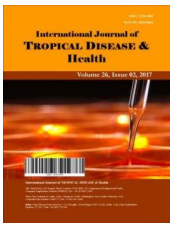

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The Use of Paper Based Obstetrics Wheel and Electronic Applications for Calculation of Estimated Date of Confinement and Gestational Age, Which is More Accurate?

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Authors' contributions

This work was carried out in collaboration between the two authors. Author IEH designed the study, performed the statistical analysis, wrote the protocol and the first draft of the manuscript. Author IEM contributed immensely in literature search. Both authors read and approved the final manuscript.

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ABSTRACT

This study demonstrates that the USS EDD is more in agreement with the date of spontaneous delivery than the EDD estimated from LMP. This highlights the importance of dating USS in all pregnancies which would be helpful in the management of pregnancy in late stages.

Background: During antenatal care, accurate determination of the gestational age and expected date of confinement are mandatory, for management decisions and birth plan. This could be achieved by the traditional Naegle's rule, the mechanical obstetrics wheel, and recently the electronics applications.

Objective: To compare the accuracy and consistency of the mechanical or paper-based obstetrics wheel to that of electronics applications in calculating expected date of confinement and gestational age. It would also recommend the application that is most suitable for use in our environment, for the benefit of the patients and the health personnel.

Materials and Methods: An analytical study of 1200 pregnant women who presented for antenatal care on their booking visit. The study was carried out from May 2010 and April 2013, at the antenatal clinic of the department of obstetrics and gynaecology, Niger Delta University Teaching

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Hospital, Southern Nigeria. Women who presented in the antenatal clinic on the booking visit were identified, and consent was obtained from them. Relevant information concerning the first day of the last regular menstrual period and patient's bio-data were obtained for those who accepted to participate in the study. Using Naegle's rule as control, the expected date of confinement and gestational age were calculated using the mechanical obstetrics wheel and the electronics application. The results were then analysed.

Results: Using the mean gestational age by Naegle's rule 27.6 ± 7.6 as control, the mean gestational age obtained by mechanical obstetrics wheel 28.4 ± 7.6, and electronics application 27.8 ± 7.6 were compared respectively using the student's t-test. The difference was statistically significant for the paper-based wheel, t = 2.62, p = 0.008 [0.21, 1.43], while that for the electronics applications was not significant, P = 0.48. Also, there was a higher tendency for the paper-based wheel to deviate from +1 to +5 days beyond the normal duration of pregnancy of 280 days, when used to calculate expected date of confinement.

Conclusion: The electronics applications are more accurate in calculating expected date of confinement and gestational age than the mechanical or paper-based obstetrics wheel. The mechanical wheel is less precise, with a high tendency to deviate when used to calculate expected date of confinement. The electronic applications are hereby recommended as first-line tools in all antenatal clinics.

Keywords: Antenatal women; gestational age; expected date of confinement; mechanical obstetrics wheel; electronics applications.

1. INTRODUCTION

During pregnancy, Naegle's rule is by far the method mostly employed worldwide to calculate the gestational age and expected date of confinement [1,2]. The mean duration of pregnancy is 280 days or 40 weeks from the first day of the last normal menstrual period (NLMP). The expected date of confinement (EDC) is therefore 9 calendar months plus 7 days from the first day of the LMP. Using the Naegle's rule, the EDC is calculated by counting back 3 months and adding 7 days to the first day of the last menstrual period [3,4].

Naegle's rule is very accurate in calculating the EDC and gestational age (GA) if the rules establishing it are well applied. It assumes that a woman's menstrual cycle is approximately 28 days, and ovulation occurs on the 14^{th} day. It is a well-known fact that the follicular phase of the menstrual cycle is variable, while the luteal phase is always 14 days [2,5]. It implies that the variations in length of the menstrual cycle in women is determined by the length of the follicular phase. Therefore, for women with menstrual cycle longer or shorter than 28 days, the difference must be added or subtracted for the calculated EDC to be accurate [3].

The use of transvaginal ultrasound scan in early pregnancy to measure crown-rump length for dating is very accurate [4]. The discrepancy in dates between early pregnancy ultrasound and those calculated from LMP usually result when the date of ovulation and conception is not exactly two weeks from the LMP [5,6]. In general, in the first trimester, if the EDC by LMP differs by more than 7 to 10 days based on ultrasound, then the EDC should be adjusted based on ultrasound dating, but in the second trimester, the difference should be more than 14 days.

