

Smart Decision-aid Information Design (DID) for Feto-Maternal Care

Daniya Noor

Researcher, Institute of Information and
Communication Technologies
Mehran Univ. of Engr. And Technology
Jamshoro, Pakistan
Daniya.noor@unifiedcrest.com

Dr. Adnan Ashraf

Dept. of Computer Systems Engineering
Mehran Univ. of Engr. And Technology
Jamshoro, Pakistan
Adnan.arain@unifiedcrest.com

Mehak Memon

Researcher, Department of Computer Systems
Engineering, MUET
Jamshoro, Pakistan

Dr. Noor Ahmed Shaikh

Professor, Information Technology
SZABIST, Hyderabad
Pakistan

Dr. Sanam Narejo

Dept. of Computer Systems Engineering
Mehran Univ. of Engr. And Technology
Jamshoro, Pakistan
sanam.narejo@faculty.muett.edu.pk

Dr. Manzoor Ahmed Hashmani

Professor, Dept. Computer and Information
Sciences, Universiti Teknologi PETRONAS
Malaysia
manzoor.hashmani@utp.edu.my

Abstract— Supervision at regular monitoring for a maternity patient is an essential requirement. A lot of physical and psychological changes occur during pregnancy. It is natural that a woman passing through this experiment eagerly want to know about the changing events she experiences in her health. Health professionals responsible to care and manage any risk to her satisfaction. In doing so health professionals face numerous problems during whole time period of feto-maternity monitoring, care and treatment. This study aims to design a cost-effective information system for feto-maternity (FM) care equipped with some new and useful features which are not available in existing such information systems. The study focuses two stages, the first stage includes collection of Feto-maternal care data from tests and data sheets from obstetrician and gynecology department. Obtained data was analyzed in consultation with experts of obstetrician and gynecologist. Based on this analysis, a survey was conducted on nationwide scale in order to know the nature of obstacles the health practitioners facing during treating the gestation period of a woman. The Second stage envisaged the design of a decision-aid information (DID) system is a significant achievement of this study. This DID system comprises of unique features such as color and graphical representation of all kind of national and international recommended tests in feto-maternity, baby resuscitation and section to enter the data of mother who has other medical disorder during her childbearing process.

Keywords—Maternity; fetal-care; decision support system; Cloud

I. INTRODUCTION

Pregnancy or gestation is a renowned and common health condition. It is the time during which one or more offspring develops inside a female. Maternity is defined as the state of being mother, it is the period in which a woman is pregnant or has just given birth to a child. Feto maternal care is term used for care of a pregnant woman regarding her health and health of her fetus going to deliver. Throughout the time of pregnancy, early detection of risk factors associated with pregnancy and their prevention is primary goal of feto maternal care. This can only be achieved by regular and timely communication between pregnant woman and her family and health care provider. Pregnancy is associated with lot of changes physical psychological and social changes in the life of a concerned woman and her family [1]. In positive aspect, it is associated with sense of achievement, being completed in self being and happiness, expectations, wonders and wills, but also provoke fair uncertainty and depression in negative sense, both run side by side from the day one of pregnancy awareness till termination and outcome of pregnancy.

Normally pregnancy lasts 40 weeks from the first day of the last menstrual period (LMP) till the birth of child. The whole pregnancy period is divided into three phases, each phase is termed as Trimester i.e. First trimester, Second trimester, and Third trimester [2]. Prenatal and Antenatal care is term applied for careful monitoring of a woman before pregnancy after pregnancy till delivery; creation of relationship between a pregnant woman and caring obstetrical professionals. Each trimester has its own risk factors monitoring criteria and caring protocols [3,4].

A. *Pregnancy Problems and Telemedicine*

Maternal and infant health is a global healthcare problem affecting developing and developed countries alike. Pregnancy complications may lead to serious health issues to both mother and her infant. Subsequently in the shape of still birth, miscarriages etc. A pregnant woman throughout her period of maternity seeks supervision and monitoring by attending regular visits to health professionals. Health professionals are responsible to mentor her and reassure her about early recognition and management of any risks during pregnancy and counselling of ongoing problem [4].

