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A Survey on Cloud Computing based Health Care for Diabetes: Analysis and Diagnosis

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Abstract : *The major interest of the authors in surveying cloud computing based healthcare of diabetes is to make a thorough check in the patient's blood glucose control at remote areas. The improvement in the technology and combined research can bring out the best medication and diagnosis for any disease. Today, the most challenging syndrome across the globe is diabetes mellitus. In the latest survey, the world's 65% of the population is suffering from either Type 1 or Type 2 diabetes mellitus. But in most of the cases, the patient's blood glucose level is not the same 24x7 hours and medication 24x7 hours is impossible. Thus cloud based healthcare is the one and only solution. Also the data's stored in the cloud can be easily retrieved and placed quiet safe and secure with best security technique adopted. Doctors can maintain the patience history related data set and test results through his mobile, laptop, desktop and though the patient is at remote location, he can prescribe the medication through mail, mobile SMS based on the latest blood glucose level tested through glucometer or nearby lab.*

Keywords–*Cloud Computing, Health Care, Diabetes, Analysis, Diagnosis, Literature Survey*

I. INTRODUCTION

Cloud computing has been coined as an umbrella term to describe a category of sophisticated on-demand computing services initially offered by commercial providers, such as Amazon, Google, and Microsoft. It denotes a model on which a computing infrastructure is viewed as a "cloud," from which businesses and individuals access applications from anywhere in the world on demand. The main principle behind this model is offering computing, storage, and software "as a service." One of the biggest concerns of any healthcare provider is minimizing or eliminating the occurrence of mistakes during treatment. The speed and accessibility of the cloud allows every staff member working with a patient to double or triple check details again and again without adding time to the processing. This allows for much more checks and balances. This not only helps protect patients, which is the first priority of any provider, but also minimizes expensive lawsuits and damage to a hospital's reputation.

II. CLOUD COMPUTING IN HEALTH CARE

Keeping tablet computers on hand to access the cloud during operations has become more common these days. Surgeons are expected to have a great deal of knowledge, and having access to the cloud can allow them to quickly reference surgical texts in an electronic format as needed. It also allows running pre-operative assessment software, communicating with other professionals, referencing medical records, or video conferencing.Cloud computing in hospitals creates interesting possibilities for sharing information with patients about their condition, their options, and the treatment process. They can be given the opportunity to log in and view their details as needed or even play more of a role in their own medical care. Healthcare providers can also use it as a way to educate current or future patients about how to stay healthy.The costs of medical care has become one of the biggest issues. One of the ways to minimize the costs is to cut down on how much the hospital spends to care for patients, and the cost of storing and processing information has become a significant factor. If cloud service solutions can make a hospital work together more efficiently, and it very well can, this typically amounts to cost savings as well.

It's legally required for most hospitals to store images produced by ultrasounds, x-rays, CT scans, MRIs, and other procedures for seven or more years, and then backups are needed in case the system goes down. With all the imagery being created, this means a huge mass of storage space to archive everything. Cloud storage provides a cost-effective, more streamlined solution for health-care providers to follow the guidelines and regulations required.By storing information on the cloud, you open up possibilities for instant, easy sharing between different medical professionals. Not only does this make it easier for staff within the hospital to work together more efficiently but it also provides an option to receive a quick opinion from more qualified specialists for unique cases where experienced input is needed.Before cloud computing becomes the absolute standard; patients, medical professionals, and government officials alike are demanding that service providers guarantee the privacy of their information. They also would like for it to always be accessible in situations where a

patient's health is on the line.Cloud computing is a very secure service to store data. It is a secure service that is provided by some of the largest and most trusted companies such as Citrix, Microstoft and VMware. Companies such as these have some of the most secure networks in the world and can be highly trusted with sensitive information and data.

