Intelligent Decision Support System in Diabetic eHealth Care
From the perspective of Elders

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This thesis is submitted to the Department of Interaction and System Design, School of Engineering at Blekinge Institute of Technology in partial fulfillment of the requirements for the degree of Master of Science in Computer Science. The thesis is equivalent to XXX weeks of full time studies.

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ABSTRACT

This thesis proposes intelligent decision support System in diabetes eHealth care in order to improve the quality of life of Diabetes patients. Diabetes is one of the chronic diseases that can cause the serious health complication. Patients of diabetes especially elder people need more care than others as well as regularity in medicine.

Only patients themselves or doctors cannot provide the care that patient needs. To improve the quality of daily life of patient a team of care providers work together. This thesis covers the different fields of intelligent decision support system for the diabetes type2 patients. The proposed intelligent decision support system is 24-hours accessible for the patients and care providers. The system stores the patients’ information and gives them optimal advices according to their condition entered by them. It also provides adequate and detail information about the patient to the health-care providers that help them to take an optimal decision about the patients. If system analyzes any alarming condition of the patient, it generates automatic alarming message for the health-care providers to help the patients. We validate our study by conducting interviews with diabetes health-care providers and perform questionnaires filled from diabetes type2 patients.

KEYWORDS
IDSS (intelligent decision support system), IMIS (Integrated mobile information system), eHealth, Diabetes mellitus, architecture of IDSS, Diabetes patients’ problems.
ACKNOWLEDGEMENT

In the name of Allah who is the most gracious and merciful. We are thankful to our creator who blessed us with abilities to complete this thesis.

We are very thankful to our supervisor Guohua bai and Mr. Liu Yang for their guidance and patience at every step of this thesis. Without their support and invaluable feedback, we could not be able to complete it. We acknowledge their contribution to enhance our knowledge on the subject.

We are also thankful to our friends for sparing their time to review our thesis and their moral sports.

We cannot forget to thanks our beloved parents and special ones who always pray for our success. Their love always remains the keys source of our motivation. We dedicate our thesis to our respective families.
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1 INTRODUCTION

Computer implementation and automation is used in all fields of life whether it is entering through the door or measuring nutrition value from a cup of tea. Almost all natural phenomena are digitized now. Advancements in computer technologies are increasing day by day and covering all fields of the life. Implementation of computer technology in the area of health-care is an old story but there are still some areas of health-care where computer applications can make a difference. Improving the quality of life for diabetes patients by computer application is one of those.

Diabetes is a dangerous chronicle disease which can make the life miserable. In most of the cases; the disease changes the life of patient up-side-down. Diabetes patients have to live with the disease. If we talk about diabetes type2 mellitus, it can be more dangerous because it becomes worse slowly but steadily. Precautions in diet, precaution for body movement, avoiding injuries, obligatory exercise, follow a time table for medicine and diet, are some main problems for the diabetes patients as well as visiting the doctor frequently and getting the time for other medical activities e.g. medical tests. It is more problematic for elderly patients. On the other hand treating the diabetes disease is also difficult, expensive and complex task for the medical staff. There are number of important things to record about the patient and disease, periodically e.g. diet plan, exercise plan, frequent appointment timings, patient’s daily blood sugar level readings, patient’s diet taken and lots of others. All these records help the doctors to make an optimal decision about the patient to make his/her life better. It is almost impossible for a patient to visit the health-care center daily and inform the doctor about his blood sugar level and other necessary things. Intelligent decision support system (IDSS) in diabetes eHealth care is a good solution to the problem that can help the patients and medical staff as well.

Health-care providers appreciate such kind of system that provides the appropriate and different kind of advices about the health to the diabetes patients, especially elderly patients. Such a system can help to reduce their unnecessary visits to the hospital. System should provide enough facility to the patient that is helpful,
inexpensive and quick to make an optimal decision for the patient’s disease. There must be easy way to save the records and show such outputs that are easy to understand and helpful to make a decision. There must not be continuous communication channel between health-care provider and patients.

On the contrary patients want continuous communication channel with the doctors. They demand such system that can help them to update their records remotely so that the overhead of visiting healthcare center can be reduced. It is one the requirement that patients need advice about their diet and exercise. The system should also be accessed remotely.

Our research is all about designing an intelligent decision support system to help the patients and health-care providers. The purpose of the study is to provide 24-hour adequate health-care services to the diabetes type2 patients remotely and provide decision support service to the health-care providers. Periodically updating the patient’s record is also an important feature of the system.

An IDSS in Diabetic eHealth Care can save the information about the patients into their medical record, whenever there is a need to upload the records. The system gives the advices about the diet and exercise itself without disturbing the health-care providers. It will alert the health-care providers when system analyzes the alarming conditions of the patient.
2 BACKGROUND

2.1 DIABETES MELLITUS CONCEPTS

Diabetes mellitus is one of the major chronic diseases associated with abnormally high level of glucose (sugar) in blood and it is becoming the public health problem in both developed and developing countries. Diabetes is at seventh position in the top list of reasons for death [1]. This disease affects more than 180 million people in world and this figure is expected to be doubled by the year 2030 [2, 3]. Diabetes problem is more common in Asia. 90 million people are affected by diabetes in Asia; including 4 of the world’s 5 largest populations: India 33 million; China 23 million; Pakistan 9 million; and Japan 7 million people with diabetes [4].

Insulin is the hormone secreted by pancreas to control the blood sugar. Insulin split glucose into pieces so that it can dissolve into muscles, fat and liver cells of human body where it can be used as fuel. In the case of diabetes, the blood cannot generate enough insulin to dissolve the glucose or cannot use its own insulin (muscle, fat, and liver cell do not respond to insulin normally) that increases the sugar level in blood. It can cause the serious health complication like blindness, heart disease, kidney failure, weight loss, and poor healing of wound especially in feet [5].

There are three major types of diabetes:

2.1.1 TYPE-1 DIABETES (INSULIN DEPENDENT DIABETES MELLITUS-IDDM)

Type-1 diabetes, the body make little or no insulin, it is usually 5 to 10 % diagnosed in children and young adults. Many patient suffering with diabetes type 1 are diagnosed when they are older than 20 years. In this type of diabetes injection of insulin or insulin pump is need. It can be controlled by diet and exercise. Type 1 Diabetes is more likely lead to kidney failure. Kidney failure develops in 20 to 40 % of people having diabetes type 1 in the age of 50. The exact cause is unknown; genetic, virus and environmental factors are involved in this disease [6, 7].

2.1.2 TYPE 2 DIABETES (NON INSULIN DEPENDENT DIABETES MELLITUS-NIDDM)
It is more common as compare to type-1 diabetes, usually 90 to 95%, it is diagnosed in adults but young people are also diagnosed with this disease. In this type pancreases does not produce enough insulin to keep blood sugar level normal. It is serious type of diabetes; mostly people do not know they are suffering with it. Three major causes of diabetes type 2 are lifelong bad diet, inactive or sedentary lifestyle, and overweight [4, 6]. Type-2 diabetes is becoming more common due to risk factors like older age, obesity, lack of exercise, family history of diabetes, heart diseases [6]. Some changes in lifestyle, importantly increase in physical activities e.g. exercise and modest weight reduction can reduce the chances of suffering from type 2 diabetes by as much as 58%. Use of metformin (a drug used as a treatment for type 2 diabetes [8]) along with good lifestyle and healthy diet, reduces the risk of development of type 2 diabetes by 31%, but metformin is almost ineffective in patients more than 60 years old [4, 9]. For treatment of elder people proper care of diet, exercise and medication as well is more important [4].

2.1.3 GESTATIONAL DIABETES

It is high blood glucose that develops 2% to 5% at any time during pregnancies but it overcome when a pregnancy is over. [6].

<table>
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<th>Type 2</th>
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<tr>
<td>Age at onset</td>
<td>Most commonly &lt; 30 yr</td>
<td>Most commonly &gt; 30 yr</td>
</tr>
<tr>
<td>Associated obesity</td>
<td>No</td>
<td>Very common</td>
</tr>
<tr>
<td>Propensity to ketoacidosis requiring insulin treatment for control</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Plasma levels of endogenous insulin</td>
<td>Extremely low to undetectable</td>
<td>Variable; may be low, normal, or elevated depending on degree of insulin resistance and insulin secretory defect</td>
</tr>
<tr>
<td>Twin concordance</td>
<td>≤ 50%</td>
<td>&gt; 90%</td>
</tr>
<tr>
<td>Associated with specific HLA-D antigens</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Islet cell antibodies at diagnosis</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Islet pathology</td>
<td>Insulitis, selective loss of most β cells</td>
<td>Smaller, normal-appearing islets; amyloid (amylin) deposition is common</td>
</tr>
<tr>
<td>-----------------</td>
<td>------------------------------------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>Prone to develop diabetes complications (retinopathy, nephropathy, neuropathy, atherosclerotic cardiovascular disease)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Hyperglycemia responds to oral antihyperglycemic drugs</td>
<td>No</td>
<td>Yes, initially in many patients</td>
</tr>
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</table>

Table-1 General Characteristics of Types 1 and 2 Diabetes Mellitus [10]

Most People suffering with diabetes do not develop nephropathy (disease of kidney) that can lead the kidney failure even diabetes is controlled. The main case of kidney failure is diabetes which account is 45%. In united state, there are 18 million people are suffering with diabetes and about 150,000 people are living with kidney failure due to diabetes [7].

Our research work is related to diabetes type 2 patients, how to improve their quality life and how can they access the health services at home. The patients have to set the time for exercise, diet, medication, doctors and other care provider’s appointments. It can completely change their daily routine. Our research work will reduce the unnecessary visits of patients to doctors for clinical tests, diet and exercise plan.

2.2 MOBILE INTEGRATED INFORMATION SYSTEM (IMIS) AND EHEALTH SERVICES

IMIS provides a communication platform and agent based services to the users (doctors, nurses, chemist, patients) at home so that patients of diabetes can access and share information at right time form anywhere and any place [12]. In IMIS, there are two groups that are accessing information from shared platform.

2.2.1 PATIENTS (HEALTH CARE RECEIVERS)

The first group is patients (Health care receivers). IMIS provide the eHealth services to diabetes patients at their homes through mobile network such as self-treatment, preparation before face-to-face meeting with care providers and home care supervision [12].
2.2.2 ALL CARE PROVIDERS

The second group is all care providers. IMIS provides the services to all care providers (doctors, patients, nurse, relatives) through same mobile network communication platform in order to access right information at anytime and anywhere [12].

