Editor's Choice

Artificial Intelligence in Obstetrics & Gynaecology

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Introduction:

Artificial intelligence (AI) is the simulation of human intelligence in machines that are programmed to think and learn like humans. AI has the potential to revolutionise the way that healthcare professionals diagnose, treat, and manage conditions affecting all organs including the female reproductive system. AI has been applied to the field of medicine for several decades. One of the earliest examples of AI was the development of computer-aided diagnostic systems for ultrasound images in the 1970s and 1980s. These systems were designed to assist radiologists in identifying fetal anomalies and other conditions. In recent years, there has been a renewed interest in the use of AI in obstetrics and gynaecology, driven by advances in machine learning (ML) and the availability of large amounts of data. One of the primary areas in which AI and ML are being used in obstetrics and gynaecology is in the analysis of imaging data, such as ultrasound and magnetic resonance imaging. AI algorithms can be trained to automatically identify and classify different structures in the images, such as the placenta or fetal organs, with high accuracy.

Artificial intelligence (AI) is a type of digital computer system that parallels the way the human brain processes information. AI is organised in a similar way that neurons in the brain are arranged, with their multiple neural nodes, and so are referred to as neural networks. These networks attain the most probable outcomes as the neurons are associated with numerous synapses that aid in transferring the data among the neurons back and forth.[1] Assembling these manifold connections helps the computers imitate cognitive functions such as finding the appropriate solution to a problem, reasoning, etc. This complex algorithm AI software is being utilized in medicine to analyse large amounts of data, which can assist in disease prevention, diagnosing, and monitoring patients.

AI & Personalised Medicine:

Modern medicine has shifted from developing treatments after the fact, to preventing, personalising and delivering precision care. This requires vast amounts of data to increase available knowledge on disease processes. AI can play an important role in the development of personalized medicines at all relevant phases of the clinical development and implementation of new personalized health products, from finding appropriate intervention targets to testing them for their utility. Four emerging complementary themes in biomedical science are personalized medicine, emerging data-intensive technologies, big data and information technologies (IT) infrastructure and artificial intelligence. AI is required in all phases of the development of personalized medicine.[2] The ability of AI to advance personalized medicine will depend critically on the refinement of relevant assays and ways of storing, aggregating, accessing and ultimately integrating the data they produce. AI has been declared as the primary tool to synthesise data to achieve the vision of personalised medicine.

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Applications of AI in Obstetrics:

Obstetrics and Gynaecology are the debatable specialties which account for indemnity payments due to negligence claims. Besides litigation costs, socioeconomic consequences on a long-term basis due to medical errors are also detrimental. Hypoxia-induced encephalopathy has become the most common confrontational event due to intrapartum fetal misinterpretation, which can be partially preventable. The conventional methodologies are considered inadequate in offering treatment stratification on an individualized basis with various limitations. In obstetrics, artificial intelligence is being actively applied and integrated into our medical system such as for obstetric diagnostic purposes, in fetal cardiotocography, ultrasonography, magnetic resonance imaging, aiding in the determination of pregnancy complications and preterm labour etc. Similarly, infertility treatment too has remained a major concern with conventional approaches.

Antenatal Ultrasound: USG is a safe, non-invasive checkup method for prenatal diagnosis. Despite the standard application of USG, measurements are challenging in circumstances such as maternal obesity, motion blurring, missing boundaries, acoustic shadow, speckle noise and a low signal-to-noise ratio. AI is being applied and actively studied in obstetrics for fetal biometry, identification of fetal structures and gross fetal imaging.[3] A semi-automatic program which automatically performs fetal body parts measurements using an AI algorithm after the sonographer or doctor selects an appropriate image of each body part is being used. In 2020, the *International Society of Ultrasound in Obstetrics and Gynaecology* concluded that in addition to identification and measurement of fetal parts, AI systems have been developed which can suggest a suspected diagnosis based on the measured values. The day is not far away in the future, when an ultrasound probe placed on a mother's abdomen will not only measure basic parameters, but also provide related diagnosis and further treatment directions.

