further research is needed on the usage of CDSSs in everyday general practice in order to find reliable methods for effective implementation and further dissemination.

It is important to confirm our findings in larger groups of end-users regarding the influence of end-users' attitudes and characteristics on the acceptance of a CDSS. This could be done in a questionnaire study. The results could then be used to design an instrument for assessing the intended users' backgrounds and individual needs when planning the implementation. Tailoring the implementation process to the individual end-users to a larger extent than is done today would ensure a more effective implementation.

We know that using CDSSs as the only strategy for improving the quality of care and adherence to clinical practice guidelines in chronic diseases is not sufficient. Review studies show that a combination of different methods is more fruitful. Outreach visits by opinion leaders combined with further education and the use of computerised guidelines could be a successful way of implementing guideline-based CDSSs in everyday clinical practice. We also need to investigate the effect of such interventions on patient outcomes in larger groups. As CHF is still under diagnosed and insufficiently treated in Swedish PHC, according to recent studies, it would be very appropriate to test such a combined strategy for quality improvement in the management of CHF in larger groups and evaluate its effects on patient outcomes.

# Appendix

**Patient:**

Case number:

Year of birth:

Gender:

**Questionnaire to answer after the assessment of each CHF case**

**1) If the visit was today, would you consider completing the medical investigation?**

a. Yes, with the following :

- ECG
- Exercise test
- Echocardiography
- X-ray
- S-BNP
- Spirometry
- Other, namely:.....

b. No, I would not do any more investigations

**2) Have the usage of the CDSS influenced your confidence in whether the patient has CHF or not?**

- I am more confident
- No difference
- I am less confident

**3) If the visit was today, would you consider making changes in the medication?**

a. Yes, I would consider to discontinue the following drugs:

.....  
.....  
.....

b. Yes, I would consider add the following drugs:

.....  
.....  
.....

c. Yes, I would consider change the dosage of the following drugs:

.....  
.....

d. No, I would not consider to make any changes

**4) How much support have you got from the CDSS for your management of this patient case?**

Put a mark on the scale to indicate the degree of support.



**5) Comments:**

# Acknowledgements

I wish to express my sincere gratitude to everyone who has helped me during my work on this thesis. In particular, I want to thank:

Associate Professor *Gunnar Nilsson*, my main supervisor, for genuine support and encouragement and skilful mentorship.

Professor *Lars-Erik Strender*, my associate supervisor, for proficient guidance in scientific reasoning.

Associate Professor *Anna-Karin Furhoff*, my supervisor during the first part of my thesis work, for believing in my project, and guidance in scientific thinking and writing.

Assistant Professor *Inger Wårdh*, for stimulating support and for introducing me to the world of qualitative research methods

Professor *Jan Sundquist* and Professor Emeritus *Hans Åberg*, for giving me the opportunity to do my thesis work at the Center for Family and Community Medicine.

*Rolf Linnarsson*, for starting my first project and guiding me in the world of medical informatics, and helping me to put the idea of the reminder program into effect. His untimely death in October 1994 was a great loss to Swedish primary health care, as well as a great personal loss.

*Britt-Gerd Malmberg* and *Anita Wärmé*, the heads of the PHC districts in Sundbyberg, and *Eva Neramo-Lindquist*, the head of Enebyberg health centre, for encouragement and for giving me the opportunity to do this research.

*Kenneth Nordgren*, for skilful support with data retrieval and for teaching me SQL programming.

*Marie-Louise Nordström*, for statistical advice and support.

*Lars Berg*, for help in the planning of the first project and for supportive advice.

My fellow GPs at Kronan health centre and Enebyberg health centre for their commitment, without which these projects would not have been possible.

*Jane Wigertz*, for revising the English text.

Other friends, colleagues and staff at the Center for Family and Community Medicine, for their interest and for fruitful discussions.

My family – *Aleksander*, *Anne* and *Peter Markowski* – for loving support.

This thesis was supported by grants from the Stockholm County Council and the Union of Swedish General Practitioners.

# Summary in Swedish – Sammanfattning på svenska

Studierna behandlar områden som är av direkt intresse för den svenska primärvården: förebyggande hälsovård för äldre samt behandling av kroniska sjukdomar och hur datorer kan vara till stöd i detta arbete för att utveckla sjukvården. Sjukvårdens omorganisation har inneburit att patienterna i allt högre grad sköts inom primärvården. Det har lett till ökade behov av att kunna hantera stora mängder information som är nödvändig för att fatta väl underbyggda medicinska beslut. Medicinsk information förnyas och uppdateras ständigt. Man har visat att datoriserade beslutsstödssystem kan bidra till att höja sjukvårdens kvalitet genom att tillhandahålla relevant och uppdaterad information i rätt tid när medicinska beslut fattas. Ändå används de fortfarande inte i nämnvärd omfattning till vardags.