III. DIABETES MELLITUS

Diabetes mellitus is a group of diseases characterized by an elevated blood glucose level (hyperglycemia) resulting from defects in insulin secretion, in insulin action, or both. Diabetes mellitus is not a pathogenic entity but a group of etiologically different metabolic defects. Common symptoms of diabetes are lethargy from marked hyperglycemia, polyuria, polydipsia, weight loss, blurred vision and susceptibility to certain infections. Severe hyperglycemia may lead to hyperosmolar syndrome and insulin deficiency to life-threatening ketoacidosis. Chronic hyperglycemia causes long-term damage, dysfunction and failures of various cells, tissues and organs. Diabetes mellitus is a continuous medicated syndrome. Permanent cure of diabetes is rare and the patient can be classified into two categories of Type 1 Diabetes and Type 2 Diabetes.The following symptoms of diabetes are typical. However, some people with type 2 diabetes have symptoms so mild that they go unnoticed.Early detection and treatment of diabetes can decrease the risk of developing the complications of diabetes.Common symptoms of diabetes:

- ✓ Urinating often
- ✓ Feeling very thirsty
- ✓ Feeling very hungry - even though you are eating
- ✓ Extreme fatigue
- ✓ Blurry vision
- ✓ Cuts/bruises that are slow to heal
- ✓ Weight loss - even though you are eating more (type 1)
- ✓ Tingling, pain, or numbness in the hands/feet (type 2)

Type 1 diabetes is usually diagnosed in children and young adults, and was previously known as juvenile diabetes. Only 5% of people with diabetes have this form of the disease.In type 1 diabetes, the body does not produce insulin. Insulin is a hormone that is needed to convert sugar, starches and other food into energy needed for daily life. With the help of insulin therapy and other treatments, even young children can learn to manage their condition and live long, healthy lives.Diabetes is a problem with our body that causes blood glucose (sugar) levels to rise higher than normal. This is also called hyperglycaemia. Type 2 diabetes is the most common form of diabetes. In Type 2 diabetes,the body does not use insulin properly. This is called insulin resistance. At first, the pancreas makes extra insulin to make up for it. But, over time our pancreas isn't able to keep up and can't make enough insulin to keep our blood glucose levels normal. Some people with type 2 can control their blood glucose with healthy eating and being active. But, doctor may need to also prescribe oral medications or insulin to help us meet our target blood glucose levels. Type 2 is treated it with lifestyle changes, oral medications (pills), and insulin.When glucose builds up in the blood instead of going into cells, it can cause two problems:

Right away, our cells may be starved for energy.

Over time, high blood glucose levels may hurt our eyes, kidneys, nerves or heart.

IV. CLOUD COMPUTING AND DIABETES MELLITUS

Cloud computing is a general term for anything that involves delivering hosted services over the Internet. These services are broadly divided into three categories: Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS) and Software-as-a-Service (SaaS). The name cloud was inspired by the symbol that's often used to represent the Internet in flowcharts and diagrams. Perhaps it is common that, some of our family photos are on a desktop computer at home, others at work and still more on our phone. That's very inconvenient when it's time to create a photo album. The same is true when diabetes data is stored in different places. By hosting all information in one place and making it accessible anywhere, one can have a complete view of everything that impacts their blood glucose levels, no matter where they are. Cloud computing can also help people stay more connected to their self-care. Study has already shown that access to information over the internet can help enhance engagement and control for people who live in remote areas where healthcare services aren't readily available. Finally, it's been established that using an information management system can contribute to a significant, lasting improvement in blood glucose control. Cloud computing takes that one step further by providing immediate, anywhere access to our numbers. The general analysis and diagnosis of diabetes mellitus is as shown in Fig.1.