Fetal Echocardiography: Fetal Echo is an essential imaging modality in perinatal care as it helps in diagnosing and monitoring intrauterine growth restriction, twin-to-twin transfusion syndrome, and congenital heart anomalies. *Fetal Intelligent Navigation Echocardiography 'FINE'* was developed for detecting fetal congenital heart anomalies.[3] However, it is challenging due to involuntary movements of the fetus, small fetal heart, fast fetal heart rate, limited access to the fetus, lack of experts in fetal echocardiography.

Fetal MRI: It is usually performed in obstetrics to discriminate fetal brain diseases and the severity of placenta previa.[3] AI helps in automatically analyzing the MRI scans and provide information on whether related treatments are needed along with a diagnosis. Application of AI techniques through MRI also helps in diagnosing the severity of placenta previa, PAS and distribution of vessels on the placental surface.

Fetal Heart Rate monitoring and CTG: AI can give a qualitative and quantitative overview of baseline FHR, variability, acceleration, deceleration, uterine contraction intensity, FHR pattern changes.[4] It helps by decreasing the discrepancies in the interpretation by different obstetricians and gives a more reliable and replicable output for each analysis. Thus, helps in reducing the perinatal and maternal complications and morbidity. The *Computerised Interpretation of Fetal Heart Rate During Labour (INFANT)* study protocol is a large trial currently evaluating the ability of AI interpretation of CTG during labor to assist practitioners in deciding the best management on an individual basis. *CAFE (Computer-Aided Fetal Evaluator)* also studied the possibility of an AI system being able to interpret CTG data and concluded that the AI system read the information at a similar level as the experts in the field and was also able to detect errors. AI technology can also be used for in-home pregnancy monitoring especially, in surveillance of high-risk patients.

Preterm Labour: Machine learning, particularly deep learning, has achieved good to excellent prediction of perinatal outcome in asymptomatic pregnant women with short cervical length in the second trimester. Currently, short cervical length is the strongest risk factor for prematurity. However, many women with this condition carry their pregnancy to term. *Singh et al*. studied the combination of AI and amniotic fluid proteomics and metabolomics, in conjunction or independently with imaging, demographic and clinical factors to predict perinatal outcome in asymptomatic women with short cervix. Amniotic fluid of the subjects was additionally studied for

omics like metabolomics and proteomics to shed light on potential new biomarkers that might be involved in preterm birth. Deep learning displayed good to excellent performance for prediction of preterm birth <34 weeks, delivery within 28 days after amniocentesis and NICU admissions. AI helps in stratification of patients at risk of preterm birth better than current risk factors like short cervical length and prior preterm delivery.

Several studies[5] used electrohysterography (EHG) signals and used three distinct machine learning algorithms to classify these signals for identifying true labour and accurately diagnosing preterm labour and had 97% accuracy in predicting preterm labour.

GDM Screening: Current screening method for gestational diabetes mellitus is costly and a burden for pregnant women. AI techniques can thus be used to screen GDM in a more cost efficient and less inconvenient way. Polak and Mendyk created an AI[6] calculator to screen for GDM using risk factors like high blood pressure, hyperlipidemia, smoking, weight, low fat diet and ethnicity.

HDP Screening: During pregnancy, the placental images of patients having hypertension deviate from those populations without hypertension. This can be used as a marker to predict hypertensive disorders of pregnancy (HDP), for it is a noninvasive, cost-efficient technique to promote future directions. Hence, utilization of AI to assess the variations in the placental ultrasound image texture of pregnant women with hypertension can prove to be beneficial. This could estimate adverse pregnancy outcomes even before the clinical manifestation of the disease.

Hypothyroidism in pregnancy: AI techniques/ ANN models can be used to check the intake of iodized salt, iodized supplements, and iodine rich-foods to predict the deficiency of iodine in the earlier pregnancy period, which aids experts in going for a feasible diagnosis.