Det behövs mer kunskap om främjande och hindrande faktorer vid introduktionen av dessa system i sjukvården för att kunna utnyttja deras fulla potential. Främjande och hindrande faktorer kan finnas både hos själva beslutsstödssystemen och hos metoderna som används när beslutsstödssystemen introduceras i verksamheten.

Syftet med den första studien var att utforma och implementera ett påminnelseprogram ”on-screen” för opportunistisk screening av äldre patienter i primärvården och att utvärdera programmets effekter på undersökningsfrekvens och relaterade kliniska utfall inom sju diagnosområden (Studie I). Det datoriserade påminnelseprogrammet individanpassade listan av rekommenderade screeningtester efter tidigare uppgifter om diagnoser, behandlingar och testresultat från ett välstrukturerat, problemorienterat, elektroniskt journalsystem. Påminnelseprogrammet aktiverades av läkaren under besöket och var helt integrerat i journalsystemet. Programmet användes under 20 månader, med en 20 månaders uppföljningsperiod. Målgruppen var alla patienter, 70 år eller äldre, som besökte distriktsläkare vid den aktuella vårdcentralen. Av 914 patienter som uppfyllde dessa inklusionskriterier deltog 602 (66 %) i undersökningen. Patologiska provsvar fann man i 2–23 % och nya diagnoser i 1–4 %.

Resultaten från studie I jämfördes sedan med motsvarande uppgifter hämtade från patientjournalerna för en kontrollgrupp bestående av 1989 patienter som uppfyllde samma inklusionskriterier vid tre närbelägna vårdcentraler (studie II). Man fann att det togs prover i signifikant högre frekvens (13–75 %) på patienter som genomgick screening i studie I, att de hade högre frekvens patologiska provresultat för systoliskt blodtryck och vitamin B12, samt högre frekvens av nya diagnoser av vitamin B12-brist under studietiden. Före studien var provtagning för

vitamin B12-brist betydligt mindre vanligt bland patienter i studie I än bland patienterna i kontrollgruppen.

I studie III undersökte vi hur användningen av ett beslutsstödssystem påverkade fem distriktsläkares handläggning av sina egna patientfall med diagnosen hjärtsvikt. Beslutsstödsprogrammet, som var en datoriserad översättning av svenska och europeiska vårdprogram för diagnostik och behandling av hjärtsvikt, nåddes via Internet och var inte kopplat till journalsystemet. Programmet gav förslag på fortsatt handläggning av enskilda patientfall utifrån de patientuppgifter som läkarna matade in i programmet. Varje läkare gick igenom 9–11 patientfall med hjälp av programmet och fick sedan ange i en enkät om man skulle göra ytterligare diagnostiska undersökningar, om man skulle ändra behandlingen, och hur stort stöd man upplevde från programmet i handläggningen av fallet. Resultaten visade att läkarens säkerhet med avseende på om hjärtsvikt förelåg eller inte förändrades i 25 % av fallen. Läkarna övervägde att utföra ytterligare undersökningar i 31 % av fallen, och att ändra medicineringen i 19 % av fallen. Läkarna fick också uppge hur stort stöd de upplevde från programmet i varje enskilt fall. I 35 % av fallen tycktes stödet ha varit betydelsefullt.

Användningen av beslutsstödsprogrammet från studie III undersöktes sedan med kvalitativa metoder (studie IV). Vi kombinerade flera olika metoder för datainsamling: upprepade intervjuer med läkarna, observation av patientbesök, patientintervjuer och mätning av hur ofta programmet användes. Insamlade data analyserades med hjälp av kvalitativ innehållsanalys. När man på det sättet undersökte läkarnas bakgrundsfaktorer och attityder kunde man urskilja tre olika profiler, d.v.s. kombinationer av egenskaper som föreföll vara relaterade till i vilken grad man tog till sig, accepterade och använde beslutsstödssystemet. Skillnaderna mellan profilerna berodde på olika uppfattningar om allmänläkarens professionella roll, på olika attityder mot datorer och olika förväntningar på datorernas möjlighet att vara ett stöd i sjukdomshandläggning och beslutsfattande. Acceptansen påverkades negativt av otillräcklig datorvana samt tidsbrist under arbetsdagen.