Telemedicine can improve the quality of pregnant women's lives. At an early stage a large part of the normal pregnancies would not require intensive examination. Telemedicine permits the calculation of premature delivery; the smart phone technology may be used by health practitioners to improve the estimation of the probability of premature delivery and to potentially alter clinical management decisions. Self-monitoring of vital signs during pregnancy is beneficial and can be easily maintained using Telemedicine.

B. *Demographic Health Situations in 3rd World Countries (Case Study: Pakistan)*

Every day about 800 women die from preventable causes related to pregnancy and childbirth and more than 2.6 million stillbirths occur globally every year [5]. Almost these deaths occur in low-income settings as a result of conditions that are preventable and curable. The Maternal Mortality Rate (MMR) is calculated on per 100,000 live births and Infant Mortality Rate (IMR) is calculated on per 1000 live births. Pakistan stands on 44 rank in maternal mortality rate (MMR) as per 260 deaths. According to reports regarding Infant Mortality Rate (IMR) by World Health Organization (W.H.O), merely in Pakistan almost 200,000 newborn die within 24 hours of their birth out of One million in the world annually [6]. The study also highlights the reasons behind these deaths. Although most of the issues are been resolved but still there is need to look on some potential areas.

II. LITERATURE REVIEW

Feeling a new life developing inside a pregnant woman is an amazing experience for her even though she may not always feel her best at some points along the way. Dr. Draion Burch, an obstetrician and gynecologist at Magee-Women's Hospital at the University of Pittsburgh Medical Center, United States of America said that "Pregnancy is a long, 10-month journey". [7] It is essential to keep in touch with the health services during pregnancy. New information and communication technologies hold promise for the creation of effective and innovative health promotion. The speedy development of ICT Information Communication Technology in the past few decades has enormously changed the lifestyle of human beings around the world. This progresses the knowledge of everyone and delivers a quality lifestyle. Today 40% of the world population use internet. This progression in usage of internet has made people to gain more and

more knowledge and makes them experts [8]. Today, Knowledgeable women throughout world use ICT tools and applications for information and as an important source of communication during their childbearing period.

It is clear from the various professional and scholarly opinions that inimitable challenges are present when evaluating health risks of various birthing options. Pakistan's rank of MMR and IMR is discussed in section 1, most of the deaths can be controlled as they occur due to treatable and curable problems. There are many issues and challenges which an obstetrician and gynecologist and also the woman has to face during FM monitoring, care and treatment. Problems may include symptoms and proper guidance, data security, midwives' issues, Physician contact, QoS, hospital standards, data availability and report management. Although most of the issues are been resolved but still there is need to look on some disputes as well.

Lifestyle modifications before and during pregnancy have been shown to reduce the risk of pregnancy complications. To monitor the behaviors the wearable sensor technology can be used, but all 5 discussed technologies in this work have limited access and accuracy issues.[9]. In [10] Martin has particularly examined mHealth applications in Africa. He concluded after taking survey that Mobile devices and mobile health (mHealth) services and applications help maternal care, chronic disease management, and disease epidemics. They improve the efficiency and effectiveness of the medical system through patient tracking and reporting, and they extend critically needed health services to underserved areas.[11] Health information technology (HIT) at nonhospital facilities (NHF) improves health outcomes and decreases resource use at hospitals within the same health care network and the authors have concluded that Clinical HIT applications at NHFs may reduce the possibility of adverse birth outcomes. Another work was recently done to monitor CTG and contractions of the patient during 3rd trimester and result successful in pilot testing. The system comprises of three modules: 1. ob-gyn systems used by doctors, 2. Ob-gyn care app used by patient and 3. Smart sensors attached to the patient; may monitor the readings and if any risk measure is monitored an alert is sent to the doctors. All the data will be stored in the cloud and be accessed by medical staff. The system limited scope as it is only used during 3rd trimester and data monitored is not kept in electronic form, also lack of real-time transmission of data, loss of data and delays are observed [12,13]. Health of defined patients' group can be improved by multiple web support sources. Yet many health professionals may not use the option of integrating internet information in the care of patients in general together with pregnant women. The reason may be there is no reliable sources of information are available. Researchers are sightseeing how new ICTs which may include internet forms websites emails and smart phone apps can be used to promote maternal and neonatal health [14]. Even though the awareness of patient safety and standards of patient safety are priority in most of the hospital departments but there is