![IMIS and eHealth services](image)

Figure 1 IMIS and eHealth services [12]

2.3 RELEVANCE TO EXISTING RESEARCH

Nowadays health organizations are providing home’s medical treatments of chronic diseases like diabetes and un-hospitalized settings at home specially for elderly patients. In such a diabetes healthcare system, there are some existing researches [7].

2.3.1 Patient self-care with agent-based personal assistant

According to World Health Organization’s definition of Self-Care “*activities individual families and communities undertake with the intention of enhancing health preventing disease, limiting illness, and restoring health*” [13]. In-patient Self-Care users get the intelligent assistant support from agents such as simple diagnosis based on newly measured medical data. Patient self-care with agent-bases personal assistant, assist the patient to self-care and it may reduce the number of visiting to hospitals. Example of this system is Super Assist projects [7].

Super Assist project application has an electronic agenda that looks like a big board and can be hanged into living room. The electronic agenda provide personal assistants to the patient of diabetes, e.g. motivation plan, consulting medical specialist and regular checkups. Super Assist project connects to the Internet and linked with the patient’s glucometer, online
cookery book and a virtual personal trainer. Information stored in agenda is remotely accessible for the doctor. However, it does not have any intelligence or autonomy that is necessary for user direct manipulation to manipulate the system. The terminals of this project are gateways and medical devices [7, 14]. Super Assist project provides a good terminal to patients to assist them for diet, exercise, medication, time scheduling and their medical checkup. There is a limitation of the project; it is a big electronic board, which shows everything on the screen. It is not portable. Patient has to approach to specific location (home or office) to get assistance.

2.3.2 Decision support to actors via diabetes monitoring and alarm

This decision support system supports the healthcare providers in order to take decision about the diagnosis. It can be realized via real-time diabetes monitoring and alarm system. Example of this system is M2DM [15, 16] application.

M2DM (Multi access services for telemetric Management of Diabetes Mellitus), a European Commission’s project that provides multi access services of tele-medicine to diabetes patients to improve the quality of their life by providing better communication medium(web services, computer telephony interfaces) between residential and mobile diabetes patients and care providers. It can monitor and receive blood glucose data and pass it to an intelligent agent, if there is any alarming condition, it triggers an alarm [17]. The main objective of M2DM is to process patient data and generate alarms automatically by the help of some rule-based techniques, combination of statistic and model based techniques in its knowledge Management agent, advanced methods for data analysis of aggregated blood glucose measurements. It provides 24 hours a day, easy and online services to patients and physicians, which is same objective of this research [15-17].

2.3.3 Trust from healthcare actors

In health related research, trust about the medical data is an important issue. To the diabetes healthcare systems there are relevant agents systems are working but in these systems trust from healthcare actors should be considered. Alfebiite project is an example these systems [6].

Alfebiite project provide a prolog-based validation system for task allocation and solution to keep track on the roles, responsibilities and competence of healthcare personal [18]. This project supported designing and implementing of trustworthy medical services in eHealth. The main objective of Alfebiite project is integrating trust into the task delegation in healthcare, it explains how the same action performed in different methods symbolize
different cultures, social and legal consequences and how a ‘trust’ is created in the presence of known standards (Logos, Hallmarks etc.) [19].

2.4 PROBLEMS OF TYPE 2 DIABETES PATIENTS

The problem in communication and working with risk and uncertainty is a serious one for many fields, so also in healthcare [20]. Patients of diabetes especially elder peoples need more care than others. They need proper rest, care of whole body e.g. skin, joints, foot, as well as regularity in medicine. They need also care in their diet, wrong medicine and wrong food may cause serious illness. Only a patient by self or a doctor cannot provide the care that a patient needs. To improve the quality of daily life of patient, a team of care providers working together is needed. The team consists of patient by self, doctor, nurse, clinician, chemists and relatives.

Patient cannot visit the doctor every day or cannot get appointment for laboratory test daily, even no care providers can visit the patient daily or in short periods of time to keep themselves update about the health of patient. Many decision support systems support only a single, and isolated decision - For example, what drug to prescribe or whether to refer a patient to a specialist. Most decisions however are made in the context of plans of action, where they may interact or conflict with other planned actions or anticipated events [20, 21].

There is a great need to develop a communication system, so all of care providers can work effectively and efficiently. By using minimum medical resources (doctor, nurse, medical experts, chemists, medical equipments, time) and getting maximum benefits (improve the quality of life) of healthcare. Automation or simple decision support systems are not enough to provide such kind of high-level communication and health services.

2.5 INTELLIGENT DECISION SUPPORT SYSTEM (AS A PROPOSED SOLUTION)

An intelligent decision support system in diabetes eHealth care can provide a better solution with the help of Tele-health or integrated mobile information system (IMIS). IMIS provides a communication platform and agent based services to the users (doctors, nurses, chemist, patients) at home [22]. IDSS system in diabetes eHealth care will acts like an expert system under the supervision of any trained medical staff. Expert system is a computer program that helps to solve problems or make decisions which storage of relevant
Information with the implementation of artificial intelligence. It imitates the process of reasoning [23, 24].

The intelligent decision support system in diabetes eHealth care will provide a 24-hour medical facilitates to patient and care providers at anytime and anywhere. Patient would be able to update his/her health status and can get basic instructions (diet, exercise) and prescriptions while staying at home. In the case of emergency, auto message will be sent to care provider e.g. doctors, relatives of patents and ambulance services. Due to this system patient can keep in touch with care providers and get the basic instructions regarding his/her health at home.
3 PROBLEM DEFINITION AND GOALS

Diabetes mellitus is one of the major chronic diseases that can cause the serious health complication like blindness, heart disease, kidney failure, weight loss and poor healing of wound especially in feet [5]. Diabetes patient have a shorter life expectancy than those without diabetes [25, 26] and they requires lifelong self-management with regular health care providers and supervision [27].

Patients of diabetes especially elder peoples need more care than others. They need proper rest, care of whole body e.g. skin, joints, foot, as well as regularity in medicine. They also need care in their diet, wrong medicine and wrong food may cause serious illness. Only a patient by self or a doctor cannot provide the care that a patient needs. To improve the quality of daily life of patient, a team of care providers working together is required. The team consists of patient by self, doctor, nurse, clinician, therapists, chemists and relatives.

Most diabetes patients contact their care providers on daily bases. The quality of diabetes patient can be improved by providing reliable and easy access between care providers and patient. A guideline for diabetes healthcare describes that, for a good quality of diabetes healthcare, teamwork is required in which main emphasis on diabetes patients. The patients need special training, support, and supervising so that they can take a better care of themselves, control own situation, and self-treatment. The patients must have easy communication with the care providers [22, 27].

Patient cannot visit the doctor every day or cannot get appointment for laboratory test daily. They can be too ill to attend the hospital appointment, patients may have rational behavior that they do not accept to visit the care provider [28], even no care providers can visit the patient daily or in short periods of time, to keep themselves update about the health of patient. Some time hospital or clinic are too crowded and patient have to wait long to visit to doctors and laboratory test, it is also difficult for patients [26, 29].
3.1 PROBLEM AND CHALLENGES FOCUS

- Patient’s daily life routine is completely dependent on the schedule of all care providers. She/he has to wait for medical checkups or any other medical exercises. Too many visits to the hospital/clinic and appointments of laboratories for medical tests disturb the daily life.
- Diabetes patients suffer many types of complications. They need special type of care (diet, exercise), patient by self or a doctor cannot provide the health care that patient needs.
- Care providers cannot visit the patient daily or in short periods of time to keep themselves update about the health of patient. They may not well aware of the patient’s condition all the time especially if the care provider has to perform different kind of activities. In such situation, it is difficult to update care providers about the patients’ health status.

These above problems/ challenges contribute the important role in our study. By eliminating these issues, we can save many medical resources and a lot of precious time of medical staff, relatives and patients as well. The time can be utilized for other constructive activities by both patient and care providers. Patient can spend his/her more time in social activities instead of spending most of the time in depressed environment of hospital.

3.2 RESEARCH QUESTIONS

1. How to increase the quality of life for diabetes patients by providing intelligent terminal (IDSS in diabetes eHealth care) for self care at any place and any time?

2. How can patients’ health status will be updated and notify to the care providers if there is any alarming condition?

3. How technology can support the care providers and help the doctors in decision making about the patient diseases?
As Diabetes is the chronic disease and patient of diabetes need more cares then others, they need special care in diet and they need exercise to maintain themselves. Patient of diabetes needs regular checkups from care providers. These regular checkups, medical tests, therapies, diet instructions, exercise and exercise instructions disturb the life of patients. According to our 1st research question, we will try to provide the solution for some of these problems by intelligent terminals, through which the quality of patient life will increase and they can access it from anywhere and anytime. Patients can take diet, therapy and exercise instructions while staying at home or moving around and reading blood sugar level and updating in the medical record without visiting hospital is focus. According to our 2nd research question, patient will update his/her status data in the system to get instruction but if there is some alarming conditions, auto message (SMS or email) will go to care providers about the condition of patient. In our third research question, on the bases of the data that patients update on his/her daily base and previous recorded history of disease or other diabetes patients, it will help the care providers (doctors) in decision making about the patients.

3.3 GOALS AND RESULTS

The Goal of our research will support the diabetes patients and care providers by reliable and intelligent communication system to get better health care services at home.

- Improve the quality of daily life of diabetes patients; they can get the basic instructions and basic treatments regarding their health while staying at home.
- Reduce the unnecessary visits of the patients to hospitals or care providing centers through effective and easy access communication between the care providers.
- Increase the co-operation among care providers and patients can access the information or system at anytime and anywhere. This will increase the integration of various existed healthcare systems.
- Save the medical resources and a lot of precious time of medical staff, relatives and patients as well.
4 METHODOLOGY

This chapter illustrates the research methodology carried out for the thesis. Research methodology defines what the area of research is, how to proceed, how to measure progress and what constitute to success. We adopted mixed methodology (Qualitative and Quantitative) to conduct this research. Quantitative method gives numerically precise solutions, also needs accurate and a complete set of input information; on the other hand, qualitative methods can work with incomplete information, but generate approximate solutions [30].