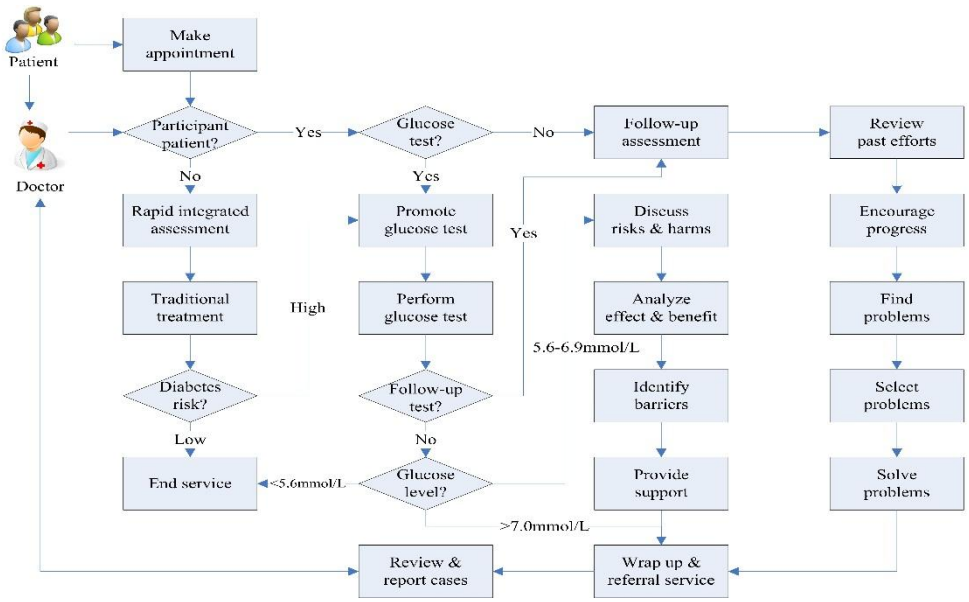

Fig.1 General Analysis and Diagnosis of Diabetes Mellitus

V. LITERATURE SURVEY

Yan Hu, Fangjie Lu, Israr Khan, Guohua Bai et al. [1] concluded that to accomplish the needs of healthcare information sharing in e-health, cloud computing is a superior solution. Cloud computing is a new technology and have good performance in storing and accessing information. Their research was mainly focused on the implementation of SaaS cloud computing technique to share healthcare information. With the designed prototype, could cover the current interoperability gap in e-health. The experiment results indicate that there are many strengths to use SaaS service to solve the problem such as quick development, high availability, large data table storage, application as web service and authorized information. In the other hand, obvious drawbacks like limitation of picture sharing and unpredictable latency are still challenges for widely using SaaS service to e-health development for diabetes management as well.

G.Nikhita Reddy, G.J.Ugander Reddy et al. [2] presented that the major advantage of using mobile technologies with cloud technologies is its mobility and easy sharing of the information.The cloud computing based solutions in healthcare can help the physicians to stay in touch with their patients and examine their healthcondition effectively at a low cost.There may be some concern regarding the security and other privacy issues of data but still as every problem has a solution in the similar way these issues too can be solved. One day utilization of cloud technologies in healthcare of analysis and diagnosis of diabetes mellitus would result in a new era in the field of healthcare.Every section in the society can access this healthcare by implementation of this technology. It is always remembered that cloud computing is still a developing technology,which implies that in the future years the services it offers will be greater than our expectations or just beyond our imagination.

Yan Hu and Guohua Bai et al. [3] presented that research on applying cloud computing technology to eHealth is in its early stages; mostresearchers have presented ideas without real-world cases validation. The obvious features ofcloud computing technology provide more reasons to adopt cloud computing in sharing andmanaging health information. The main purpose of their review was to identify some challenges andfeasible cloudbased solutions which can be applied in eHealth. The current review suggests thatwith the unique superiority of the cloud in big data storage and processing ability, a hybrid cloudplatform with mixed access control and security protection mechanisms will be a main researcharea for developing citizen centred homebased healthcare system for diabetes.

Sanjay P Ahuja, Sindhu Mani and Jesus Zambrano et al. [4] decided that the current trend of adopting cloud computing in the medical field can improve and solve several collaborativeinformation issues in healthcare organizations as well as cost optimizations. Standardized cloud-basedapplications will bring obvious advantages to patients, physicians, insurance companies, pharmacies, imaginingcentres, etc. When sharing information across medical organizations yielding better results. Challenges such assecurity concerns and interoperability will rise due to the cloud-computing model. Therefore, the adoption of thecloud is progressing slowly. Through the implementation of best practices in the design, deployment and use ofit will hopefully generate a future growth of the cloud-based systems adoption of diabetes management, despite all of the obstacles.

Atiya Parveen, Sobia Habib, Waseem Ahmad et al. [5] concluded that E-health cloud is the next big buzz in healthcare sector. Cloud has the potential to transform the healthcaresector. With the use of cloud computing in healthcare sector, it would become centralized, and as data could beshared between all the healthcare providers on cloud, there would be collaboration as well as virtualization.With the help of cloud computing, rural healthcare centres would efficiently use their IT infrastructure to themaximum and increase its profits. It would also help patients to have better treatment, hospitals as well asdoctors. It would also help in carrying out research work, sharing data and analysing it. There cannot be onedeployment model or the service model that can cater to Healthcare world.