abundantly need for improvement with respect to event reporting and positive feedback from patient point of view [15]. In order to enhance patient satisfaction, the physician-patient communication needs more attention, exclusively in the field of obstetrics and gynecology. The author has proposed the E.D.U. (educate, unite and deduce) Method of enhancing patient satisfaction, it's still a conceptual model for improving communication within a diverse patient group.[16].

Most of the work has been done for the patient's safety and satisfaction, there is no any study available which may satisfy the health professionals of the field of obstetrics and gynecology and may assist them during FM monitoring care and treatment. The design of a low-cost information system for feto-maternal care (FMC) across the medical platform is also lacking.

III. DESIGN CHALLENGES OF DECISION-AID INFORMATION SYSTEMS FOR FMC

This work is based on an observational study carried out through a questionnaire survey specially designed for this study. The health professionals of the department of Obstetrician and Gynecology across Pakistan have been chosen as the population for the study. The formal data was collected through interviews, data sheets, records and reports from the concerned department [17, 18, 19]. A questionnaire was especially designed for the purpose of this study, which is used for primary data collection. The questionnaire is designed in such a way that it covers the areas which we want to determine the need of the Decision-aid Information Design (DID) template. The focus of the questionnaire was satisfaction towards patients regarding their record keeping, sharing feedback with their consultant doctors and following instructions given them by health providers, traditional filling system of the patients, troubles in Decision making. The design itself is a challenging problem such that its data should be well-coordinated with Obstetricians / Gynecologists' feedback and provide a broader scope and usage. The prototype of the DID template was premediated by using Balsamiq Mockups Version 3.5.6. The presentation of the dummy mockups was given to gynecologists and obstetricians within nationwide in order to get their feedback about DID. For the data collection the aspects that are considered are:

For the data collection the aspects that are considered are:

- Different stages of FM.
- Types of Medical Tests and Reports needed during all stages of childbearing process.
- Threshold values of each test.
- Types of data include in each test i.e. text data, image data or numeric data.

After completing the pre-investigation, inquiry and speak of people in very different situations but where each could benefit from my solution; the design of an

information system for FM care across the medical platform is lacking. The data of FM information system (DID) is well coordinated with the feedback of Obstetricians / Gynecologists across the nationwide and system will provide a broader scope and usage. The architype of the DID is planned by using Balsamiq Mockups V 3.5.6, A variety of tests and tools, are used to analyze the obtained data and shape an information system for FM mockup.

A. Attributes of DID

The DID is designed in a very simple way as it can be utilized by the doctors and other medical practitioners of the ob-gyn department easily. The DID includes the following topographies:

- The DID has unique medical record number for every patient.
- DID would be accessible on laptops, smart phones etc.
- The DID contains important information about all tests of mother during her childbearing process and patients' data can be entered and view effortlessly in it.
- Through DID the patients' record can be kept effortlessly
- The most important feature of the DID is the colors and graphical representation of test reports and results. The risk stages of patient i.e. mild, moderate and sever conditions are signified by colors.

The main purpose of DID is to create joint health goals and accountability with the healthcare providers. DID provide a platform and gives performance measurement to patients to share accountability for the success or the failure of their treatments given by the doctors. DID will portrait accurately that how well the health professionals are treating their patients.

B. FMC Decision-Aid Template

The DID is structured by keeping in view all that issues and challenges faced by healthcare providers of feto-maternity.