Sammanfattningsvis visar studierna att:

- Ett datoriserat beslutsstödssystem för screening av äldre patienter, helt integrerat i det elektroniska patientjournalsystemet, framstod som ett effektivt sätt att öka den sjukdomsförebyggande verksamheten inom primärvården. Att systemet var helt integrerat i patientjournalen hade betydelse för att det så störningsfritt kunde inlemmas i rutinarbetet.
- Beslutsstödsprogrammet för screening tycktes vara särskilt effektivt för att upptäcka sjukdomar som tidigare varit rutinmässigt mindre väl undersökta, exempelvis vitamin B12-brist. Programmet kan därför också tänkas vara användbart vid införandet av nya screeningmetoder.

- Ett beslutsstödssystem baserat på nationella och internationella vårdprogram för hjärtsvikt påverkade distriktsläkares sätt att handlägga sina patientfall både vad gäller diagnos och behandling av hjärtsvikt.
- Man kan identifiera och beskriva specifika behov hos olika grupper av distriktsläkare under implementeringen av ett beslutsstödssystem. Introduktionsmetoderna kan därefter skräddarsys och därmed resultera i högre acceptans och användning av beslutsstödssystem i primärvården.

## References

- Adams A, Blandford A, Attfield S (2005) Implementing digital resources for clinicians' and patients' varying needs. *Med Inform Internet Med* 30(2) 107-122.
- Aguero Torres H, Fratiglioni L, et al. (1994) Hypertension in the elderly population: prevalence data from an urban area in Sweden. *Aging (Milano)* 6(4) 249-255.
- Ammenwerth E, Graber S, et al. (2003a) Evaluation of health information systems - problems and challenges. *Int J Med Inf* 71(2-3) 125-135.
- Ammenwerth E, Iller C, Mansmann U (2003b) Can evaluation studies benefit from triangulation? A case study. *Int J Med Inf* 70(2-3) 237-248.
- Andersson DK, Lundblad E, Svardsudd K (1993) A model for early diagnosis of type 2 diabetes mellitus in primary health care. *Diabet Med* 10(2) 167-173.
- Austin SM, Balas EA, et al. (1994) Effect of physician reminders on preventive care: meta-analysis of randomized clinical trials. *Proc Annu Symp Comput Appl Med Care* 121-124.
- Balas EA, Austin SM, et al. (1996) The clinical value of computerized information services. A review of 98 randomized clinical trials. *Arch Fam Med* 5(5) 271-278.
- Beck LH (1999) Periodic health examination and screening tests in adults. *Hosp Pract (Off Ed)* 34(12) 117-118, 121-112, 124-116.
- Beers MH, Fink A, Beck JC (1991) Screening recommendations for the elderly. *Am J Public Health* 81(9) 1131-1140.
- Berg BL (2006) An Introduction to Content Analysis. IN *Qualitative research Methods for the Social Sciences*. Boston: Allyn and Bacon, pp. 303-339.
- Bero LA, Grilli R, et al. (1998) Closing the gap between research and practice: an overview of systematic reviews of interventions to promote the implementation of research findings. The Cochrane Effective Practice and Organization of Care Review Group. *Bmj* 317(7156) 465-468.
- Bitzen PO, Schersten B (1986) Assessment of laboratory methods for detection of unsuspected diabetes in primary health care. *Scand J Prim Health Care* 4(2) 85-95.
- Bodenheimer T, Grumbach K (2003) Electronic technology: a spark to revitalize primary care? *Jama* 290(2) 259-264.

- Booth N, Robinson P, Kohannejad J (2004) Identification of high-quality consultation practice in primary care: the effects of computer use on doctor-patient rapport. *Inform Prim Care* 12(2) 75-83.
- Bouhaddou O, Frucci L, et al. (1993) Implementation of practice guidelines in a clinical setting using a computerized knowledge base (Iliad). *Proc Annu Symp Comput Appl Med Care* 258-262.
- Brown SH, Coney RD (1994) Changes in physicians' computer anxiety and attitudes related to clinical information system use. *J Am Med Inform Assoc* 1(5) 381-394.
- Bulpitt CJ, Benos AS, et al. (1990) Should medical screening of the elderly population be promoted? *Gerontology* 36(4) 230-245.
- Burkle T, Ammenwerth E, et al. (2001) Evaluation of clinical information systems. What can be evaluated and what cannot? *J Eval Clin Pract* 7(4) 373-385.
- Cabana MD, Rand CS, et al. (1999) Why don't physicians follow clinical practice guidelines? A framework for improvement. *Jama* 282(15) 1458-1465.
- Chew-Graham CA, May CR, Perry MS (2002) Qualitative research and the problem of judgement: lessons from interviewing fellow professionals. *Fam Pract* 19(3) 285-289.
- Classen DC (1998) Clinical decision support systems to improve clinical practice and quality of care. *Jama* 280(15) 1360-1361.
- Cleland JG, Cohen-Solal A, et al. (2002) Management of heart failure in primary care (the IMPROVEMENT of Heart Failure Programme): an international survey. *Lancet* 360(9346) 1631-1639.
- Coumou HC, Meijman FJ (2006) How do primary care physicians seek answers to clinical questions? A literature review. *J Med Libr Assoc* 94(1) 55-60.
- Craig JC, Irwig LM, Stockler MR (2001) Evidence-based medicine: useful tools for decision making. *Med J Aust* 174(5) 248-253.
- CTF (1979) The periodic health examination. Canadian Task Force on the Periodic Health Examination. *Can Med Assoc J* 121(9) 1193-1254.
- Davis DA, Taylor-Vaisey A (1997) Translating guidelines into practice. A systematic review of theoretic concepts, practical experience and research evidence in the adoption of clinical practice guidelines. *Cmaj* 157(4) 408-416.
- Davis FD (1993) User Acceptance of Information Technology - System Characteristics, User Perceptions and Behavioral Impacts. *International Journal of Man-Machine Studies* 38(3) 475-487.
- Dixon DR, Stewart M (2000) Exploring information technology adoption by family physicians: survey instrument valuation. *Proc AMIA Symp* 185-189.