“Mixed method research in which the researcher uses qualitative research paradigm for one phase and the quantitative research paradigm for a different phase of the study” [31]. Mixed research approach is the combination of both qualitative and quantitative methods. Mixed research approach uses both inductive and deductive methods to obtain the qualitative and quantitative data, attempts to corroborate and complement findings and takes a balanced approach to research.

This research will carried out at multiple phases. In the first phase we studied literature review to understand what is diabetes, diabetes types, problems and complications due diabetes in elders, eHealth, Tele-health, IMIS, intelligence Decision support systems. This literature review will help us to design the questionnaires, guideline about analyzing and conduction of questionnaires. After the questionnaires conduction, in final phase interview will conduct with care providers to validate study.
4.1 LITERATURE REVIEW

Literature review plays an important role to know what the state of art is or what the existing researches are and what other researchers says about any specific topic. A deep literature review is done to know the existing materials and to know the answers of our research questions. Our mainly focus was to find research papers, articles, books journals, websites related to our research area. For this different research engine, Google search engine, IEEE Explore, ACM Digital library, BTH Library, Zotero are used to find information and knowledge. We also used some websites to get information about our research area. A literature review process help to understand the system and its functioning and where its need more research.

4.2 QUESTIONNAIRES

A questionnaire is designed on a basis of literature review and distributed to the 10 patients of diabetes. The objective of this questionnaire is to get the qualitative and quantities data to improve the diabetes eHealth services to patients at homes. Questionnaires is
formulated with open ended and close ended questions that will provide the opportunity to the diabetes patients to express their options, ideas and their problems about the system.

4.3 INTERVIEW

After the literature review and questionnaires, we have designed the interview with care providers to express their opinions about diabetes eHealth services and communication problems between care providers and diabetes patients. These interviews are conducted with care provider’s teams, doctors and nurse. The main objective of the interviews is to know the communication problems between care providers and diabetes patient and how can they get the basic treatment at home by the help of IMIS.

During the interview, authors ask both formal and informal questions with interviewees. In this formal approach, authors designed some preplanned questions to ask about the eHealth services for diabetes patient, their problems and needs. In the informal approach, questions are not preplanned. All that conversations is noted down for observation.
5 THEORETICAL WORK

Today Diabetes mellitus is the one of the most frequent non-contiguous disease in the world. According to the international diabetes federation, today 5.1% of world population is suffering with diabetes mellitus and in 2025 it will increase the 6.3%. From the last few decades, the biomedical engineering has been major focus on the improvement the diagnosis, monitoring and treatment of diabetes peoples. The rapid growth and development in technology provide different application in mobile computing, Internet, computer telephony integration and mobile Internet to access the health services. In this chapter we present the intelligent decision support system, how to will work, architecture, framework and structure and its services for diabetes patients. This will provide the on line service to patients of diabetes and care providers. [32]

5.1 E-HEALTH SERVICES

“eHealth tools or solutions include products, systems and services that go beyond simply Internet-based applications”. They include tools for health authorities and professionals as well as personalized health systems for patients and citizens. Examples include health information networks, electronic health records, tele-medicine services, personal wearable and portable communicable systems, health portals, and many other information and communication technology-based tools assisting prevention, diagnosis, treatment, health monitoring, and lifestyle management” [33].

The word “eHealth” refers to information and health services delivered using the information technologies. Main purpose of the services is to provide patients convenient health services while staying at home, or away from hospital. The Prominent aspects of the success of eHealth are increasing the quality of medical information, effective user interaction, and personalization of patient data according to need and requirement [34].

5.2 MOBILE INTEGRATED INFORMATION SYSTEM (IMIS) AND EHEALTH SERVICES

Diabetes is the one of the chronic diseases that affects many peoples. Patients of diabetes especially elder peoples need more care than others. They need proper rest, care of whole body e.g. skin, joints, foot, as well as regularity in medicine. They need also care in their
diet, wrong medicine and wrong food may cause serious illness. Only a patient by self or a doctor cannot provide the care that a patient needs. To improve the quality of daily life of patients, a team of care providers working together is needed. The team consists of patient by self, doctor, nurse, clinician, chemists and relatives. There are many problems in the current process of diabetes; one of them is communication problems between the patients and care providers. IMIS provides the communication platform to the patient of diabetes and care providers in order to increase their quality of life. Patients of diabetes can access and share information at right time form anywhere and any place [22] In IMIS, there are two groups that are accessing information from shared platform.

One group is patient (Health care receivers).IMIS provide the eHealth services to diabetes patients at their homes through mobile network such as self treatment, preparation before face to face meeting with care providers and home care supervision[22] and second group is all care providers. IMIS provides the services to all care providers(doctors , patients, nurse, relatives) through same mobile network communication platform in order to access right information at anytime and anywhere.[22]

Integrate Mobile Information System for Diabetes Healthcare (IMIS) provides a platform to store patient’s information in a conventional way and integrates the patients and the care-providers. Both services share the same communication platform and process the same information at a proper time for a transparent cooperative work among every member in the organization [22].

1. Monitoring:
   - Continuous (on-line) monitoring of vital signs, such as EKG, blood pressure, blood glucose, body temperature, body alarm clock.
   - Monitoring and central switch-off for ‘good night’ ‘good bye’ functions, environment alarm.

2. Communication /accessibility
   - All measured vital signs should send first to a database and if the value is abnormal comparing with preset value in the database IMIS should be directed to send alarm to pre-defined care providers.
   - Access journal from wireless portable computer that brings together at the point of care all information relevant to the care of patients, and even together with relevant knowledge and evidence.
– Re-new prescriptions, book time for visit, and ask questions to care providers.

3. Knowledge and decision making:
   – Public medical advices Q/A (*Informedica*) armed with search engine FAQ.
   – ‘My journal’ in which patients medical history can be stored as profile to decision support and advices from care providers, and also to gain knowledge on a citizen’s actual health status.
   – Making diagnoses, detecting trends and react on it. Together with feedback devices, IMIS should be able to interact with the patients as well as with professional services.

4. Support relatives and social life
   – Provide psychological support to contact with relatives by video chat.
   – Entertainments (films, music, games, news, etc.)
   – ‘Community’ forum there people exchange experience and advices how to do. [22]

![IMIS Architecture](image)

**Figure 2 IMIS Architecture [12]**

IMIS is an integrated system for a huge community. They use the same channel to interact with the system. In login process, an interface agent will be created and it will automatically identify different group of people. This process identifies different users, gets
their profile, and brings them to the proper service page. This could also skip some unnecessary process for reliable and frequently user so that the interface became more user-friendly for them [35].

5.3 DECISION SUPPORT STSTEM

Decision support system is computer-based tools that are used to support complex decision-making and problem solving. Decision support systems (DSS) are computer-based systems that used to assist the human to make better decisions. In health-care, such systems improve the quality of health-care, with the possibility of reduce cost without loss of quality. Successfully implemented DSS eliminates the human limitations of reasoning, complex evaluations, memorizations and time to make an optimal decision [36] and DSS is a general terminology which can cover all types of systems in the field of health-care. [37]

5.4 INTELLIGENT DECISION SUPPORT SYSTEM(IDSS)

IDSS is an inherited class of DSS [38] that uses different intelligent techniques to find the most optimal solutions of real world problems. It has ability to improve and expand its analytical capabilities. Normally IDSS has large number of options to analyze and has to decide among the options in short time. It describes size able options as an output.[39] Many computerized systems including decision support systems have been developed to help the patients and to assist the other care-providers 60-70% of them are effective and minimize the communication gap and maximize the accessibility of information and resources.[6,40]

5.5 INTELLIGENT DECISION SUPPORT SYSTEM IN DIABETES EHEALTH CARE

The Intelligent decision support system in diabetes eHealth care will provide a 24-hour medical facilitates to patient and care providers at anytime and anywhere. Patient would be able to update his/her health status and can get basic instructions (diet, exercise) and prescriptions while staying at home by the help of Tele-system. In the case of emergency, auto message will go to care provider e.g. doctors, relatives of patients and ambulance services. Due to this system patient can keep in touch with care providers and get the basic instruction regarding his/her health at home. IDDS system in diabetes eHealth care will acts
like an expert system under the supervision of any trained medical staff. Expert system is a computer program that helps to solve problems or make decisions by a store of relevant information with the implementation of artificial intelligence. It imitates the process of reasoning. [18, 19].

![Diagram of IDSS in Diabetic eHealth Care]

**Figure 3 Overview of IDSS in Diabetic eHealth Care**

### 5.6 ARCHITECTURE OF IDSS in Diabetic eHealth Care.

The architecture of IDSS in Diabetic eHealth Care is layered approach with the graphical interface on top, going down to the central part of the system that connects the storage to the model and up to the user interface.

The architecture of, IDSS in Diabetic eHealth Care, comprises on decision supporting functionality for doctors and provides easy access of healthcare services to the diabetes patient. The architecture is defined form two perspectives:

1. **Interface Architecture**: it defines the user interface of both ends (patients and care-provider), whether it is web-based or wap-based (Internet on mobile phone).
2. **Data Architecture**: consist on the design of database. How different repositories communicate with each other for the best possible options provides to the medical staff for the effective and efficient decision to improve the health and quality of patient’s life.
In construction of the architecture of the IDSS for elder patients of diabetes, we define 3 principles:

1. **Integrated**: there can be different representation of knowledge e.g. civic registration database, medical database of citizen, and several mechanism to deal with the knowledge e.g. data mining and rule execution. A integrated architecture is necessary for the system. Therefore, the system can be inter-operable and consistent.

2. **Customizable**: The IDSS will be customizable according to the situation, patient needs (mobile or web, graphical representation) and care-providers.

3. **Applicable**: The architecture of the system is practically applicable in the real world.

### 5.6.1 PATIENT

In our proposed system, patients interact with the system by the existing technologies and mobile web as well. Use of mobile technology facilitates the user to update his/her disease’s status in the medical record of hospital and can get the advice(s) or prescription from the care-providers on a remote location. Patient has to login to the system through the web (wap or web) by his personal number (civic registration number) and password.

### 5.6.2 DATABASE

In proposed IDSS, database contains different type of well-engineered and connected information. It has detailed information about, Diabetes patient history, diabetes cases history, optimal solutions from different medical experts for different conditions, suitable exercises and diet plans according to the condition of patient, and record of relevant care-providers. Centralized database architecture provides faster and precise problem solving process. Quality of decision depends upon, quantity, quality and structure of information stored into the database.
5.6.3 CARE PROVIDERS

Care providers consist of number of people who take care of a patient. This team consists of doctors, nurses, emergency service, pharmacy, clinical staff, nutritionist, exercise instructor and the relatives of a patient. Effective and efficient work of the team can improve the quality of life of a patient.