Postpartum period: Pelvic floor dysfunction (PFD) is another general gynaecological disease. The major clinical manifestations are pelvic organ prolapse, sexual dysfunction, urinary loss, and faecal incontinence. A study was conducted to explore the application benefit of ultrasound technology and rehabilitation training, depending on AI algorithm in postpartum pelvic organ prolapse recovery and concluded AI algorithms possess good impacts in the processing of ultrasonic images. Thus, pelvic floor rehabilitation training had a better effect on postpartum nursing of pelvic organ prolapse patients.

IVF: AI can be used to predict IVF outcomes by using a learning vector quantizer which allows generalization and standard parameters for enhanced predictive power. It also has the possibility of identifying the most viable oocyte and embryos and to help clinicians predict pregnancy success rates as concluded by Manna et al.[7] The results proved to above average when compared to current methods and could help to select the best possible oocytes or embryos noninvasively and objectively.

AI in Gynaecology:

AI and ML are also being used to develop new tools for the management of gynaecological conditions, such as endometriosis and fibroids. These tools can be used to predict the progression of the disease and guide treatment decisions. AI algorithms can be used to identify patients at high risk of complications, prioritise them for care and ensure that they receive the appropriate level of care in a timely manner.[8]

One example of the use of AI in benign gynaecology is the development of computer-aided diagnostic systems for endometriosis. These systems use ML algorithms to analyse images of the pelvic region and identify the presence of endometrial tissue, which can be a sign of endometriosis. AI and ML are being used to analyse imaging data and predict the growth and behaviour of fibroids, which can aid in the development of personalised treatment plans.

AI in Gynaecological Surgery:

AI and ML are rapidly evolving fields that have the potential to revolutionise the field of surgery. These technologies can be used to assist surgeons in a variety of ways, from pre-operative planning to real-time guidance during procedures. One of the key areas where AI and ML are being applied in surgery is in image analysis. Another area where AI and ML are being used in surgery is in the development of robotic systems. Overall, AI and ML have the potential to significantly improve the field of surgery by increasing accuracy and precision, reducing the risk of complications, and improving patient outcomes.

AI in Gynaecological Oncology:

Artificial intelligence has been shown to enhance diagnosis, refine clinical decision making, and advance personalized therapies in gynaecological cancers. The rapid adoption of AI in gynaecological oncology will depend on overcoming the challenges related to data transparency, quality, and interpretation. In gynaecologic oncology, more studies have been conducted on cervical cancer than on ovarian and endometrial cancers. Prognoses were mainly used in the study of cervical cancer, whereas diagnoses were primarily used for studying ovarian cancer.[9]

Other Uses: In addition, different consumer-grade, wearable devices, including smart rings and smartwatches, could track semicontinuous physiological measures such as body temperature, heart rate variability, oxygen saturation, blood pressure. They also track other behaviour measures such as quality of sleep, sleep duration, the relative location of patients and their activity. The tracking process of those physiological parameters has obvious benefits for precise early pregnancy-related conditions determination, including gestational hypertension and preeclampsia.

Further, Three-dimensional (3D) printers could offer materials that mimic real tissues and supports trainees to get practice with the realistic model. 3-D imaging permits better deep perception than its two-dimensional counterparts, permitting the surgeon to generate preoperative plans by the dimensions and of tissues.

Conclusion:

AI has a promising future in overcoming diagnostic challenges and improving treatment modalities in Obstetrics. Further studies need to be done to decrease the bias when creating algorithms and to increase adaptability in the system, enabling the incorporation of new medical knowledge. Practitioners must also take safety measures to ensure that the analysis is valid and accurate. AI is not meant to replace practitioners but, rather to serve as an adjunct in decision making and will help clinicians to make more self-assured decisions. Despite the numerous advantages, there are certain difficulties and challenges associated with AI such as reproducibility, generalizability, human engagement, privacy protection, legal issues, systematic biases and improper labelling of data, leading to skewed results. However, it is essential to keep in mind that it is not a substitute for clinical experience.