- Dreiseitl S, Binder M (2005) Do physicians value decision support? A look at the effect of decision support systems on physician opinion. *Artif Intell Med* 33(1) 25-30.
- Duff L, Casey A (1998) Implementing clinical guidelines: how can informatics help? *J Am Med Inform Assoc* 5(3) 225-226.
- Eccles M, McColl E, et al. (2002) Effect of computerised evidence based guidelines on management of asthma and angina in adults in primary care: cluster randomised controlled trial. *Bmj* 325(7370) 941.
- Elson RB, Connelly DP (1995a) Computerized decision support systems in primary care. *Prim Care* 22(2) 365-384.
- Elson RB, Connelly DP (1995b) Computerized patient records in primary care. Their role in mediating guideline-driven physician behavior change. *Arch Fam Med* 4(8) 698-705.
- EviBase URL: <http://www.inlinedss.se/evibase/> [accessed 31 October 2007].
- Falkenberg M, Kagedal B, Norr A (1983) Screening of an elderly female population for hypo- and hyperthyroidism by use of a thyroid hormone panel. *Acta Med Scand* 214(5) 361-365.
- Feldstein A, Elmer PJ, et al. (2006) Electronic medical record reminder improves osteoporosis management after a fracture: a randomized, controlled trial. *J Am Geriatr Soc* 54(3) 450-457.
- Figar S, Waisman G, et al. (2004) Narrowing the gap in hypertension: effectiveness of a complex antihypertensive program in the elderly. *Dis Manag* 7(3) 235-243.
- Flocke SA, Stange KC, Zyzanski SJ (1998) The association of attributes of primary care with the delivery of clinical preventive services. *Med Care* 36(8 Suppl) AS21-30.
- Frame PS (1999) Preventive care for the elderly: getting by in the absence of evidence. *Am Fam Physician* 59(7) 1747-1748, 1750.
- Frank O, Litt J, Beilby J (2004) Opportunistic electronic reminders. Improving performance of preventive care in general practice. *Aust Fam Physician* 33(1-2) 87-90.
- Friedman CP, Wyatt JC (1997) Subjectivist Approaches to Evaluation. IN Friedman CP and Wyatt JC eds *Evaluation Methods in Medical Informatics*. New York: Springer, pp. 205-221.
- Fuat A, Hungin AP, Murphy JJ (2003) Barriers to accurate diagnosis and effective management of heart failure in primary care: qualitative study. *Bmj* 326(7382) 196.