5.7 STRUCTURE OF IDSS IN DIABETIC EHEALTH CARE

It consists on user interface, database, database management tool and DSS model to analyze the results. In proposed IDSS, patient interacts with the user interface. If there is alarming conditions then system will call the emergency automatically. Otherwise system appends the current information with the history of patient’s disease and start matching it with diabetes cases in the past. Then after, it selects the most similar case with the optimal solution (including diet and exercise plan) of the case, at the same time the system get the optimal solution (including diet and exercise plan) from the database of expert opinion database according to the patient’s conditions. Now the solution from expert’s opinion database is matched with the diabetes cases history database to find, where the expert’s solution had been applied in history? What were the conditions of patients? And what was the output of the solution? All three solutions (disease history, expert’s opinion, expert’s opinion+Desease history) compared and combined into one report. That report sends to relevant care providers (doctor, nutritionist, exercise instructor). They will take final decision and sends to patient and other care providers of the patient.
5.8 TASK FLOW OF PATIENTS IN IDSS IN DIABETIC EHEALTH CARE

5.8.1 INPUTS

Patient inputs his/her personal number, sugar level, blood pressure and taken diet using the web or mobile services. After the login process, patient can enter the Blood Sugar, diet of the day, and time of meal taken, exercise and other description. By clicking “Submit” button request sends to the system.

5.8.2 PROCESSES

Processes comprises on data mining of patient history, disease history, experts opinion, diet plan and exercise plan. System will find the perfect combination of medicine (if required), diet and exercise and validate it by applying the available cases of the disease. If
currently entered data shows the alarming condition of patient, then the system instantly call for the emergency services.

5.8.3 OUTPUTS

Outputs are instructions about diet and exercise. Validated single report sends to the nutritionist, therapist and doctor at same time for final decision. Final decision sent back to the patient by email and notifies the patient by SMS, so that patient can check email at right time. System saves the patient’s update in the patient’s history repository. It also notifies all other care provider (e.g. relatives), about the current condition of patient and advice(s) against the condition, by email and SMS (notice).

![Diagram of Task flow in IDSS in Diabetic eHealth Care](image)

**Figure 5 Task flow in IDSS in Diabetic eHealth Care**
5.8.4 USER INTERFACE OF IDSS IN DIABETIC EHEALTH CARE

User interface is way of communication between the users and IDSS. It deals with ease of use, accessibility and human machine interaction. User interface of IDSS in Diabetic eHealth Care is user friendly, as most users are elderly patients of diabetes with low computer skills.
IDSS interface follows the design principal in order provide more flexibility and ease of use to diabetes patients as most of patients are elders and they are not much familiar with computers.

5.9 PRINCIPAL OF USER INTERFACE DESIGN

5.9.1 VISIABILITY

For the better understanding of users, to insure that things are visible in interface. The interface provides complete visibility and clarity in all aspect, icons, links, buttons, text are clear and visible to users. Most of users of IDSS in Diabetic eHealth Care, elder people with low computer skills. Interface should be clear and visible to them so that they can easy interact with system.

5.9.2 CONSISTENCY

To be consistent in the use of design features. A system should look, act and operate same throughout, graphics, appearance, and feedback should be same. Position and function of standard elements must remain same that is called consistency in interface design.

5.9.3 FAMILIARITY

Main text, titles of the buttons or functions and help text should be easily understandable to the user. It helps the user to get familiar with the system easily.

5.9.4 AFFORDANCE

Arrangement of the things must be clear to the user to understand it.

5.9.5 NAVIGATIONS

Principle of navigation in interface designing provides the ability to move freely in the application. It also informs the user about his current location.

5.9.6 FEEDBACK

Good interface design must provide the ability to fast feedback to the user on every action, even error sound or signal, if something wrong happened.
5.9.7 TOLERANCE

If a user makes some mistake e.g. unfilled text field in form and submitted, system must not restart the form. Let the user know about the error and allow him to correct it, instead of restart the application.

5.9.8 CONSTRAINT

This is a nice action, minimizing the chances of occurring errors by providing the information about the things or don’t allow to do wrong e.g. selecting one choice from two, it is better to use radio buttons, instead of two check boxes.

5.10 USER INTERFACE DESIGN GUIDELINES

The guidelines of user interface design are used to provide an efficient, effective, and structured and usable design of IDSS in Diabetic eHealth Care.

5.10.1 USE OF COLORS

Color selection has great importance in the design of user interface that makes it interactive. Color makes the blind interface into radiance interface.

5.10.2 AMOUNT OF COLOR

Matching and consistency in colors increase the simplicity and visibility of the interface.

5.10.3 WINDOWS DESIGN

The best design approach is to divide the information into different windows and sections. Step by step information can be provide into multiple windows for users satisfaction.

5.10.4 INFORMATION PRESENTATION

Different information can be presented in the form of symbols, text in the interface. Use upper and lower case for text and images to express meaning of the whole scenario.

5.10.5 MENU DESIGN

Menu design vary application to application, in some application users feel convenient with hierarchal menu design and in some vertical menu.
5.10.6 AMOUNT OF COLOR

Consistency and matching colors on the interface increase the simplicity and visibility of the interface.

5.10.7 BACKGROUNG COLOR

It is best practice if use the background color in large blocks, not all colors is equally readable but use light colors for the background. Color choice depends on the user's age, so use that colors which are more acceptable [41].

5.10.8 DATABASE

Database is used to store and retrieve the data; the database consists of some collection of some persistent data that is used by the application systems of some given enterprise. Two major properties of database. Firstly, it is integrated which means that previously distinct data files have been logically organized to eliminate redundancy. Secondly, it is shared which means that all qualified users in the organization have access to some data for use in a variety of activities. The data base design requires the lot of effort in the implementation of the data model, security issue and query languages. A rational database model can be used to present the data in the form of tables with their values called “attributes” and classified under a specific domain. A relational data model is simply a method of representing, manipulating, and retrieving information. Relational model has many benefits. It is intuitive and simple and carries a high degree of data independence. The SQL(structured query language can be used to conceptual decision support system. The database contain the information of the patients, patient disease history, diabetes cases history, care providers information, diet instructions, exercise plan, optimal solution from different medical experts for different conditions.
<table>
<thead>
<tr>
<th>Database Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient information</td>
<td>Contain the information of patients, name, personal number, address, phone number, disease type.</td>
</tr>
<tr>
<td>Patient disease history</td>
<td>Contain the history of patient disease</td>
</tr>
<tr>
<td>Diabetes case history</td>
<td>It will contain the general information of diabetes case.</td>
</tr>
<tr>
<td>Care provider information</td>
<td>Information of doctors, their professions, experts, nurse</td>
</tr>
<tr>
<td>Diet instructions</td>
<td>Contain the diet information for diabetes patients, which nutrition is useful and which are harmful for them. Will provides the diet plan to patients</td>
</tr>
<tr>
<td>Exercise plan</td>
<td>Will provides the exercise information to patients according to their situations.</td>
</tr>
<tr>
<td>Optimal solution from different medical experts for different conditions</td>
<td>It contains the advise or solutions from different medical experts about the different conditions of diabetes and suggestions from medical experts.</td>
</tr>
</tbody>
</table>

**Table 1  Database Entities**
5.11 ACTIVITY DIAGRAM

In the figure, you can see how the patients and care providers (Doctors) will interact with system. Figures below show the flow of IDSS in Diabetic eHealth Care system.

![Activity Diagram of patients]

Figure 7 Activity Diagram of patients
Figure 8 Activity Diagram of care providers (Doctors)
5.12 USE CASE DIAGRAM

![Use case diagram]

Figure 9 Use case diagram

5.13 KEYS FEATURES OF SYSTEM

5.13.1 REDUCE UNNECESSARY VISITS OF HOSPITAL

As diabetes is a chronic disease and patients of diabetes are suffering many problems or complications. One of them is communication problem between patients and care providers.
Patients cannot visit the doctors every day or cannot get appointment for laboratory test daily, even no care providers can visit the patients daily or in short periods of time to keep themselves update about the health of patients.

IDSS in Diabetic eHealth Care will reduce the unnecessary visits of patients to hospitals and clinics. Now with help of IDSS in Diabetic eHealth Care, they can get the basic instructions (diet and exercises) at home. They can access this system from anywhere and at any time.

5.13.2 PATIENT DATA UPDATION AND HELP CARE PROVIDERS IN DECISION MAKING

Diabetes Patients updates his/her status on daily bases to get the basic instruction at home, these data will save in database. Care providers e.g. doctors, nurses can access patient’s data in order to review the patient’s conditions and can make suggestion for him/her. This database will help the care providers to make decisions about the health of patients.

5.13.3 DIET PLAN FOR DIABETES PATIENTS

IDSS in Diabetic eHealth Care, provides the diet plan to diabetes patients, they can get the instruction regarding their diet at homes according to their situations. It provides how to maintain the healthy diet in general and gives indications to diabetes patients what diet is healthy or unhealthy? Diet plays a vital role to control the diabetes and is planned according to the patient weight, height, age, sex and type of diabetes. The main focus is on type2 diabetes that can be controlled by healthy diet [42]. A sample diet plan for diabetes type2 patients can be designed as following:

| Sample Type 2 Diabetes Diet Menu for Breakfast | • Two slices of bread  
| | • One cup of skimmed milk  
| | • One boiled egg  
| | • One serving of your favorite fruit  

| Sample Type 2 Diabetes Diet Menu for Lunch | • One bowl of pasta  
| | • Two servings of your favorite vegetables  
| | • One serving of meat (chicken or turkey)  

| Afternoon Snack                          | • A fruit  
|                                        | • Three saltines or crackers  
|                                        | • Half a cup of tea or coffee (with artificial sweetener)  |
| Type 2 Diabetes Diet Sample Menu for Dinner | • Three servings of meat or fish  
|                                        | • Half of a baked potato  
|                                        | • Two helpings of vegetables  
|                                        | • A fruit  |
| Snacks After Dinner                    | • A cup of milk  
|                                        | • Cheese or a few saltines  |

**Table 2 diet Plan**

5.13.4 EXERSIE PLAN FOR DIABETES PATEINTS

Exercise is very important for diabetes patients especially type2 patients to manage themselves. An exercise with combination of diet and medicine play a vital role to control the weight and blood sugar level of diabetes patients.