VMware cloud solutions [6]proposed that healthcare organizations to transform the cost, quality anddelivery of patient care products and services for any syndrome including diabetes. Healthcare IT departments are reshapedinto nimble and efficient entities that can respond faster to the needs of researchers,providers, payers and consumers while reducing infrastructure and operating costs. Any organization can think about building for the cloud. Although true cloud computing is a standardized approach, the way each individualorganization approaches cloud computing is not.The way we approach cloud computing will depend on our objectives. Do we want tobegin with an internal private cloud or do we want to leverage public cloud services.

Kyle D. Lutes et al. [7] designed the Diabetic E-Management System seemed to beusable based on the SUS scores and the interviews that was conducted. The SUS scores indicated that the system wasusable. Most of the participants interviewed felt that thetechnology was usable, yet some felt that DEMS wouldbe useful only if the patient was motivated to managehis/her diabetes. Furthermore, it was apparent that olderdiabetes patients would not be willing to use a system likeDEMS since they have been using a pencil and papersystem that they have developed over the years. Theparticipants seemed to enjoy the overall concept ofDEMS, but DEMS still posed some shortcomings, likestrict compliance rates and the inability to wirelesslyintegrate the glucometer and insulin pump readings to thePocket PC PDA. In conclusion, this research exemplifieda big potential for a DEMS-like system to becommercialized and used in the real world once all thetechnical issues were overcome, and the system matured,becoming well integrated with the insulin pumps and thecommercially available glucometers.

George Hsieh andRong-Jaye Chen et al. [8] proposed a design for a secureinteroperable cloud-based personal health record service.This design uses a self-protecting security framework thatintegrates access control, confidentiality, integrity control,and authorization in an embedded and fine-grained manner.It uses the standard CCD for storing and exchanging PHRinformation. The design leverages recent advancements inattribute-based encryption and public-key based searchableencryption to support patient-controlled and fine-grainedencryption, and privacy-preserving keyword search. It alsoutilizes a variety of open standards to enhance the portabilityand interoperability of the system, and leverage open sourcesoftware packages that are readily available forimplementing these open standards.Going forward, they planned to continue with the detaileddesign of the proposed system, and the implementation of aprototype system for demonstration purpose. Further they decided to exploit emerging cryptographic schemes that canenhance the functionality, efficiency, and usability of theencryption and key management operations such as multiauthorityABE.

Wei-Tse Tang, Chiu-Ming Hu, and Chien-Yeh Hsu et al. [9] concluded that many factors can cause a deviation value whensubjects are taking physiological measurements. For example,blood pressure of our hands may not being the same, sosubjects must use one specific hand during the test forconsistent values and ease of the following research andcomparison. In addition, for the measurements not beingaffected, it is necessary to avoid talking, moving or shakingtheir body. It will also cause an error value if taking themeasurements during the time of 30 minutes after meal, smoke,exercise, and bathing or drinking (wine, coffee or tea).Therefore, taking physiological measurements under anabnormal situation must be avoided.In the future, the system can build a real-time imageprocessing system to provide the hospital's internal medical imagetransmission services,and it will also follow the transmissionstandard of electronic medical records which Department ofHealth in Taiwan enacted. Through their cloud managementsystem, medical image data could be transmitted to localcommunity clients and read by physicians. Additionally,through the Voice over Internet Protocol (VoIP) services,physicians and consultants may easily discuss and providepatients' family members a distance visits service. This willfurther enhance the system to give out patient bedside videosand multimedia medical and sanitary education information.To improve the services, their system will further integrateprevention health services, provide internet browsing ordownload the service for people throughout the advisory by allmedical institutions and offering hygiene tips for chronicpatients, or other weight control information.

Carlos Oberdan Rolim, Fernando Luiz Koch, Carlos Becker Westphall et al. [10] proposeda design promotes re-usability through the use of a standardservices implemented and deployed by using a Platform as aService (PaaS). In addition, it leverages others health-careinstitutions to use services through a Software as a Service(SaaS) model without investments on hardware or softwarelicenses.Moreover, they suggested that this project contributes toscientific and social fields. On the scientific field, the projectgenerates new knowledge and applications for utilitycomputing, cloud computing, sensor networks and mobilecomputing. These areas are being extensively explored bythe academic community and the developments from thisproject will address some of the outstanding questions.There are many lines of research involved in thisdevelopment, such as: information systems, systemmodeling, networking, mobile service development, servicemanagement, computational security and quality of service(QoS) for cloud computing based diabetic management system.