- Garg AX, Adhikari NK, et al. (2005) Effects of computerized clinical decision support systems on practitioner performance and patient outcomes: a systematic review. *Jama* 293(10) 1223-1238.
- Gibson M, Jenkins KN, et al. (2005) Multi-tasking in practice: coordinated activities in the computer supported doctor-patient consultation. *Int J Med Inform* 74(6) 425-436.
- Goldberg TH, Chavin SI (1997) Preventive medicine and screening in older adults. *J Am Geriatr Soc* 45(3) 344-354.
- Graneheim UH, Lundman B (2004) Qualitative content analysis in nursing research: concepts, procedures and measures to achieve trustworthiness. *Nurse Educ Today* 24(2) 105-112.
- Grimshaw JM, Russell IT (1993) Effect of clinical guidelines on medical practice: a systematic review of rigorous evaluations. *Lancet* 342(8883) 1317-1322.
- Grimshaw JM, Shirran L, et al. (2001) Changing provider behavior: an overview of systematic reviews of interventions. *Med Care* 39(8 Suppl 2) II2-45.
- Gronlie M, Hjortdahl P (1991) The erythrocyte sedimentation rate; its use and usefulness in primary health care. *Scand J Prim Health Care* 9(2) 97-102.
- Gupta L, Ward JE, Hayward RS (1997) Clinical practice guidelines in general practice: a national survey of recall, attitudes and impact. *Med J Aust* 166(2) 69-72.
- Haglund BJ (1989) Preventive activities in primary health care in Stockholm County, Sweden. Results from a survey in November 1985. *Scand J Soc Med* 17(3) 227-230.
- Halling A, Berglund J (2003) Diagnosis and treatment of heart failure in primary health care among elderly patients with non-insulin-dependent diabetes mellitus, with special reference to use of echocardiography. *Scand J Prim Health Care* 21(2) 96-98.
- Hanson RL, Nelson RG, et al. (1993) Comparison of screening tests for non-insulin-dependent diabetes mellitus. *Arch Intern Med* 153(18) 2133-2140.
- Hayward RS (1997) Clinical practice guidelines on trial. *Cmaj* 156(12) 1725-1727.
- Heller I, Isakov A, et al. (2004) Evaluation of CaDet, a computer-based clinical decision support system for early cancer detection: a comparison with the performance of clinicians. *Cancer Detect Prev* 28(5) 352-356.
- Henderson J, Britt H, Miller G (2006) Extent and utilisation of computerisation in Australian general practice. *Med J Aust* 185(2) 84-87.
- Hensrud DD (2000) Clinical preventive medicine in primary care: background and practice: 1. Rationale and current preventive practices. *Mayo Clin Proc* 75(2) 165-172.

- Hetlevik I, Holmen J, et al. (1998) Implementing clinical guidelines in the treatment of hypertension in general practice. *Blood Press* 7(5-6) 270-276.
- Hudon E, Beaulieu MD, Roberge D (2004) Integration of the recommendations of the Canadian Task Force on Preventive Health Care: obstacles perceived by a group of family physicians. *Fam Pract* 21(1) 11-17.
- Hulscher ME, Wensing M, et al. (2002) Interventions to implement prevention in primary care (Cochrane Review). *The Cochrane Library*(4) CD000362.
- Hunt DL, Haynes RB, et al. (1998) Effects of computer-based clinical decision support systems on physician performance and patient outcomes: a systematic review. *Jama* 280(15) 1339-1346.
- James PA, Cowan TM, et al. (1997) Family physicians' attitudes about and use of clinical practice guidelines. *J Fam Pract* 45(4) 341-347.
- Jerant AF, Lloyd AJ (2000) Applied medical informatics and computing skills of students, residents, and faculty. *Fam Med* 32(4) 267-272.
- Johnston ME, Langton KB, et al. (1994) Effects of computer-based clinical decision support systems on clinician performance and patient outcome. A critical appraisal of research. *Ann Intern Med* 120(2) 135-142.
- Kaplan B (2001a) Evaluating informatics applications--clinical decision support systems literature review. *Int J Med Inform* 64(1) 15-37.
- Kaplan B (2001b) Evaluating informatics applications--some alternative approaches: theory, social interactionism, and call for methodological pluralism. *Int J Med Inform* 64(1) 39-56.
- Kaushal R, Shojania KG, Bates DW (2003) Effects of computerized physician order entry and clinical decision support systems on medication safety: a systematic review. *Arch Intern Med* 163(12) 1409-1416.
- Kawamoto K, Houlihan CA, et al. (2005) Improving clinical practice using clinical decision support systems: a systematic review of trials to identify features critical to success. *Bmj* 330(7494) 765.
- Keeffe B, Subramanian U, et al. (2005) Provider response to computer-based care suggestions for chronic heart failure. *Med Care* 43(5) 461-465.
- Khunti K, Hearnshaw H, et al. (2002) Heart failure in primary care: qualitative study of current management and perceived obstacles to evidence-based diagnosis and management by general practitioners. *Eur J Heart Fail* 4(6) 771-777.
- Kirkeby OJ, Risoe C, Vikland R (1989) Significance of a high erythrocyte sedimentation rate in general practice. *Br J Clin Pract* 43(7) 252-254.
- Kligman EW (1992) Preventive geriatrics: basic principles for primary care physicians. *Geriatrics* 47(7) 39-50.