Exercise helps to control the type 2 diabetes by,

- Help to decrease and control weight
- Help to control blood pressure
- Improve the body to use insulin effectively
- Reduce the modest weight by burning the extra body fat, it improves insulin sensitivity
- Getting muscles strong
- Strengthens the bones
- Controlling the blood pressure
- Reduce the LDL cholesterol (bad cholesterol) for helping to protect against heart disease
- Increase body’s energy level to enhance work capacity
- Work as stress reliever, promoting relaxation, and releasing tension and anxiety
IDSS in Diabetic eHealth Care, provides the instructions to patients about exercise to improve their quality of life. [44]

5.13.5 AUTOMESSAGEING OR SMS TECHNOLOGY

Short Messaging Service or SMS is a good mean to collect the data of patients remotely. It has been successfully used in health-care for different purposes including appointment reminders, contraception reminders and diabetes education. According to Robert and Gorman, use of SMS communication in health-care has some advantages like improved patient ease; quick results with reduced paper work and less expensive [45, 46]. Communication through SMS between the patients and health-care providers can be provided by web-SMS server and a GSM mobile service [47].

One of the key features of IDSS in Diabetic eHealth Care is auto messaging or SMS. When patients update his/her data in order to get instructions about health then system checks the conditions of patients. If it is going to worse or any alarming conditions, an auto message or SMS will go to the care providers to inform the patient’s health.

The patients have to connect with the IDSS through Internet from personal computer or mobile phone to updates his/her data in order to get instructions about health. The IDSS is connected through databases and has different thresh-hold values e.g. sugar level, defined by the medical experts. The IDSS checks the entered data of patients, if it the entered data is equal to or more than the predefined alarming values, an auto message or SMS will be sent to the care providers to inform the patient’s health. This feature makes the IDSS in Diabetic eHealth Care distinguish from others systems that are working for diabetes patients. For SMS technology, IDSS in Diabetic eHealth Care, connected with SMS providing websites. Every time, the blood sugar level enter by the patients will compare with predefined values.

![Figure 10 SMS Technology](image-url)
5.13.6 24 HOURS SERVICES

IDSS in Diabetic eHealth Care provides the 24-hours services to the patients of Diabetes. Patient can access the IDSS from anywhere and anytime with help of web services or mobile services.
6 QUESTIONNAIRE

Questionnaire is comparatively convenient and inexpensive method to collect information. This method also provides greater anonymity [48]. We conducted the questionnaire with patients of diabetes in order to know about the problems of diabetes patients regarding visits of health-care centers and other communication problems with health-care providers. What are their opinions about IDSS in diabetes eHealth services at home.

To accomplish this purpose we distributed a questionnaire to the patients. The patients filled out the questionnaires and provided us useful information.

6.1 CONDUCTION OF QUESTIONNAIRE

This chapter contains the detail of questionnaire that we conduct with the patients of diabetes type2 especially, elderly peoples for our thesis. The planning of questionnaires is given in section 5.2. The section 5.3 describes the questionnaires design and section 5.4 identifies the questionnaire distributions in the patients of diabetes. The selections of questionnaire are given in section 5.5 and questionnaire analysis in the question 5.6.

6.2 QUESTIONNAIRE PLANNING

We planned questionnaires to get the information about the problems faced by the patients of diabetes. The targeted problems in questionnaires, to visit care providing centers regularly and communication problems between patient and care providers and how can the quality of patients life can be improved. It was planned to visit health centers in Ronneby and Karlskrona to contact with the diabetes patients.

6.3 QUESTIONNAIRE DESIGN

After completion of literature review about the diabetes mellitus and existing technology for diabetes patients, we have designed an intelligent decision support system to provide convenient health-care services to the patients. After designing IDSS in Diabetic eHealth Care, we design the questionnaire. The purpose of the questionnaires was to collect the
both quantitative and qualitative data to measure the problems they are suffering to visit care-providing centers regularly and communication problem between patients and care providers. What are patients’ opinions about IDSS in diabetes eHealth services and what they suggest for more development? We discussed both open ended and close-ended questionnaires. After the completion of questionnaires, statistical analysis was done to analyze the results of questionnaires.

<table>
<thead>
<tr>
<th>Questionnaires</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How often do you see your healthcare provider in a month?</td>
</tr>
<tr>
<td>2. How often do you see your dentist in a month?</td>
</tr>
<tr>
<td>3. How often do you see your foot exam in a month?</td>
</tr>
<tr>
<td>4. How often do you see your doctor in a month?</td>
</tr>
<tr>
<td>5. Is it easy to get an appointment with care providers (doctors)?</td>
</tr>
<tr>
<td>6. How many times in a day, you check your blood sugar?</td>
</tr>
<tr>
<td>7. What change in life do you experience due to the diabetes?</td>
</tr>
<tr>
<td>8. Do you feel any difficulty to visit doctor? (if yes then give description)</td>
</tr>
<tr>
<td>9. Do you feel any problem in managing your daily life routine?</td>
</tr>
<tr>
<td>10. How much time do you spend for your health-care in a day?</td>
</tr>
<tr>
<td><strong>Exercise</strong> _________</td>
</tr>
<tr>
<td><strong>Checking blood sugar</strong> _________</td>
</tr>
<tr>
<td><strong>Book an appointment</strong> _________</td>
</tr>
<tr>
<td>11. How to improve their situation?</td>
</tr>
<tr>
<td>12. What are your suggestions to improve quality of life of diabetes patients, so the</td>
</tr>
</tbody>
</table>
patients can use health services without disturbing their daily life?

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>13. Do you use health services on internet?</td>
<td>No Yes</td>
</tr>
<tr>
<td>14. Do you use mobile phone for health services?</td>
<td>No Yes</td>
</tr>
<tr>
<td>15. Do you feel convenient for e-prescription?</td>
<td>No Yes</td>
</tr>
<tr>
<td>16. Is it a problem to visit doctor, nutritionist and other health providers?</td>
<td>No Yes</td>
</tr>
<tr>
<td>17. Is it OK, If you get basic instruction at home by mobile phone / internet?</td>
<td>No Yes</td>
</tr>
<tr>
<td>18. Is it OK, if you can update your doctor about your health by using IDSS in diabetes eHealth services at home?</td>
<td>No Yes</td>
</tr>
<tr>
<td>19. Do you want to get the instructions (diet plan, exercise instructions and medicine instructions) at home?</td>
<td>No Yes</td>
</tr>
</tbody>
</table>

Table 3 Questionnaire

### 6.4 QUESTIONNAIRE DISTRIBUTION

Questionnaire was distributed to the 10 peoples who are suffering diabetes type2. Questionnaires are in both languages Swedish and English. Patients were selected from different areas of Blekinge County. Selection of patients was done carefully to get maximum possible outcomes. Hard copies (print out) of questionnaires were distributed to the patients.

### 6.5 QUESTIONNAIRES ANALYSIS

Authors perform the quantitative analysis of questionnaires to get the accurate results. Response of Diabetes patients against the open ended and closed ended questions are calculated and given in percentage below.

### 6.6 OPEN-ENDED QUESTIONS

There are different methods used by survey researchers to measure the attitude and opinions of public. Open-ended question method is one of them, which allows the user to respond in their own words [49]. With the help of open-ended questions, different point of views and different style of thinking of people can be measure.

In the questionnaire’s question 1, 70% patients state that they need to visits health care Providers three times in a month, 20% patients state that they visits two time in month to
visit hospitals and only 10% patients state that visits once in a months to care providers.

In questionnaire’s question 2 and 3, 70% patients state that they do not visit their dentist and foot exam to every month, only 30% patients state that they need to visit one time in month to dentist and foot exam.

In the questionnaire's question 4, 90% patients state that they need to visit to doctors two to three times in a month.

In the questionnaire’s question 5, 50% patients state that they do not feel any difficulty to get appointments with care providers and 50% patients state that they have difficulties to visits care providers due to their busy schedule. They want to get all the facilities on Internet.

In the questionnaire’s question 6, 80% patients state that they need to check three time their blood sugar to maintain themselves in a day and 20% state that they check the blood sugar two times in day. If they take some candy or chocolate, in that case they need more time to check it.

In the questionnaire’s question 7, 100% patients are agree that diabetes changes their life. They feel some difficulties in their social and married life. Especially they have to be more careful about their diets and drinks. Every time they have to be Conscious about food, is it good for them? They also response due to diabetes they feel tiredness quickly. One patient states” I love cake and chocolates but due to diabetes, i cannot eat much”

In the questionnaire’s question 8, 50% patients claim that they have some difficulties in visiting the doctors due to busy schedule or some other activities and 50% patients state that they have no problem to visit doctors and in the questions 9, 90% patients claim that after having diabetes they feel problems in managing their daily life routines. They are always conscious about diet, drinks and exercise. They cannot lead life like normal persons.

In the questionnaire’s questions 10, 80% patients state they spend proper time in exercise, checking blood sugar level and booking an appointment.

In the questionnaire’s question 11 and 12, 100% patients state, they can improve their situation and quality of daily life by proper diet, exercise, proper knowledge about diabetes, awareness about the effects of diabetes on health, regular blood
monitoring and exercise, visiting doctors 2 to 3 times in a month, eHealth services.

Figure 11 patients Response against Questions No 1

Figure 12 Patients Response against question No 6

6.7 CLOSED-ENDED QUESTIONS

A questionnaire may contain closed-ended questions. Such questions which has predefined answers e.g. “YES”, “NO” or multiple choice questions
This type of questions are easy to analyze and can provide quantitative results. Our questionnaire has some closed-ended questions.

According to question 13, 100% patients are agree with health services on Internet. They feel difficulties to visits doctors and care providers due to their busy schedule. They stated “I don’t normally have time to visit a doctor so i would really like everything to be available on Internet even my own doctor.”

According to questions number 14 and 15, 100% patients are agree to use mobile phone for health services, they articulate it’s more convenient for them to use mobile or Internet to get health services and they are also feel convenient with e-prescriptions.

According to questions 16, 17, and 18. 100 % patients agree with the services of IDSS in Diabetic eHealth Care. They want to get basic instruction such as diet, exercise and blood monitoring at home. It will make their life easier. They will get rid of the tension to take printout of their blood sugar level every time they check and keep it with them to care providers when they visit them. Now in this case, they will feel more easiness because the health status will automatically save in database, care providers can check any times. They also want to get the basic instructions of diet and exercise and medicine at home. Before this every time, to take some other diet they need to inquire care providers to know which food is harm for them or not.