Abdullah Al-Malaise Al-Ghamdi et al. [11] proposed that the art of researches in expert system for the purpose of diagnosis and determining the treatment of the diabetes. They introduced a new cloud computing based expert system for diabetes treatment using Google app engine. The system is an open source software, also researchers and developers can add to it. It web-based flexible, easy to use, and guarantees the security. The authors will develop their system in sophisticated manner and will provide a version for smart phones and IPad.

Roma Chauhan, AmitKumar et al. [12] suggested that the e-Health Cloud represents an efficient technologysolution for several healthcare providers experiencing variousconcerns of increasing healthcare delivery costs, informationsharing, and scarcity of healthcare professionals. The benefitsgained cannot be suppressed by issues of trust, privacy, andsecurity. The technical issues that must be addressed beforehealth care providers can fully adopt and trust the e-HealthCloud. Challenges of security and interoperability will risewith the cloud computing model leading to the adoption of thecloud remarkably slowly. With the implementation of bestpractices in the design, deployment and use of it will hopefullygenerate a future growth of the cloud based systemsembracement despite all of the obstacles. The paper providesan overview of the necessity and utility of big data mining incloud computing. Not much research has been done in the areaof big health care data mining. The future perspective ofresearch explores management and application of healthcarebig data mining for improved decision making in healthcare.

Vishesh Ved, Vivek Tyagi, Ankur Agarwal, A. S. Pandya et al. [13] proposed a Web-based PHRS that can store data in acloud-based architecture. The proposed system provides anavenue to store images such as MRI, CAT, X-Ray and Medicalpersonnel can view images with Image J viewer and diabetic related analysis. A user case isdiscussed to show the functionality of the system. Futureupdates will focus on security and privacy aspects.

Vassiliki Koufi, Flora Malamateniou and George Vassilacopoulos et al. [14] decided that Cloud computing and SOA convergence can be used tomeet the increased collaboration and coordinationrequirements between emergency healthcare processparticipants by facilitating relevant information access byauthorized people where and when needed. Cloudcomputing was used to produce a flexible and scalablesystem, supporting interoperability and execution ofplatform independent applications while providing secureaccess to sensitive data. Their paper presents a cloud EMSsystem, within the context of a prototype healthcare portal,namely NefeliPortal. One important characteristic of theproposed system specifically calls for the integration ofEMS systems with PHRs and, possibly, other externalsystems since systems integration is a prerequisite foraccurate safety alerts, patient monitoring, and otherrecommended capabilities.Usability constitutes one of the key features of everysystem and is primarily concerned with making a systemeasy to learn and use. On these grounds, one of the tasks tobe undertaken in the near future is system evaluation, whichwill be performed by potential users in order for theusability of the system to be determined. Thus, potentialweaknesses of the system may be revealed suggestingalterations in the system design.

Nourhan Bayasi, Hani Saleh et al. [15] concluded that many methods and systems have been proposed to targetand monitor the blood glucose level of diabetic patients. Their paper has summarized the work ofImplanted Microsystem, Wireless Contact-Lens Sensor for Tear Glucose Monitoring, Hydrogel-Based Implantable Glucose Sensor SoC and comparedbetween them based on different metrics. As a result, they proposed a full system level SoC for non-invasive glucosemonitoring, which integrates biomedical sensor/s, energyharvesting and power management units, low power SoC, andwireless RF transceiver.

Shaftab Ahmed, M Yasin Akhtar Raja et al. [16] proposed that Social networking activities have created communities of users enjoying mobility and continuous connectivity in health, illness or excursion. Wireless communication protocols have enabled the integration of e-healthcare solutions with the PDAs, mobile

phones, IPad and laptops. While information availability and user interest is growing a number of issues require attention. Some of them include Availability, Security, Quality of service, Fault Tolerance and Power Management. The indigenous development of data acquisition boards for a hospital to support patient monitoring from nursing console has been carried out. The scope of e-healthcare services will be extended to Virtual Hospital concept to have all time connectivity through social networks.