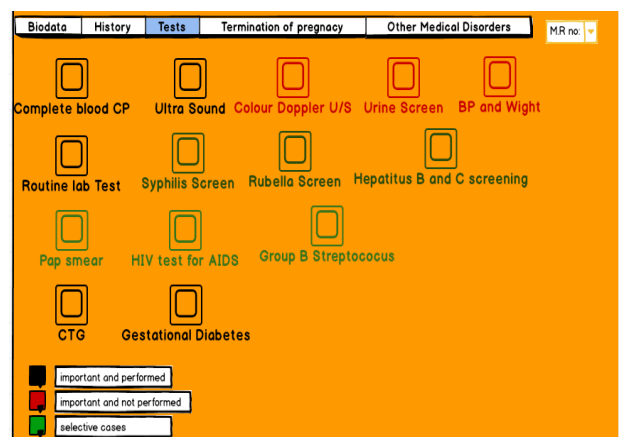


Fig 1. Test screen showing test status

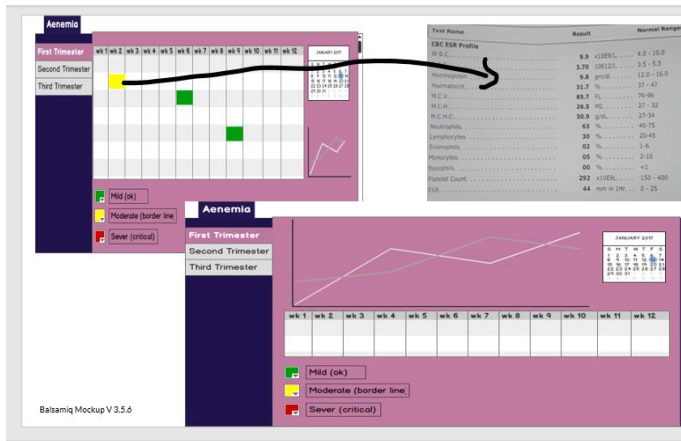


Fig 2. Test screen showing mild, moderate and sever test status

The contents of the DID template includes, Medical Record Number (MR. no), Biodata, History and others.

The colors scheme is a prime factor in the designed template for a practitioner. The test status of the patient is shown through color scheme as shown in fig. 1. The screen test reading / label shown in black color refers the important and necessary tests and has been performed. The red points that important and necessary tests and are not performed whereas, the green means that tests are from special / selective category and have not been performed yet. The test screen has further sub screens as well, which shows tests that are performed in line graph, and describes risk factor of that particular test through colors appeared on screen. Let say a mother is been asked to do an anemia test during her First Trimester visit. Her test reports will appear in the first trimester area on what particular date the test was done, and test appears in yellow color which indicates that her outcomes are on borderline. It is been noted that the threshold values of every test is already been saved in the template. The risk factors mild, moderate and sever are been shown through green, yellow and red color respectively as shown in fig. 2

Another key content of DID is Termination of pregnancy which shows the time when mother has completed her antenatal and prenatal duration and she is going in labor. This screen includes further three more sub sections:

Test and examination include the elaborated test and examination of mother done by doctors manually to assess the progress of labor of the mother.

Decision: In the light of test and manual examination done by ob-gyn the required data are entered in test and examination area. At this point it is decided that if there will be the option of labor i.e. normal, spontaneous, induction, operative or Caesarean section etc.

Newborn Resuscitation; it is a new feature added, one of the unique options of DID is Newborn Resuscitation. This is significant achievement as this

screen is not available in existing literature, no any EMR related to FM has this option to enter baby's APGAR conditions.

Other Medical Disorders can also be mentioned if required as provision is made in the DID template.

C. Cloud Access DID Model

The use of cloud computing has pivotal role to play in health care sector organizations. There is growing trend to obtain cloud computing in the medical field, many organizations and companies such as Microsoft, Google etc are now focusing on health treasure and health vault applications. However, there are some obstacles in the way of adopting cloud computing for healthcare units. The reason is its diversity complexity and security issues in protecting patient's health data. It is hoped that due to its potential benefits such as optimal cost storage of health and fitness information in one location and availability to healthcare providers and healthcare seeker as well. The cloud computing will find its due place in medical field [20]. The DID template for FM care and monitoring is designed efficiently by keeping the patients data saved and only accessible and approachable to authorized healthcare professionals, so patient's data can be saved and secured properly. The record can be organized and shared effortlessly across healthcare entities.