Limitations of AI:

Main limitation of AI in healthcare is the potential for ethical and privacy concerns. AI systems in healthcare rely heavily on patient data, including sensitive medical information. There is a need to ensure that this data is collected, stored, and used in a secure and privacy-conscious manner. Protecting patient privacy, maintaining data confidentiality, and preventing unauthorized access to personal health information are critical considerations.

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Review Article

Project RIDA 100%
Rajgir Institutional Delivery Achievement 100%

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ABSTRACT

Institutional delivery provides an opportunity for timely management of intrapartum complications and reduces neonatal infections. It is estimated that around 40% of maternal deaths, stillbirths and neonatal deaths take place during labour and the day of birth.[1,2] Birth asphyxia, an Intra-partum complication, contributes 20% of neonatal deaths.[1] Quality care during labour and childbirth ensures early detection and prompt management of complications. Bihar accounts for over 3.2 million newborns every year. Only 63.8% institutional delivery (15% lower than the national average of 78.9%) and over 35% home deliveries was reported as per NFHS-4. Home delivery was found high particularly in pockets having migrant population or far away homes and populations with low education and awareness level. With the Project RIDA 100% (Rajgir Institutional Delivery Achievement 100%), an intervention model was tested in 2018 to demonstrate that a package of both facility and community-based interventions could lead to attain 100% institutional delivery in Rajgir Block of Nalanda District, Bihar. The evaluation findings showed an increasing trend of the Institutional delivery in successive quarters of 2018 and the finding was remarkable. Of the 21 reported home deliveries, 10 (47.6%) deliveries were in the first-quarter (January- March 2018), 6 (28.5%) in the second-quarter (April-June 2018), 5 (23.8%) in the third-quarter (July- September 2018) and no home delivery reported in the last quarter (October-December 2018). This apart, coverage of Four ANC visits within the recommended time was noteworthy, rising from 43.8% of pregnant women to 77.8% between in given time period.

Keywords: Institutional Delivery, Anti Natal Care, Bottleneck Analysis & Respectful Maternity Care.

Introduction

Institutional delivery provides an opportunity for timely management of intrapartum complications and reduces neonatal infections. It is estimated that around 40% of all maternal deaths, stillbirths and neonatal deaths take place during labour and the day of birth.[1,2] Intra-partum related complications/birth asphyxia contributes 20% of neonatal deaths.[1] Quality care during labour, childbirth, and in the immediate postnatal period not only prevents the onset of complications, but it also enables their early detection and prompt management. Bihar, being the third most

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populous state of the country, accounts for over 3.2 million newborns every year. Of these, more than 35% is home deliveries as per NFHS4, contributing to maternal and neonatal morbidity and mortality. In this context, the pilot project titled "RIDA 100% (Rajgir Institutional Delivery Achievement 100%)" was implemented in Rajgir Block of Nalanda District, in Southeast of Bihar.

Context:

In Bihar only 63.8% deliveries take place in health care facilities which was 15% lower than the national level (78.9%) as per NFHS-4. RIDA 100% was designed in January 2018 as a model to strengthen institutional delivery under MNH programme. Home delivery rate was found very high particularly in pockets having migrant population, in populations with low education status and awareness level and in homes which are far away from delivery centers. This pilot project unfolded many buried reasons like unofficial charging of money by the staff of facilities, less importance towards respectful maternity care, poor quality of care, poor accessibility, lack of referral transport facilities and social taboos as some of the factors refraining the pregnant women to avail quality institutional delivery services. Evaluation report of the pilot project recommended a number oflow-cost strategies and package of interventions to overcome the barriers and to promote institutional delivery across the state.