The use of the mechanical obstetric wheel as a tool to calculate the expected date of confinement and gestational age has been in practice for decades. It is very convenient, relatively accurate, cheap and available in many antenatal clinics globally. Just a few years ago, the obstetric electronic applications were developed for this purpose, and there are various types in the android and apple stores [7]. They have the advantage of speed, accuracy, convenience, and are designed for use not only by health personnel, but by the patients themselves at home. [7,8] studies done in Harbor-Ucla Medical Center in California revealed that the obstetric wheel is less accurate, and differed by an average of more than 3 days from computer-assessed EDC, with a range of + 1 to +5 days [8].

A study done in London, UK revealed that the use of electronic devices for calculating EDC and GA consistently had no errors, in contrast, the manual devices were prone to bias, and significant inter-observers variability, with individual differences of up to 4 days [9]. In another study done in Creighton University School of Medicine, Phoenix Arizona, the use

paper based obstetrics wheel to calculate EDC was found to produce inconsistent results, with deviation of about 4 to 7 days from the standard duration of pregnancy of 280 days [10]. The author actually recommended that the paper-based obstetrics wheel should be abandoned.

Most obstetrics centers in Nigeria, including the Niger Delta University Teaching Hospital have not adopted the use of electronics applications for calculation of EDC and GA, despite the fact that several reports are validating their accuracy, in addition to the fact that they have been in existence for years. What is consistently used is an application of Naegle's rule, and the paper based or mechanical obstetrics wheel. This study intends to compare the accuracy of the obstetric wheel with that of the electronic applications to calculate EDC and GA, using Naegle's rule as control.

2. METHODOLOGY

2.1 Study Site

The study was carried out at the antenatal clinic of the department of Obstetrics and Gynaecology, at the Niger Delta University Teaching Hospital, Southern Nigeria.

2.2 Study Design and Subjects

It was an analytical study of 1200 pregnant women who presented at the antenatal clinic for antenatal care on their booking visit. The study was carried out between May 2010 and April 2013.

2.3 Inclusion Criteria

Pregnant women who presented for antenatal care on their booking visit, and were sure of the date of their last menstrual period (LMP). Also included were women who were unsure of their dates but had an early pregnancy ultrasound scan.

2.4 Exclusion Criteria

Excluded from this study were parturient who were un-booked, women with no formal education, and those who were unsure of the date of their last menstrual period. Also excluded were women who were already booked and have been attending antenatal clinic, for the sake of easy calculation and to avoid bias as their information was already on the case notes.

2.5 Training Workshop on the Use of Obstetrics Wheel and Electronics Apps

A training workshop was organized to train volunteer house officers, and resident doctors in the department of obstetrics and gynaecology on the use of obstetrics wheel and electronics APPs to calculate EDC and GA. This was necessary because in this department, calculation of EDC and GA is usually done via LMP by applying Naegle's rule.

2.6 Calculation of Expected Date of Confinement and Gestational Age Using Naegle's Rule

Applying Naegle's rule, the EDC was calculated based on the fact that the mean duration of pregnancy was 280 days or 40 weeks from the last normal menstrual period (LMP). This is equivalent to 9 calendar months plus 7 days from the first day of the LMP. The EDC was therefore calculated by counting back 3 months and adding 7 days to the first day of the last menstrual period. For women with irregular menstrual cycle (longer or shorter than 28 days), the difference was added or subtracted from the calculated EDC as recommended by Naegle's rule. The gestational age (GA) was calculated in weeks from the first day of the normal last menstrual period.

2.7 Calculation of Expected Date of Confinement and Gestational Age Using the Paper Based Obstetrics Wheel

The mechanical or paper based obstetric wheel was held in the hand or placed on a flat surface. The arrow on the obstetric wheel designated for LMP was turned to the position of the first day of the last menstrual period of the patient. By following the arrow designated for the probable date of birth, the expected date of confinement (EDC) was recorded. The gestational age was determined by reading the GA column on the wheel where the short arrow points.

2.8 Calculation of Expected Date of Confinement and Gestational Age Using the Electronics Apps

Various electronics softwares are available in the android or apple stores for calculation of expected date of confinement and gestational

age. Various products are available, such as gestational calculator, obstetrics calculator, pregnancy calculator etc. The software was downloaded into a smart or android phone, it was then opened, and relevant information concerning the first day of the last normal menstrual period was fed into the LMP column. The EDC and GA were displayed automatically; the values were then recorded on the patient's antenatal record, and on the research protocol. For the purpose of standardization, the application used for this study was the obstetrics pregnancy calculator (OBS calc).