Kyung-Soon Park, Nam-Jin Kim et al. [17] developed a PDA based personaldiabetes management system. The diabetes require a fewtimes of self-test and sometimes emergency tests. PDA easy tocarry and perform computing could provide more efficientand better quality medical services. The smaller size screenthan PC was overcome by visualizing abstractive andimportant information. The system consisted of 4 mainmanagement menus of personal information, diet, exercise,and blood glucose, enabling the patient to self-manage. Datainput from these 4 main menus are closely engaged with eachother to generate useful information's being instantlyfeedback to the patient thus would encourage continuous andpersisting self-management, eventually leading to a betterregulation of blood glucose. Personal motive to using thesystem could also be raised by providing the obesity and thediabetes danger index evaluated from the physical data andthe personal habit. Furthermore, the diet and exercisemanagement are capable of prediction of weight loss toremind the patient of the importance of self-management.Remotemedical service through frequent communication also enhanceshealth quality by improving self-management, point-of-care,and assurance of disease control. Future developmentneeds to be performed for remote communication capabilitywith hospital personnel to widen the scope of the presentsystem to successful mobile medicine using cloud computing.

Sepideh Poorejbari, Hamed Vahdat-Nejad et al. [18] concluded that the opportunities and challenges of using cloud computing in healthcare sector and proposed important parameters in a cloud-based pervasive healthcare system in more detail. In addition, a classification of different services and context types have been suggested. Cloud computing offers potential opportunities for improving EHR adoption and provides an altogether new generation of healthcare services. It also provides more flexibility, less expense, and more efficiency in IT services. Cloud-based healthcare systems can create more vital solutions for preventive or emergency care in cases such as chronic diseases like diabetes.Cloud-based pervasive healthcare is a new paradigm in healthcare sector and has many potential and beneficial features, but there are still several problems and challenges that need to be addressed by researchers in the future.

Myung-kyung Suh1, Jonathan Woodbridge et al. [19] developed WANDA, a three tier remotehealth monitoring system and focused on increasing ease ofuse in order to improve patients' system adherence. Thedeveloped system applies EM-based data discretization andApriori rule learning algorithms and finds association rulesusing collected sensor readings with dynamic slidingwindows. They assumed that sensor readings from patientsare Gaussian mixture and quantize continuous features andapplied Apriori algorithm which efficiently finds relateddata using support values. The designed algorithmminimizes the number of action items and reorganizes seriesof tasks for maximizing information gain.

Joseph George et al. [20] conveyed that the art researches in cloud computing and the possibilityto utilize the cloud power in diabetes treatment and research. He then introduced a new concept of Blue Circled Cloud, which is meant for centralized management of Diabetes via cloud. It is web based, flexible and easy to use. Healso analysed the technical aspects of the concept. Through this, if the healthcare sector can achieve some improvements in the area of Diabetes treatment and help the diabetic patients to improve their lifestyle.

R.P. Ambilwade, R.R. Manza et al. [21] concluded that there is a need for research in diagnosis of diabetes which is helpful for medicalpractitionersand patients. Their paper discussed expert systems for both diagnosing and treatment of diabetes. It clearly shows that, there are several expert systems developed which are used either for diagnosis or treatment of diabetes. Majority of expert systems uses Pima Indian pregnant women dataset for diagnosis purpose. However, some systems used the patient's data from hospital. The methodologies used for diagnosis/classification of diabetes are soft computing techniques like neural network, fuzzy systems.

VI. CONCLUSION

In this paper, a detailed survey been conducted on analysis and diagnosis of cloud computing based healthcare for diabetes. It is so interesting that cloud computing though an emerging technology, found the core of healthcare monitoring and management of all diseases and diabetes as such. Diabetes lays the foundation for various malfunctioning of the important organs including kidney, heart, brain, liver, etc. and periodical analysis of them is very essential. The annual heath report of various organs and periodical blood glucose level report of the diabetic patient should made available with the doctor through cloud. Though the earlier medication of

diabetes was based on paper and pen, pictorial evaluation of the patient healthcare was not possible and with cloud computing the doctors can make the pictorial analysis as shown in Fig.2,3,4,5. By storing the diabetes patient's medication history in cloud, analysis and diagnosis of his timely health care can be made available to the doctor 24x7 hours either through his mobile, IPad, Laptop or Desktop in remote areas. In-accordance with security issue, more rigorous research is supposed to be conducted in-order to make in an efficient cloud computing based healthcare for analysis and diagnosis of diabetes.