Methodology:

RIDA 100% Institutional delivery model piloted during 2018 with ultimate objective to demonstrate a proof of concept for widespread replication of the learnings to strengthen institutional delivery across Bihar. The pilot planned with the **Objective:**

a. To identify the Bottlenecks in Institutional Delivery and Reasons of high Home Delivery
b. To develop Strategies and activities for achieving 100% institutional delivery in Rajgir block of Nalanda District

Implementation Measures:

A. Mapping of High home delivery blocks:

- First, mapped all the high home delivery blocks of Bihar for equity analysis (Found 71 out of 534 Blocks are having home delivery more than 50%) by using Health Management Information System (HMIS) Data.

B. Situation Analysis/BNA: (Community, Facility and Enabling Environment)

- Through Bottleneck analysis (BNA) done to find out the major reasons of high home delivery and found that populations with low awareness, low literacy level in female, deep rooted cultural practices (don't like delivery by male staff, low male participation in decision making etc.), hospital far away, difficult roadway conditions, high migrant population, Non-availability of Aadhar Card/Bank Account etc.
- Mapping of all the available of delivery points, skilled service providers especially at the block facility & sub health center level, ambulance availability etc. (Only 41% of available ANMs are found trained for skilled birth attendant)

C. Stakeholder Mapping:

Mapping of the different potential stakeholders working in Bihar who can be engaged in this project, as this was not a simple pilot, but the moto was to test different intervention/hypothesis's which are fitting & not fitting with an ultimate objective was to improve institutional delivery across the state and alone by Health this was not possible. Apart from Health, other stakeholders identified who can support in the intervention are: JEEViKA- members of State Rural Live-hood Mission (SRLM), Self Help Groups (SHG), CARE, Social Mobilization Network (SMNet), ICDS Workers, Panchayati Raj Institution (PRI), Public Relations Department (PRD), Public Administration Department etc.

D. Selection of Block:

Rajgir Block was chosen based upon 3 criteria's (High Home Delivery, Routine Immunization (RI) High Risk Block & to bring Political Buy In- as this was CM's home constituency) (RI High Risk Blocks in terms of Coverage, Accessibility, Migration, Resistant etc.)

E. Implementation Strategy with Roadmap:

Based upon the above observations and stakeholder's consultation a Three-pronged implementation strategy with roadmap was developed with strategically viable specific facility & community-based interventions

were undertaken in the block to achieve 100% institutional delivery in Rajgir Block of Nalanda District.

Prong-I (Community intervention Model)- Major focus was to engage the JEEViKA, SHG, SMNET team members to execute the community level tasks along with ASHA, AWW, women's groups and village volunteers because it was totally difficult to achieve the desired results without effective participation of community. Though JEEViKA, SMNET & SHGs have not worked earlier in MNH area, however we choose them because of their in-depth understanding of community programming, practices, beliefs and needs of community.

Prong-II (Facility Intervention Model)- To engage Consultants to support Facility Gap Improvement, Capacity building of Staff, Expansion of Delivery Points and Quality assurance at the facility level services and to coordinate with the Block Health, ICDS, PRD, BDO & JEEViKA team. Facility Based Interventions included improved management and governance of Health Services and improved availability and quality of MNH services.

Prong-III (System & Governance Strengthening)- Strategic linkage with District Health & ICDS Officials, District Administration, PRD, State Health Society Bihar (SHSB), SRLM and CARE to address the pilot pitfalls through the Block Health Officials and Consultants.

Under the Improved Management and Governance of Health Services, Rajgir Pilot Project Core Committee (RPPCC) was instituted with the chairmanship of Civil Surgeon, Nalanda district and with weekly progress review mechanism. Quality Assurance Core Committee (QACC) was strengthened for labour room and OT room of Sub Divisional Hospital Rajgir. local resource allocation was increased for institutional delivery services by utilizing RKS fund on priority basis. village wise excepted level of achievement (ELA) of each sub-centre was updated and streamlined HMIS monitoring data for systematic progress review by RPPCC and QACC.