Figure 13 Patients response against close ended questions.
7 INTERVIEW

Interview is a very useful technique to collect such data that is not accessible by using other techniques such as observation or questionnaires [51]. Interview is a good method to verify and validates our research. So, we decided to interview with care providers that are working for diabetes patients.

7.1 IDEA BEHIND INTERVIEWS

The authors planned to conduct interviews with care providers (diabetes nurses) that are working specially diabetes. The idea behind the interviews is to verify and validate the results of the questionnaires, literature review, and the IDSS for diabetes patients and our thesis study. Expert’s opinion on the IDSS can helpful to design a better system for the diabetes patients. The authors want to know, what support users wants from the IDSS.

7.2 INTERVIEWEES

We selected three different persons for our interview purpose. We selected Ulla Aghide, Carina Thorkelsson from diabetesmotagningar (diabetes clinics) Karlskrona and Kristina from Capio City Klinik Ronney. By profession they are experienced nurses who deal with diabetes patients. Kristina is diabetes nurse, she has been working for two years in Capio City Klinik Ronney. Ulla Aghide has been working since 1995 and Carina Thorkelesson has been working since 1992 in diabetesmotagningar (diabetes clinics) Karlskrona for diabetes patients.

7.3 INTERVIEW EXECUTION PLANING

We conducted these three interviews at different times in diabetesmotagningar (diabetes clinics) Karlskrona and Capio City Klinik Ronneby. Time duration of each of interview was 45 minutes.

7.4 DESIGN OF INTERVIEW

Authors put both formal and informal questions to identify problems of diabetes patients, care providers, communication problems, about their needs and requirements, their opinion about IDSS in Diabetic eHealth Care. For the formal approached we designed some preplanned questions for interviewees. Informal approach had also used by the authors during the interviews where the authors had formed some questions from the reply of the nurses.
Authors had planned to do a structured interview (C. Hughe, 2006) with some specific questions. But after a short presentation of the IDSS in Diabetic eHealth Care, the interviews became discussion and during discussion we got further information which was beyond the pre-designed questions. In interviews, we noted down all the information from the care providers (diabetes nurses).

7.5 DATA COLLECTION

During the interviews, we collected the data according to the pre-designed questions and also from discussions. Every answer from the nurses and all opinions from them were noted down by both of the authors and then testified by the interviewee. During interviews, we got much precious information about the undergoing projects of diabetes health and some basic problems that the medical staff has to face when they deal with the diabetes patients. Kristina told us about the plate-model diet plan and she mentioned about national guideline program of Sweden. Ulla Aghide and Carina also told us about the national guideline program that suggests the diet plan for the patients of diabetes. They gave us the meaningful information about patients’ problems and their health and options about our system IDSS in Diabetic eHealth Care.

7.6 ANALYSIS OF INTERVIEWS

The interviews were also helpful to analyze the results drawn from the questionnaire. Well-structured interview questions helped us a lot to analyze interview. We got the expected information against each question. Then number of interviews helped us to verify all collected information. We collected the information about the diabetes patients’ population in state of in Blekinge, existing eHealth services for diabetes patients, patients self care and blood monitoring, information regarding patients, National guideline program and plate model, exercise plans, and finally IDSS in Diabetic eHealth Care.

The analysis from the interviewees and observation help us to find the missing information during the observation and documentation and help to design a more suitable IDSS system for diabetes patients. The answers of these interviews are provided in appendix2.

7.7 DIABETES PATIENTS POPULATION IN BLEKINGE

According to our question number 1, 2 and 3, the interviewee explains, in Blekinge, there are 6000 registered patients of diabetes and 14 health care centers are working for
diabetes patients. Average 425 patients are registered in one health-care center. However, number of registered patients would be increased up to 800 in any single health-care center.

7.8 EXISTING EHEALTH-CARE SERVICES

For diabetes patients there are some eHealth services available. That can be used by the patients. Online booking of an appointment and e-prescription are some eHealth services. Patients can contact the doctor by email and provide information about their current health. Other than these services, telephonic contact with the doctor is also possible.

7.9 PATIENT SELFCARE AND BLOOD MORNINOTING

According to our question number 6 and 7, patient of diabetes need special care and it depends on the condition of patients, how many time he/she test his/her blood sugar in a day. If patient is new than he/she has to check his/her blood sugar level 6-8 times in a day because patients have to learn about their disease. Why sugar-level rise up and how to slow down. But old patients can check their blood sugar level 2-3 times in a week. If patient is new (recently diabetes detected), then s/he has to visit nurse twice a month and to doctor, once in a month. But if patient is old and the disease is well controlled (blood sugar level is controlled), then s/he has to visit doctor once in a year but he/she need to take care of themselves at home, they have to take care of their diet, exercise and test blood sugar regularly. They can visit any time if there are any abnormal conditions.

7.10 INFORMATION REGARDING PATEITNS

In interview questions number 9 and 10, the interviewees (diabetes nurses) explain, either patients contact from home or visits hospital or clinic, they need to know about following things

- Patient blood
- Sugar level
- Blood pressure
- Insulin dozed
- Diet
- Exercise
- Work routine
- Sleeping time
- Family
- Social life etc

7.11 HBA1C

HBA1C is the blood sugar test for diabetes patients that are conducted after every 6 to 8 weeks. This test is used to know how many red blood cells are affected with sugars. The HBA1C test is the best way to check diabetes is under control and this test is not like ordinary sugar level test.

7.12 NATIONAL GUIDLINE PROGRAM AND PLATE MODEL

According to our questions 14 and 15, the National guideline program suggest the diet plan for the diabetes patients; they are launching new diet guideline for patients in this year, may be in the month of May. That guideline will be available on Internet and will help doctors to suggest the suitable diet. Normally, they suggest plate model for patients. Plate model is a simple way to describe how good the meal looks for patients. Plate-model diet plan does not show how much food patient need, but it shows what proportion of the food a patient need in a meal. Quantity of food is depends upon age, sex, work type and exercise. Green vegetable is good to reduce the body-weight. Actually, plate-model is a plan for diet for every single meal.

It divides a plate into three parts and each part has multiple options according to nutritional values. In the first part of plate, patient has to select one of option from rice, potatoes, pasta and bread, because these things have high carbohydrates values. In the second part, options are fish, meat and eggs. Similarly, patient has to select one thing form green vegetables, root fruits and other fruits. Patient can select one thing from each part for one-time meal. Different combinations help to change the taste every time. It also helps to keep the sugar level in control.
7.13 EXERSIE PLAN

According to our question number 14, exercise is important for diabetes patients to keep their blood sugar level normal.

7.14 IDSS IN DIABETIC EHEALTH CARE AND DECISION MAKING

According to our questions number 16, 17, 18, the interviewee explains that it’s good idea to develop and purpose an intelligent decision support system for diabetes, so that they can access the basic instruction regarding diet and exercise at home. Normally, patients do not satisfy about their diet. They always asked question which food is good for them and which is harmful for them, what they drink, which drink is good and which is not good for them. Interviewees also explain that’s this system will help a lot to care providers as patients cannot remembers all their history when they visits us, so due to this system care providers can view the previous health status of patients and it will help them a lot to make decision about patients health. In the current system, patients bring the printed form of their health status (blood sugar, blood pressure etc) but due to IDSS they no need to bring such things, care providers just enter the personal number of patients and can get the all previous health status of patients. It is nice idea and it will reduce the unnecessary visit of patients. It is more good idea if patients access the basic instructions regarding health (diet, exercise) at home.
8 DISCUSSION AND VALIDATION

This chapter illustrates the discussion and validation assessment of our thesis. In this chapter authors discuss problems of diabetes patients, communication problems, unnecessary visits, SMS technology, IDSS in Diabetic eHealth Care and validity assessment of the results.

8.1 DISCUSSION

Diabetes is the one of the chronic disease and patients of diabetes need special type of care. The authors did the detail literature review and did questionnaire with diabetes patients in order to know, how to make the diabetes patients life easy and what’s problems they are suffering, how the quality of their life can be improved.

An intelligent decision support system for diabetes disease, especially for elder patients, is difficult task to design. There are number of aspects to concern with, like understanding of the disease, willingness of patients to be cured and follow the certain criteria, availability of care providers, availability of information for both doctors and patients, useful representation of patient’s record and user interface design. According to authors perspectives there should be a system that can provide facility to patients and doctors so they can effectively and efficiently communicate with each other remotely. Patients can get basic instructions about his/her health at home. That can improve their quality of life. Availability of information and good representation of data can help the doctors to make an optimal decision for a patient.

8.2 PROBLEMS OF DIABETES PATIENTS

According to authors and interviewees point of views, patients of diabetes need special type of care (diet, exercise, skin, foot etc). Only the patients cannot care themselves. Inappropriate diet can lead the patients to serious illness or death. Same like exercise is also very important for patients; it can help them to maintain their blood sugar level.

8.3 COMMUNICATION PROBLEM

During interviews and questionnaires, it is observed that there is communication gap between patient and health care providers. Patients claim that, they cannot remember everything about their health for a month or more. If they get some problem, they cannot
inform the doctor about their problem until the next appointment. Health care providers say that, patient cannot remember and explain their conditions. Some of them note down every day conditions and most of them do not. Some patients keep their every day record with themselves but mostly it cannot help us. We do not have enough time to integrate and evaluate all given records by the patients. Therefore, there must be a system that can store every day’s information about patient and show us in such manner that can be evaluated within seconds and help us to make effective decisions. Health care providers must have good communication medium among themselves and with the consented care-providers (relatives).

8.4 UNNECESSARY VISITS

Health-care providers speak against about the unnecessary visits of patients to the hospital. Interviewees state that patients especially get hyper when they knew that their blood sugar level is high. They rushed toward the doctor or nurse to help them out. Nurses always suggest to patients try to learn yourself that, why it happened? Patients visit health care centers to inquire about their diet. Patient inquires doctors by email and telephone asking about each diet either they can consume or not.