IV. FMC TEMPLATE FEEDBACK

On completion of comprehensive mockups of the DID, the work was presented to renowned ob-gyn across Pakistan for their valuable feedback. A very positive response has been obtained from healthcare providers, because of the right combination of colors of the test outcomes. It can also be used as an educational tool for the post graduate students of medicine, in order to get quick references of patients and new case studies and researches. Further, they added that it may be helpful to become organized for upcoming appointments and saves their precious time.

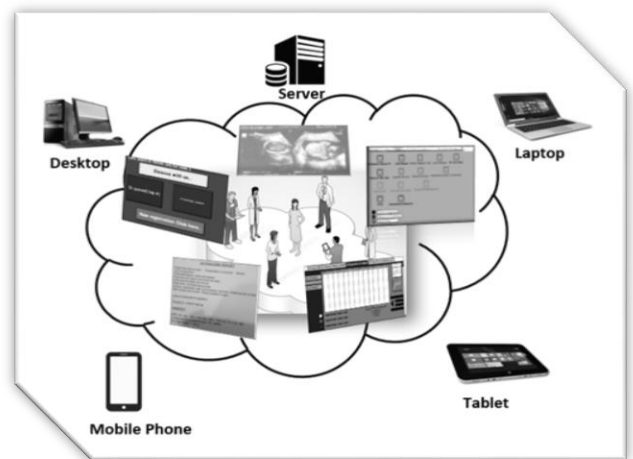


Fig 3. The concept of cloud-access-model compatible view

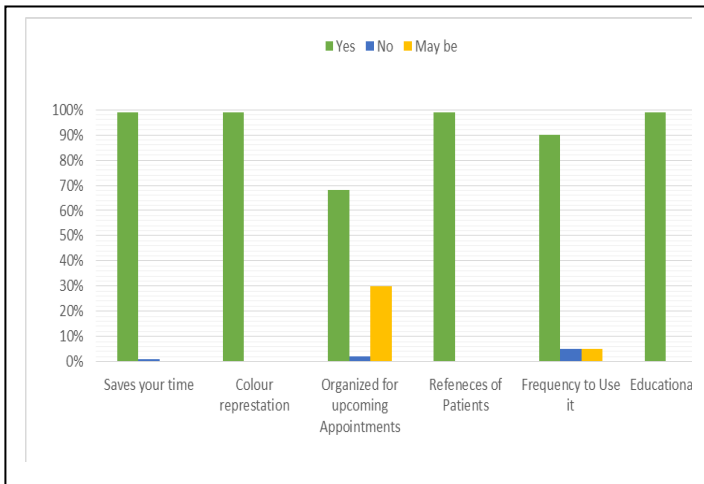


Fig 3. Expert`s feedback to DID

V. CONCLUSION

The result of pre- & post-assessment phases regarding DID template shows a very positive sign from renowned Obstetricians and Gynecologists because of the right combination of colors (i.e. red, yellow green) and graphical representation of template can really helpful in saving the time of doctors and patients and can help doctors in decision making. Eventually, the appointment (meeting time) shall be optimally utilized to strengthen the relationship between care seeker and care provider. The assistances and benefits of Decision-aid Information Design (DID) includes properly maintained EHRs and EPRs, improved processes to analyze and track information of the patients with their unique code (MR. number), self-assessment of the patient for clear understanding of her problem which will improve confidence and relation between patient and health care provider, advanced and time manageable facility for analysis of Health system.

VI. FUTURE WORK

DID can be good clinical decision support tool for all health professionals and specialists belong to other fields rather than obstetrician and gynecology. The interesting knowledge and new researches can be discovered from the saved data of the patients in DID template. It could be thought-provoking to consider the areas in the DID model and the data images such as ultrasound images with different approach, like the video recording of ultrasound tests can also be included. The DID system can be made more effective with voice interaction. By adding translator in the designed app can be helpful for other people who are less oriented towards English language.