Fig.2Pie Chart of blood glucose level before and after food of patient

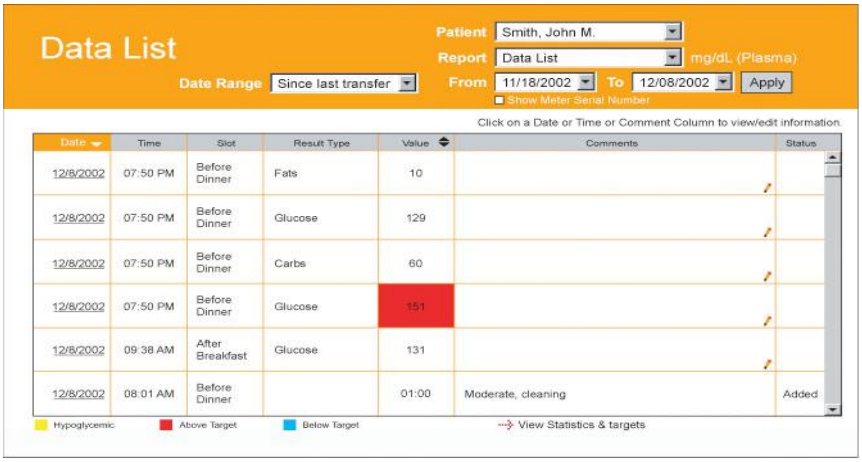

Fig.3Data list of blood glucose level at different time instant of patient

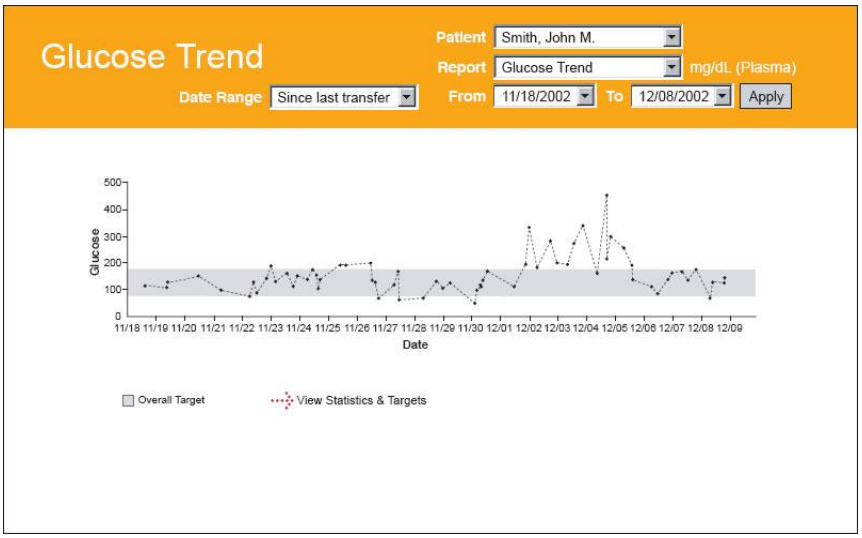

Fig.4Graphical monthly blood glucose trend of patient

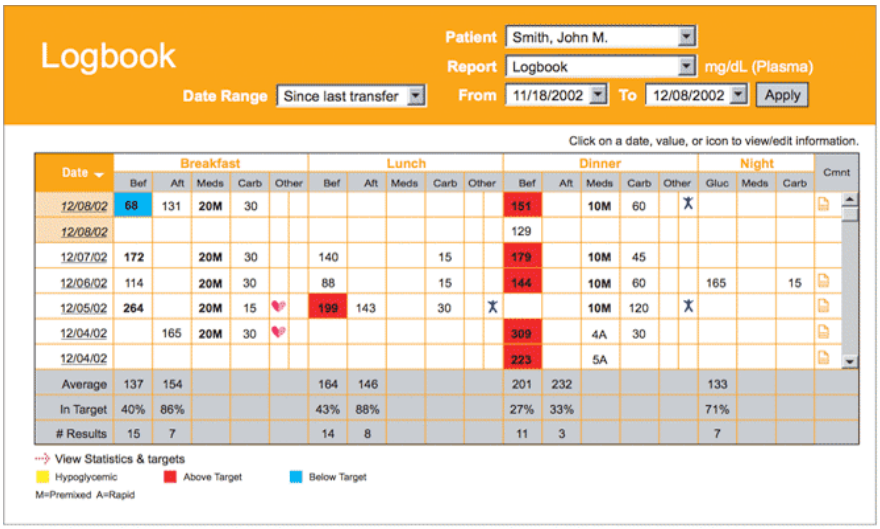

Fig.5Monthly log book for blood glucose level of patient

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