8.5 INTELLIGENT DECISION SUPPORT SYSTEM

Authors have discussed with the relevant persons and we concluded from questionnaires and interview that health-care providers and patients really appreciate the system which helps them to make a decision. Patients showed their excitement about the system when they came to know that the system can reduce their visits to health-care centers and they can update their record being at home. System makes the suggestions according to their situations, if there any rapid increase in their blood sugar level, an auto message goes to care providers. Patients say that most of the time they came to the health-care center only to let the doctor know about unusual change in the blood sugar level. Those visits are besides the regular monthly visits.

According to the interviews, health-care providers would welcome the system because the system will update the patient’s record remotely and shows it in such useful manner that can help the nurses or doctors to make a good decision without wasting their time to read the patient’s record and interviewing the patients about his/her daily life of last few weeks or months.

On the other hand, health-care providers showed their trepidations that patients must come to the health-care center as Ulla claims that we like patients to visit us. If patients don’t visit hospital then there is no need for doctors in the hospitals. On the other hand some
patients also showed lack of trust in guidance from computer or Internet. Some patients would also prefer to ask the doctor than to consult the Internet or any other system.

8.6 SMS TECHNOLOGY

According to authors and interviewees point of views, SMS technology is good thing and it is a unique idea. An auto message is sent to the care providers to inform that patient is in emergency and they must take some actions. According to Kristina, a diabetes nurse, there should be someone else to read the SMS if she is not on her duty.

8.7 VALIDATION ASSESSMENT

Validation assessment is the essential part of the research where, it is quantitative or qualitative [52]. In this thesis study, validity of the interview results can be accessed to the criteria by trochima. Validity assessment consists of the four basic criterias that are following.

- Credibility
- Transferability
- Dependability
- Conformability

8.7.1 CREDIABILITY

Creditability means results of the thesis or report must be realistic and believable form the participant’s point of view that is taking part in the research. [52]. For our thesis creditability, the authors used both quantitative and qualitative research approach. In the first phase, authors study the literature review and other existing system that are working for diabetes patients. On the bases of the finding from the first phase, questionnaires were designed and conducted with the different diabetes patients. After analysis to verify our study, an interview was designed and conducted with three different care providers that are working especially for diabetes. The finding from the three different interviews has been translated into text form and authors analyze the results of interview. The details of the interviews and questionnaires results are in appendix1 and appendix2. Authors are confident about the credibility study after analyzing the results of interview and questionnaires.
8.7.2 TRANSFERABILITY

Transferability is used to generalize the results of research. In the case of diabetes patients they are suffering many types of complications. In our thesis results from questionnaires and interview are helpful to know the problems of the diabetes patients and it helps us to design the system.

One possible threat can be same educational and culture background of the subjects. In our questionnaire, the entire subjects have same cultural background. The questionnaire results can be different if the subjects have different gender, educational and cultural background.

Second possible threat in questionnaire can be as most of the diabetes patients are elderly people, they cannot read and write English. If the questionnaire was conducted only in English then in that case the results may be different.

8.7.3 DEPENDABILITY

In research, time-to-time alterations in the previous revisions are known as dependability. New research results in the same context and their effects on the research compared to previous results are alteration [52].

The questionnaires were distributed into ten different diabetes patients. As the most of diabetes type2 patients were elderly and they cannot speak and read English, so authors converted questionnaires into Swedish language. The design of the questionnaires depends on the findings that we got form literature review and study of previous systems for diabetes patients. There can be validity threat as most of the patients can not know the logical terms in the questionnaires. In order to minimize this validity threat, authors gives the short presentation of the proposed system.

The three interviews with care providers (diabetes nurses) were conducted at different times. Authors contacted the care providing centers by email, phone and visit to get appointment. The first interview was conducted with Kristina (diabetes nurse) in Ronneby. The second and third interview was conducted at same time with diabetes nurses in Karlskrona due to their busy schedules.

8.7.4 CONFORMABILITY

Conformability is used to confirm the results by the other researchers [52]. For our thesis conformability, authors conducted the questionnaires with the diabetes patients. After
analyzing the results of the questionnaires, authors conducted interview with care providers in such a way that one person is asking questions to care providers and other was writing down the answers of the questions. In case of any misunderstanding and confusions, authors again discussed it with care providers. To make sure that it will help to stay focus on IDSS in Diabetic eHealth Care, authors refined the questionnaires and interview (section 5.4 and 6.4). Authors coded all the answers of the questionnaires and interview into MS word documents in order to save the information. [52].
9 EPILOGUE

The epilogue contains conclusion and future work.

9.1 CONCLUSION

The main aim of this thesis is to identify the problems of diabetes patients and propose an intelligent decision support system through which they can access the basic instruction of diet and exercise at home that improves the quality of patient’s life and in the case of emergency, an auto message goes to care providers. To explore the main aim of the thesis, a lecture review is done to know what problems diabetes patients are suffering, how to improve their quality of life and what existing system are providing services to patients at home.

Form the study of literature review and results from interviews shows that the quality of diabetes patients can be improved with IDSS in Diabetic eHealth Care. It provides the basic service regarding diet and exercise at home and provides a communicational channel between care providers and patients. It provides the intelligent decision support both to care providers and patients. Due to this, some unnecessary visits to care providing centers may be avoided and this obviously decrease the communication problems of the diabetes health-care management and health care centers provides the higher quality of health-care at lower cost. It saves the precious time of care providers and patients and saves many medical resources.

A questionnaire was designed on the base of literature review and existing system that are working for patients. A questionnaire was distributed into numbers of diabetes patients to know their problems, options and ideas about IDSS in Diabetic eHealth Care. The statistical analysis of the questionnaire was done to get the concrete results.

Three interviews were conducted to validate our study. To find the missing information and during the observations, documentations and questionnaires, analysis of interview was done.
For our research questions we find that diabetes patients are suffering many type of complications and they need special type of care. Through this system IDSS in Diabetic eHealth Care, the patients can get the basic instructions at home, they no need to visits to care providing centers again and again to get instruction about health. It reduces the unnecessary visits of patients and they can access it anywhere and anytime. Due to this patient daily quality of life improves. Patients update his /her health status and it automatically saves in database. This patient’s history is helpful to care providers to make decision about patients. Results from interviewees and from patients’ suggestion, due this IDSS in Diabetic eHealth Care patients can make their life easy.

9.2 FUTURE WORK

This thesis is an effort to improve the quality of daily life of diabetes patients and provide them such system through which they can access basic health instructions at home. Some related work is mentioned below as future work.

The author’s believe that, this recommendation will helpful in improving the quality of diabetes patients, as well it will be useful for care providers.

During the research work, authors found many sub branches to be researched. Due to lack of time authors had to stick to their field. So, there are some recommendations for future researches based on the findings of the research.

To provide the better facilities to patients it is suggested to research the use of SMS service to make a communication bridge between patient and IDSS. Patients can update their sugar level values in the record and can get the exercise and diet plan for every meal. Use of sophisticated wireless sugar level reader and connect them with IDSS through mobile SMS. It is also recommended to test the interoperability between mobile SMS, IDSS and web-applications.

Future research is required to improve quality of life of diabetes patients and provide easy and accessible communicational channel between care providers and patients. In future patients’ life can be made better by using pervasive computing. Moreover, more work is required to conduct survey at a greater level and with non Swedish speaking patients.
10 \hspace{1cm} \textbf{REFERENCE}


27. S.J. Griffin , Lost to Follow-up: the Problem of Defaulters from Diabetes Clinics, 1998


## APPENDIX 1

### RESULTS OF THE CLSOE ENDED QUESTIONS

<table>
<thead>
<tr>
<th>Question No</th>
<th>Questions</th>
<th>yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Internet services</td>
<td>100%</td>
<td>Nill</td>
</tr>
<tr>
<td>2</td>
<td>Mobile services</td>
<td>100%</td>
<td>Nill</td>
</tr>
<tr>
<td>3</td>
<td>e_prescriptions</td>
<td>100%</td>
<td>Nill</td>
</tr>
<tr>
<td>4</td>
<td>Problems to visit doctors</td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td>5</td>
<td>Home services</td>
<td>100%</td>
<td>Nill</td>
</tr>
<tr>
<td>6</td>
<td>Update date in IDSS</td>
<td>100%</td>
<td>Nill</td>
</tr>
<tr>
<td>7</td>
<td>Basic instructions at home</td>
<td>100%</td>
<td>Nill</td>
</tr>
</tbody>
</table>
INTERVIEW 1

1. NAME
   Carina Thorkelsson

2. Designation
   Nurse

3. How long have you been working for diabetes patients and how long in this CLINIC?
   I have been working here since 1992. (17 years)

4. How many diabetes patients are registered in this Clinic (Diabetesmotagning)?
   There are 700 – 800 patients registered in Diabetesmotagning.

5. How many diabetes patients are registered in Blekinge?
   There are 6000 patients in Blekinge where total population of Blekinge is 152,000.

6. How many times in a day, patient have to test his/ her blood sugar?
   It depends on the patient. I suggest 6-8 times in a day for new patients and 2-3 times for old patients.

7. How many times a patient have to visit to doctor in a week / month?
   New (recently diabetes detected) patient has to visit nurse twice a month and once in a month to doctor. Old diabetes patients visit doctor once in a year.

8. Do you feel any problem of communication between you and patient? (Appointments etc.)
   No, Patients can access us by email or phone call. Miss use of communication medium can be problematic sometimes. We want patients to learn about disease themselves. But they visit health-care center, call or email us very frequently and waste their and our time and money.

9. What information do you get, when a diabetes patient visit you?
   I ask everything about the patient, blood sugar level, blood pressure, insulin dozed, diet, exercise, work routine, sleeping time, family, social life etc…

10. If a patient contacts you from home about his health, what information do you need to take a good decision about the patient?
    I need all above (question 9) information for a week. So that i can guess, what is the problem? And why is the problem? But still I can make decision temporarily. I have to see the patient physically for a good decision.

11. How do you inform other care-providers (care-taker, therapist, dietician etc..) about the patient’s health?
There is an e-mail system of “ltblekinge”. I use the system to inform the dietician and apotek. I do not inform the patient’s relative or care-taker without the consent of patient.

13. **Does it help you if you get chronicle information about patient? (if yes How much %age?)**

   Yes! It would help a lot.

14. **Does it help you to make a decision, if you get if you get similar case and the solution of the case from history? (if yes How much %age?)**

   Yes, it can help sometime. Doctors have their own experiences and they have all records in their minds. Doctors learn from the experiences. Perhaps, doctors cannot get benefits from this service but, it may be helpful for non-medical person.