REFERENCES

- [1] Heidi M, A. E, S. Hathaway. (2004). What to Expect the First Year (2nd edition). UK: Pocket Books and Design Simon & Schuster Inc.
- [2] The report document, Womenshealth.gov: Centers for Disease Control and Prevention (CDC): "Stages of Pregnancy week by week.", reviewed by Wayne Blocker, MD; June 21, 2016, report document available at www.onhealth.com/content/1/pregnancy_stages_trimesters
- [3] Chervenak, J. S. (2013). Current progress in Obstetrics and Gynecology (Vol. 1). India Suketu P. Kothari Tree life Media.
- [4] James. Steer, W.G.R (2011). High Risk Pregnancy Management Options/ (2nd Edition) (vol. 1) Elsevier.
- [5] The report document, Maternal Mortality, fact sheet no. 348, updated Nov 2015, published by Media center of World Health Organization, www.who.int/mediacentre.
- [6] The Report document, CIA World Fact book: Maternal Mortality Rate, 2014 series published by Central Intelligence Agency, www.cia.gov USA (May 2014)
- [7] C. Nierenberg "Having a Baby, Stages of Pregnancy" Live Science Contributor; August 29, 2017 www.livescience.com/44899-stages-of-pregnancy.html
- [8] Jayaseelan R, Pichandy C (2016) Uses of Information and Communication Technology among Women during Pregnancy. J Mass Communication Journalism 6:309.
- [9] Julien Penders, Marco Altini, Chris Van Hoof, and Eric Dy, "Wearable Sensors for Healthier Pregnancies", Proceedings of the IEEE, Feb 2015.
- [10] Martin Gerbert Frasch," Wireless Fetal Heart Rate Monitoring in Inpatient Full-Term Pregnant Women: Testing Functionality and Acceptability", PMC US National Library of Medicine, National Institutes of Health, PLoS One, PMID: PMC4306498,2015 Jan 26.
- [11] West, D. M "Using mobile technology to improve maternal health and fight Ebola: A case study of mobile innovation in Nigeria". Center of Technology Innovation at Brookings, March 2015.
- [12] Mary E. Deily, Tianyan Hu, Sabrina Terrizzi, Shin-Yi Chou, and Chad D. Meyerhoefer "The Impact of Health Information Technology Adoption by Outpatient Facilities on Pregnancy Outcomes", research article, Health Research and Ednal Trust, Feb. 2013
- [13] A. Ni. tulescu et al. "Integrated Wireless Sensor Network for Monitoring Pregnant Women", Digital Healthcare Empowering Europeans Federation, Medical Informatics (EFMI), 2015.
- [14] D. Rodger A. Skuse, M. Wilmore, S. Humphreys, J. Dalton & M. Flabouris. ". (5 sep 2013). Pregnant women's use of information and communications technologies to access pregnancy-related health information in South Australi. Australian Journal of Primary Health.
- [15] Bindiya Gupta, Kiran Guleria, and Renu Arora. (Jul-Sep 2103). Patient Safety in Obstetrics and Gynecology Departments of two Teaching Hospitals in Delh. Indian J Community Med., 41, 235-240.
- [16] John Yeh and Eryn E. Nagel, "Patient satisfaction in Obstetrics and Gynecology: Individualized patient-centered communication" Department of Obstetrics and Gynecology, Beth Israel Deaconess Medical Center,

Harvard Medical School, Boston, MA, USA.

Corresponding author email: jyeh1@bidmc.harvard.edu

[17] Kenneth J. Leveno, M. (2013). Williams Manual of Pregnancy Complications. Texas: China Translation & Printing Service Ltd.

[18] A, Adnan. G. Mustafa, B.S. Chowdhry, M. Hashmani, Unified Application of Tele-healthcare Architecture and Globalized Patient IDs Published in conference proceedings of International Conference on Applied Computer Science (ACS), Malta September 15-17, 2010 ISSN: 1792-4863, ISBN: 978-960-474-225-7, Malta, September 15-17, 2010

[19] Kluwer, W. (2013). The 5-Min Consult Clinical Companion to Women's Health (2nd edition ed.). (Kelly A. McGarry and Iris L. Tong, Ed.) New York, USA: Wolter Kluwer

[20] Sanjay P. Ahuja, Sindhu Mani & Jesus Zambrano. (September 2015). A Survey of the State of Cloud Computing in Healthcare. Network and Communication Technologies