- Klinkman MS, Zazove P, et al. (1992) A criterion-based review of preventive health care in the elderly. Part 1. Theoretical framework and development of criteria. *J Fam Pract* 34(2) 205-209, 213-208, 221-204.
- Kottke TE, Solberg LI, et al. (1997) Delivery rates for preventive services in 44 midwestern clinics. *Mayo Clin Proc* 72(6) 515-523.
- Landahl S (1990) [Routine physical check-ups of pensioners are not justified]. *Lakartidningen* 87(4) 185.
- Lantz B, Molander A, Nilsson G (1990) Observations on biochemical and haematological parameters in healthy people above 80 years of age. *Scand J Clin Lab Invest* 50(8) 807-813.
- Laux G, Koerner T, et al. (2005) The CONTENT project: a problem-oriented, episode-based electronic patient record in primary care. *Inform Prim Care* 13(4) 249-255.
- Leslie SJ, Hartswood M, et al. (2006) Clinical decision support software for management of chronic heart failure: development and evaluation. *Comput Biol Med* 36(5) 495-506.
- Linnarsson R (1987) Development and evaluation of a complete computerbased problem oriented medical record system for primary care. IN Serio A, O'Moore R, Tardini A and Rogers FJ eds *Proceedings of Medical Informatics Europe '87*. Rome: EFMI, pp. 209-214.
- Linnarsson R (1993a) Decision support for drug prescription integrated with computer-based patient records in primary care. *Med Inform (Lond)* 18(2) 131-142.
- Linnarsson R (1993b) Medical audit based on computer-stored patient records exemplified with an audit of hypertension care. *Scand J Prim Health Care* 11(1) 74-80.
- Linnarsson R (1993c) Methods, design and components for a computer-based patient record to promote quality care in general practice [dissertation]. Linköping: Linköping University, p. 85.
- Liu J, Wyatt JC, Altman DG (2006) Decision tools in health care: focus on the problem, not the solution. *BMC Med Inform Decis Mak* 6 4.
- Lobach DF, Hammond WE (1997) Computerized decision support based on a clinical practice guideline improves compliance with care standards. *Am J Med* 102(1) 89-98.
- Lopez-de-Munain J, Torcal J, et al. (2001) Prevention in routine general practice: activity patterns and potential promoting factors. *Prev Med* 32(1) 13-22.
- Läkemedelsverket (2000) Behandling av hjärtsvikt och asymtomatisk vänsterkammardysfunktion - rekommendationer Information från Läkemedelsverket: Medical Products Agency - Sweden, pp. 7-20.

- Mandelblatt J, Kanetsky PA (1995) Effectiveness of interventions to enhance physician screening for breast cancer. *J Fam Pract* 40(2) 162-171.
- Martens JD, van der Aa A, et al. (2006) Design and evaluation of a computer reminder system to improve prescribing behaviour of GPs. *Stud Health Technol Inform* 124 617-623.
- McDonald CJ, Tierney WM (1988) Computer-stored medical records. Their future role in medical practice. *Jama* 259(23) 3433-3440.
- McIsaac WJ, Fuller-Thomson E, Talbot Y (2001) Does having regular care by a family physician improve preventive care? *Can Fam Physician* 47 70-76.
- McMenamin JP (1992) Health screening in a general practice by opportunistic recruitment. *New Zealand Medical Journal* 105(947) 495-497.
- McMurray JJ, Stewart S (2000) Epidemiology, aetiology, and prognosis of heart failure. *Heart* 83(5) 596-602.
- McRae TD, Freedman ML (1989) Why vitamin B12 deficiency should be managed aggressively. *Geriatrics* 44(11) 70-73.
- Mitchell E, McConnahie A, Sullivan F (2003) Consultation computer use to improve management of chronic disease in general practice: a before and after study. *Inform Prim Care* 11(2) 61-68.
- Nies J, Colombet I, et al. (2006) Determinants of success for computerized clinical decision support systems integrated in CPOE systems: a systematic review. *AMIA Annu Symp Proc* 594-598.
- Nilsson-Ehle H, Landahl S, et al. (1989) Low serum cobalamin levels in a population study of 70- and 75-year-old subjects. Gastrointestinal causes and hematological effects. *Dig Dis Sci* 34(5) 716-723.
- Nilsson G, Strender LE (2002a) Management of heart failure in primary health care. A retrospective study on electronic patient records in a registered population. *Scand J Prim Health Care* 20(3) 161-165.
- Nilsson G, Åhlfeldt H, Strender LE (2002b) Computerisation, coding, data retrieval and related attitudes among Swedish general practitioners-a survey of necessary conditions for a database of diseases and health problems. *Int J Med Inf* 65(2) 135-143.
- Olesen F, Lauritzen T (1997) Do general practitioners want guidelines? Attitudes toward a county-based and a national college-based approach. *Scand J Prim Health Care* 15(3) 141-145.
- Olofsson M, Edebro D, Boman K (2007) Are elderly patients with suspected HF misdiagnosed? A primary health care center study. *Cardiology* 107(4) 226-232.