Under the Improved Availability and Quality of MNH services, supply chain was strengthened and ensured availability of functional equipment and adequate stock of consumables. Ensured 24-hour availability of clinical staff for core MNH services at SDH Rajgir and positioned 2 SN/ANM at APHC Rajgir. Labour room staffs were capacitated for improved clinical practices through training programmes such as MNH, Neonatal resuscitation program (NRP), infection control etc. Handholding support was provided to facilitate routine clinical discussions and use of LaQshya-Labour Room/OT Quality Improvement Initiative and Safe birth checklist by Staff Nurse/ ANM, filling up of case sheets & registers of labour room & OT, initiate patient satisfaction survey & feedback sharing for Respective Maternity Care.

Specific community Based Interventions included the following methodology:

I. Line listing of all pregnant mother and tagging of migrant/underserved/unserved mothers with nearby ASHA, ASHA Facilitator and ANM
II. Deployed "Tele-counselor" at the Block level for case-based tracking and follow up of the pregnant women and provide counseling support particularly to the most disadvantaged.
III. Facilitated JAGO campaign for awareness building and sensitization for institutional delivery.
IV. Facilitated mass awareness throughcrowd pulling events such as magic show, nukkad-natak, rallies and other IEC activities like hand bill distribution etc. by engaging a local NGO.
V. Strengthened women's and mothers' group networks and sensitized on safe motherhood. Imparted care seeking behavior through mothers' meetings in all gram panchayats of Rajgir block. Enhanced women's and their family's knowledge and confidence about the rights and entitlements in the ambit of MNH services.
VI. Improved mechanism to ensure referral transport through frontline health workers. Volunteers were identified in hard-to-reach areas (example in Bahera Village of Rajgir) to take responsibility for emergency transport.
VII. Undertaken systematic survey on knowledge, attitude and satisfaction level towards institutional delivery by undertaking 300 pre and 300 post community level interviews to understand the bottlenecks.

Results and Discussion:

The evaluation findings showed an increasing trend of the Institutional delivery in successive quarters of

2018 was found to be remarkable. Out of 21 home deliveries reported in 2018, 10 (47.6%) deliveries had been in the first quarter (January- March 2018), 6 (28.5%) in the second quarter (April-June 2018), 5(23.8%) in the third quarter (July- September 2018) and no home deliveries reported in the lastquarter (October-December 2018). Highest number of Institutional deliveries has been conducted in third (138) and fourth quarter (137) of the life span of the pilot, i.e. 2018. As the purpose of the project was to test whether a package of both facility and community-based interventions could lead to attain 100% institutional delivery in Rajgir, the above-mentioned result endorses the theory of change and fits with international evidence and overall achievement of RIDA 100%.

Besides, there were several outcome level results achieved through this pilot intervention. There was a significant increase in reported four ANC visits (4 ANC) made at the recommended times, rising from 43.8% of pregnant women to 77.8% between in given time period. *Similarly*, there was a major increase in the institutional delivery rate, rising from 55% to 100%. *Also*, there is decline in home delivery from average number per month of 11 to 0. Similarly, improvement in essential newborn care practices was conspicuous. More positively, institutional delivery increased among the disadvantaged women marking an equity achievement.

The facility and community level intervention package contributed to improving the overall MNH services in the block in general and quality of services at facility and community level in particular.

Small flexible grants managed at block level to create an enabling environment at the health facility. Quality ANC camps were organized by using PMSMA platform.

The facility obtained license for blood bank at the sub divisional health facility. An additional delivery point made functional at APHC Amirganj. Health Management Information System (HMIS) was strengthened through systematic review processes. Social and community mobilization for behavior change enhanced demand for facility-based care. Strengthened women's and mothers' groups and networks engaged in mass sensitization on safe delivery practices.

Recommendation:

The pilot project recommended a numerous low-cost core strategies and package of interventions designed to overcome the barriers and to promote the institutional delivery via piloting in one block of the blocks of 38 districts of Bihar to emphasize the development & implementation of cost-effective strategies for maternal and newborn health (MNH), in the next health sector programming of Bihar.

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Statement: *"We confirm that the article is original, and is not under consideration by another journal. We sign for and accept responsibility for releasing this article."*

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