15. **Who suggest diet plan for the diabetes patients? And who suggest exercise instructions?**

   Doctor or nurse helps the patients for diet and exercise in some extent. There is dietician who works with diet. For elderly diabetes patients (type 2), there is a predesigned plat-model (diet model) and “bra mat för alla” (good food for all), which can be suggested by the nurse. In type2 dietician has less role. This year, after four years research project, national guidelines of diet for diabetes patients will be launched (may be in May). That guideline will be available on internet and will help doctors to suggest the suitable diet.

16. **Normally what diet plan do you suggest to the patient?**

   For the moment, I use “bra mat för alla” booklet to select suitable diet.

17. **Do you think IDSS makes it easier for you to fetch the patient records, or worse, compared with the old/current system?**

   Yes surely it will help a lot and we really need well arranged records or graphical representation of records would another advantage of system.

18. **Do you think the IDSS system can reduce the visits of patients?**

   Yes it will reduce the unwanted and less-important visit of patients to health-care center.

19. **What is your opinion about IDSS for elderly diabetes patients and email or SMS Alert-Technology?**

   Your system is a very good idea,. If patients blood sugar level is increasing, a auto message come to us, we can know this patient is in emergency condition and he/she needs the doctors but if it is a little high, they will SMS or Email us .in that case, 800 emails or Sms in a day are unacceptable as there are almost 800 patients registered with us. Everyone is conscious about himself. Whenever they feel
something wrong, they run towards doctor. We want that patient learn themselves about the disease and try to control it.
INTERVIEW 2

1. NAME
   Ulla Aghide

2. Designation
   Doctor

3. How long you have been working for diabetes patients and how long in this CLINIC?
   14 years

4. How many diabetes patients are registered in this Clinic (Diabetesmotagning)?
   There are 700 – 800 patients registered in Diabetesmotagning.

5. How many diabetes patients are registered in Blekinge?
   There are 6000 diabetes patients in Blekinge where total population of Blekinge is 152,000.

6. How many times in a day, patient have to test his/ her blood sugar?
   It depends on the patient. If patient is new than he has to check his/her blood sugar level 6-8 times in a day, because, patients have to learn about their disease. Why sugar level rise up and how to slow down. But old patients can check their blood sugar level 2-3 times in a week.

7. How many times a patient have to visit to doctor in a week / month?
   If patient is new (recently diabetes detected), then s/he has to visit nurse twice a month and to doctor, once in a month. But if patient is old and s/he is going well with the diabetes (blood sugar level is controlled), then s/he has to visit doctor once in a year.

8. Do you feel any problem of communication between you and patient?
   (Appointments etc...)

9. No, there is no certain problem in communication for anything. Patients can access us by email or phone call. Sometimes we can’t reply all emails and give proper advice on telephone because of limited time. We can’t get more information on phone or email.

10. What information do you get, when a diabetes patient visit you?
    I get everything about the patient, blood sugar level, blood pressure, insulin dozed, diet, exercise, work routine, sleeping time, family, social life etc…

11. If a patient contacts you from home about his health, what information do you need to take a good decision about the patient?
I need same information (question 9) for a week. So that I can guess, what is the problem? And why is the problem? But still I can make decision temporarily. I have to see the patient physically for a good decision.

12. How do you inform other care-providers (care-taker, therapist, dietician etc...) about the patient’s health?
There is an inside e-mail system of “ltblekinge”. I use the system to inform the dietician and apotek (pharmacist). I do not inform the patient’s relative or care-taker without the consent of patient.

13. Does it help you if you get chronicle information about patient? (If yes How much %age?)
Yes! It would help a lot. It is definitely a good idea.

14. Does it help you to make a decision, if you get if you get similar case and the solution of the case from history? (If yes How much %age?)
Yes, it can help sometime. Doctors have their own experiences and they have all records in their minds. Doctors learn from the experiences. Perhaps, doctors cannot get benefits from this service but, it may be helpful for non-medical person.

15. Who suggests diet plan for the diabetes patients? And who suggests exercise instructions?
Doctor or nurse helps the patients for diet in some extent. There is dietician who works with diet. For elderly diabetes patients (type 2), there is a predesigned plat-model (diet model) and “bra mat för alla” (good food for all), which can be suggested by the nurse. In type2 dietician has less role. This year, after four years research project, national guidelines of diet for diabetes patients will be launched (may be in May). That guideline will be available on internet and will help doctors to suggest the suitable diet.

16. Normally what diet plan do you suggest to the patient?
For the moment, I use “bra mat för alla” booklet to select suitable diet.

17. Do you think IDSS makes it easier for you to fetch the patient records, or worse, compared with the old/current system?
Yes, it would help a lot. If your system can fetch the records of the years.

18. Do you think the IDSS system can reduce the visits of patients?
It would surely help the type2 patients, because sugar level fluctuates rapidly and patients get worry and rush to health-care center. By this system they can get better advice without visiting hospital.
Type2 patients do not visit hospital frequently. Some patients are very conscious and they visit very frequently for every question. Your system would provide better answer of their questions and maintain the sugar level’s record. So, it will definitely
reduce the visits of patients and saves their and our time and money to visit the health-care center.

19. **What is your opinion about IDSS for elderly diabetes patients and email or SMS Alert-Technology?**

Your system is a very good idea., If patients blood sugar level is increasing, a auto message come to us, we can know this patient is in emergency condition and he/she needs the doctors but if it is a little high, they will SMS or Email us .in that case, 800 emails or Sms in a day are unacceptable as there are almost 800 patients registered with us. Everyone is conscious about himself. Whenever they feel something wrong, they run towards doctor. We want that patient learn themselves about the disease and try to control it.
INTERVIEW 3

20. NAME
Kristina

21. How long you have been working for diabetes patients and how long in this CLINIC?
I have been working for 2 years in the clinic. I had started my education as diabetes nurse, which had completed in 2001.

22. How many diabetes patients are registered in this Clinic?
I do not know exactly.

23. How many diabetes patients are registered in Ronneby, Sweden?
4% of population.

24. How many times a patient have to visit to doctor in a week / month?
It depends on the condition of the patient and type of the disease. There is a special blood-cells test after every 6 month.

25. How many times in a day, patient have to test his/ her blood sugar?
It also depends on the diabetes patient.

26. Do you feel any problem of communication between you and patient? (appointments)
Apparently there is no problem but when more and more people wants to meat doctor or talk on phone due to their instant change in blood sugar then there is a problem.

27. What difficulties elderly patient feels to take appointment?
I don’t think so, there is any type of difficulty. When the visit us. They feel better that we are taking care of them.

28. Any other difficulty?
Normally, patients are not satisfied with the diet plan. They always feel confusion about food.

29. What information do you get, when a diabetes patient visit you?
- Blood pressure
- Any other information that patient wants to give.

30. Is it necessary to see the patient every time? Or patient visit to hospital is necessary?
If patient have some problem then he/she must come to the clinic. I have to see the patient once to take a good decision. If I feel, I can call the patient to visit again.

31. If a patient contacts you from home about his health, what information do you need to take a good decision about the patient?
- Blood sugar level
- What they have eaten?
- Routine of the day.
- Exercise.
- Any other sickness (fever, infection)
- Medication (if they are taking any)

32. Does it help you if you get chronicle information about patient? (if yes How much %age?)
   Yes! Definitely.

33. Does it help you to make a decision, if you get similar case and the solution of the case from history? (If yes How much %age?)
   Yes I think so, many patients have similar problems.

34. Who suggest diet plan for the diabetes patients? And who suggest exercise instructions?
   National guideline program of Sweden. It provides us guideline about diet and exercise for the patients. It suggests plate-model for patient. But patients do not satisfy with the plate-model. They always have questions, what can they eat, what can not? Which drink is good and which is not good? We recommend drinking water. In this year new guideline program is expecting.

35. Do you think IDSS makes it easier for you to fetch the patient records, or worse, compared with the old/current system?
   Yes, definitely.

36. Do you think the IDSS system can reduce the visits of patients?
   Yes, it would help to reduce the visits of patients.

37. Do you think, this system will help the diabetes patients?
   Many elderly diabetes patients may have problem to interact with the computer or mobile.

38. Do you think this system will improve the quality of patients
   Yes! Definitely

39. Normally what diet plan do you suggest to the patient?
   We suggest plate-model to the patient.

40. Does it help you in decision making, if you get the daily history of patient?
   Yes! It will help.

41. What is your opinion about SMS-Alert-Technology?
   Yes, it is good thing. If I am busy, there should be someone to read this.
APPENDIX 3

Screen Shot Home Page of IMIS overview
Screen Shot IMIS Login Page overview

Last Updated: 2009-01-16

Integrated Mobile Information System

Log in

Integration Mobile Information Systems

Welcome
Login
Register
Forgot password?
Guest login
Screen Shot IMIS Registration form Overview
Screen Shot IMIS Guest Login Page overview
INTELLIGENT DECISION SUPPORT SYSTEM FOR DIABETIC PATIENT—From the perspective of elders
Screen Shot Care Providers Registration form Overview
Screen Shot Care Providers Login Page overview

INTELLIGENT DECISION SUPPORT SYSTEM FOR DIABETIC PATIENT- From the perspective of elders

Admins_Page

P_Number
Password
Submit
Screen Shot Patients Registration from overview
Screen Shot Patients Login Page overview

Screen Shot Patients Health status Updation Page Overview
## Screen Shot Patients Diet Plan Page Overview

<table>
<thead>
<tr>
<th></th>
<th>Menu for breakfast</th>
<th>Menu for lunch</th>
<th>Afternoon snacks</th>
<th>Menu for dinner</th>
<th>Snacks after dinner</th>
</tr>
</thead>
<tbody>
<tr>
<td>two slice Bread, One Egg and Half Fruit Rice, Vegetable and Fish</td>
<td>two slice Bread, One Egg and Half Fruit Rice, Vegetable and Fish</td>
<td>Cup of coffee or Tea, 1 Snack Potatoes, Meat, Root Fruit</td>
<td>Root Fruit and Milk</td>
<td>Root Fruit and Milk</td>
<td></td>
</tr>
<tr>
<td>two slice Bread, One Egg and Half Fruit</td>
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<td></td>
</tr>
<tr>
<td>2 slice</td>
<td>meat</td>
<td>3 slice</td>
<td>rice</td>
<td>rice</td>
<td></td>
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</tbody>
</table>