- Onofrei M, Hunt J, et al. (2004) A first step towards translating evidence into practice: heart failure in a community practice-based research network. *Inform Prim Care* 12(3) 139-145.
- Ornstein SM, Garr DR, et al. (1991) Computer-generated physician and patient reminders. Tools to improve population adherence to selected preventive services. *J Fam Pract* 32(1) 82-90.
- Patel VL, Kushniruk AW, et al. (2000) Impact of a computer-based patient record system on data collection, knowledge organization, and reasoning. *J Am Med Inform Assoc* 7(6) 569-585.
- Payne TH (2000) Computer decision support systems. *Chest* 118(2 Suppl) 47S-52S.
- Pennypacker LC, Allen RH, et al. (1992) High prevalence of cobalamin deficiency in elderly outpatients. *J Am Geriatr Soc* 40(12) 1197-1204.
- Persson M, Bohlin J, Eklund P (2000) Development and maintenance of guideline-based decision support for pharmacological treatment of hypertension. *Comput Methods Programs Biomed* 61(3) 209-219.
- Ramnarayan P, Roberts GC, et al. (2006) Assessment of the potential impact of a reminder system on the reduction of diagnostic errors: a quasi-experimental study. *BMC Med Inform Decis Mak* 6 22.
- Rosser WW, Hutchison BG, et al. (1992) Use of reminders to increase compliance with tetanus booster vaccination. *Cmaj* 146(6) 911-917.
- Rosser WW, McDowell I, Newell C (1991) Use of reminders for preventive procedures in family medicine. *Cmaj* 145(7) 807-814.
- Rousseau N, McColl E, et al. (2003) Practice based, longitudinal, qualitative interview study of computerised evidence based guidelines in primary care. *Bmj* 326(7384) 314.
- Saleem JJ, Patterson ES, et al. (2005) Exploring barriers and facilitators to the use of computerized clinical reminders. *J Am Med Inform Assoc* 12(4) 438-447.
- Scheitel SM, Fleming KC, et al. (1996) Geriatric health maintenance. *Mayo Clin Proc* 71(3) 289-302.
- Schellhase KG, Koepsell TD, Norris TE (2003) Providers' reactions to an automated health maintenance reminder system incorporated into the patient's electronic medical record. *J Am Board Fam Pract* 16(4) 312-317.
- Sequist TD, Gandhi TK, et al. (2005) A randomized trial of electronic clinical reminders to improve quality of care for diabetes and coronary artery disease. *J Am Med Inform Assoc* 12(4) 431-437.
- Shea S, DuMouchel W, Bahamonde L (1996) A meta-analysis of 16 randomized controlled trials to evaluate computer-based clinical reminder systems for

- preventive care in the ambulatory setting. *J Am Med Inform Assoc* 3(6) 399-409.
- Shengnan H (2003) Individual Adoption of Information Systems in Organisations: A Literature Review of Technology Acceptance Model: Turku Centre for Computer Science.
- Shiffman RN, Liaw Y, et al. (1999) Computer-based guideline implementation systems: a systematic review of functionality and effectiveness. *J Am Med Inform Assoc* 6(2) 104-114.
- Short D, Frischer M, Bashford J (2004) Barriers to the adoption of computerised decision support systems in general practice consultations: a qualitative study of GPs' perspectives. *Int J Med Inform* 73(4) 357-362.
- Shortliffe EH (1999) The evolution of electronic medical records. *Acad Med* 74(4) 414-419.
- Sox HC, Jr., Liang MH (1986) The erythrocyte sedimentation rate. Guidelines for rational use. *Ann Intern Med* 104(4) 515-523.
- Stabler SP (1995) Screening the older population for cobalamin (vitamin B12) deficiency. *J Am Geriatr Soc* 43(11) 1290-1297.
- Stafford RS, Radley DC (2003) The underutilization of cardiac medications of proven benefit, 1990 to 2002. *J Am Coll Cardiol* 41(1) 56-61.
- Stange KC, Flocke SA, Goodwin MA (1998a) Opportunistic preventive services delivery. Are time limitations and patient satisfaction barriers? *J Fam Pract* 46(5) 419-424.
- Stange KC, Kelly R, et al. (1992) Physician agreement with US Preventive Services Task Force recommendations. *J Fam Pract* 34(4) 409-416.
- Stange KC, Zyzanski SJ, et al. (1998b) How valid are medical records and patient questionnaires for physician profiling and health services research? A comparison with direct observation of patients visits. *Med Care* 36(6) 851-867.
- Steen M, Bratland SZ (1999) Har ADB-baserte påminnelser effekt på det forebyggende arbeidet hos allmennlegen? [Do computerized reminders affect the preventive work in general practice?]. *Tidsskr Nor Laegeforen* 119(1) 42-44.
- Steven ID, Dickens E, et al. (1998) Preventive care and continuity of attendance. Is there a risk? *Aust Fam Physician* 27 Suppl 1 S44-46.
- Subramanian U, Fihn SD, et al. (2004) A controlled trial of including symptom data in computer-based care suggestions for managing patients with chronic heart failure. *Am J Med* 116(6) 375-384.

- Sujansky WV (1998) The benefits and challenges of an electronic medical record: much more than a "word-processed" patient chart. *West J Med* 169(3) 176-183.
- Swee DE, Micek-Galinat L (1991) Part II: Basic approach to health screening. *N J Med* 88(7) 487-491.
- Sönksen P, Williams C (1996) Information technology in diabetes care 'Diabeta': 23 years of development and use of a computer-based record for diabetes care. *Int J Biomed Comp* 42(1-2) 67-77.
- Teach RL, Shortliffe EH (1981) An analysis of physician attitudes regarding computer-based clinical consultation systems. *Comput Biomed Res* 14(6) 542-558.
- The European Society of Cardiology (1995) Guidelines for the diagnosis of heart failure. The Task Force on Heart Failure of the European Society of Cardiology. *Eur Heart J* 16(6) 741-751.
- The European Society of Cardiology (1997) The treatment of heart failure. Task Force of the Working Group on Heart Failure of the European Society of Cardiology. *Eur Heart J* 18(5) 736-753.
- Tierney WM (2001) Improving clinical decisions and outcomes with information: a review. *Int J Med Inform* 62(1) 1-9.
- Tierney WM, Overhage JM, et al. (2003) Effects of computerized guidelines for managing heart disease in primary care. *J Gen Intern Med* 18(12) 967-976.
- Tierney WM, Overhage JM, et al. (2005) Can computer-generated evidence-based care suggestions enhance evidence-based management of asthma and chronic obstructive pulmonary disease? A randomized, controlled trial. *Health Serv Res* 40(2) 477-497.
- Tierney WM, Overhage JM, et al. (1995) Computerizing guidelines to improve care and patient outcomes: the example of heart failure. *J Am Med Inform Assoc* 2(5) 316-322.
- USPSTF (1996) US Preventive Services Task Force. Guide to clinical preventive services. Baltimore: Williams and Wilkins.
- Valenta AL, Wigger U (1997) Q-methodology: definition and application in health care informatics. *J Am Med Inform Assoc* 4(6) 501-510.
- van Ginneken AM (2002) The computerized patient record: balancing effort and benefit. *Int J Med Inf* 65(2) 97-119.
- van Wijk MA, van der Lei J, et al. (2001) Assessment of decision support for blood test ordering in primary care. a randomized trial. *Ann Intern Med* 134(4) 274-281.

- Watkins C, Harvey I, et al. (1999) General practitioners' use of guidelines in the consultation and their attitudes to them. *Br J Gen Pract* 49(438) 11-15.
- Watson R (2007) A quarter of EU citizens are being treated for chronic disease. *Bmj* 335(7620) 584.
- Webster S, Morgan M, Barnett GO (1987) Medical Query Language: Improved access to MUMPS databases. IN Stead WW ed *Proceedings of the 11th Annual Symposium on Computer Applications in Medical Care*. Washington, DC: IEEE Computer Society Press, pp. 306-309.
- Weiler PG, Chi I, Lubben JE (1989a) A statewide preventive health care program for the aged. *Public Health Rep* 104(3) 215-221.
- Weiler PG, Lubben JE, Chi I (1989b) Hypertension in elderly people in a preventive health program. *Am J Prev Med* 5(4) 216-224.
- Westbrook JI, Gosling AS, Coiera EW (2005) The impact of an online evidence system on confidence in decision making in a controlled setting. *Med Decis Making* 25(2) 178-185.
- Wyatt JC (2000) Decision support systems. *J R Soc Med* 93(12) 629-633.
- Yarnall KS, Rimer BK, et al. (1998) Computerized prompts for cancer screening in a community health center. *J Am Board Fam Pract* 11(2) 96-104.
- Zazove P, Mehr DR, et al. (1992) A criterion-based review of preventive health care in the elderly. Part 2. A geriatric health maintenance program. *J Fam Pract* 34(3) 320-347.