2.9 Sample Size

An appropriate sample size was calculated using EpiInfo statistical software based on an annual antenatal attendance rate of 2800, a booking rate of 35%, at 95% confidence level and assuming an error of 5%.

2.10 Data Collection

Women who presented in the antenatal clinic on the booking visit were identified, and consent was obtained from them. Relevant information concerning the first day of the last normal menstrual period, and patient's bio-data were obtained for those who accepted to participate in the study. The expected date of confinement (EDC) and the gestational age (GA) were calculated using the mechanical obstetrics wheel and the electronics application, while calculation using Naegle's rule served as control. Approval to use the hospital records was granted by the ethical committee of the hospital. The ethical protocol number is NDUTH/REC/0035/2010.

2.11 Data Analysis

Data collected from each subject was entered into SPSS statistical software version 20 spread sheath, and EPI info version 7. Chi-square was used to test for statistical association, differences in mean values were compared using the student's t-test, and p value was set at < 0.05, at 95% confidence interval.

3. RESULTS

3.1 Bio-Data

3.1.1 Maternal age

The mean maternal age was 27.0 ± 5.84 years, the minimum age was 16 years, and the maximum was 44 years.

Majority of the women who participated in this study 364(30.3%) were 30 – 34 years old, with a mean age of 27.0 ± 5.84 years. Most of the participants 750(62.5%) were multiparous (Para 1-4), quite a significant amount 30% were primigravidas, and only 7.5% were grand multiparous. The level of education among the participants seems to be low, as a great majority 874(72.8%) attained only secondary education; only 15.8 attained tertiary education. The women were predominantly unemployed 518 (43.2%), however it is the tradition of such women in the Niger Delta to engage in fishing and farming to support their families. About 26.3% were self employed, most of these were petty traders, and 10% were civil servants. These women were employed by the Bayelsa State Civil Service in Southern Nigeria.

3.1.2 Gestational age by Naegle's rule, paper based obstetrics wheel, and electronics apps

Using the mean gestational age by Naegle's 27.63 ± 7.65 as control, the mean gestational age obtained by mechanical obstetrics wheel and electronics application were compared respectively using the student's t-test. The difference was statistically significant for the paper based wheel, t = 2.62, p = 0.008, while that for the electronics APP was not significant, P = 0.48. This implies that using Naegle's rule as reference point; the electronics applications are more accurate than the mechanical obstetrics wheel in calculating gestational age.

3.1.3 Deviation of gestational age by paper based obstetrics wheel, and electronic application from Naegle's rule

In 230(19.2%) of the parturients, the use of electronics application to calculate gestational age coincided accurately (no deviation) with that calculated by LMP using Naegle's rule. But with the paper based obstetrics wheel, only 188(15.7%) coincided accurately. The difference was statistically significant. Odds Ratio = 0.78 [0.63, 0.96]. X^2 = 5.11, p = 0.02. This result implies that the mechanical obstetrics wheel is less consistent, and has a higher tendency to deviate from the normal duration of pregnancy of 280 days, when used to calculate GA.

It was also observed that the level of deviation by +1 to +5 days was consistently lower with the electronics application, even though the values were not statistically significant.

Table 1. Bio-Data

Bio-data	Number (n =1200)	Percentage
Maternal Age		
< 19 yrs	122	10.2
20-24	282	23.5
25-29	262	21.8
30-34	364	30.3
> 35 yrs	170	14.2
Parity		
0	364	30.3
1 - 4	750	62.5
> 5	86	7.2
Educational level		
Primary	96	8.0
Secondary	874	72.8
Tertiary	190	15.8
Occupation		
Unemployed	518	43.2
Civil servant	120	10.0
Private enterprise	76	6.3
Self employed	316	26.3
Student	170	14.2

3.1.4 Deviation of EDC by paper based obstetrics wheel, and electronic apps from LMP

In 640(53.3%) of the women, the use of electronics application to calculate expected date of confinement (EDC) coincided accurately (no deviation) with that calculated by LMP. But with the paper based obstetrics wheel, only 582(48.5%) coincided accurately. The difference was statistically significant. Odds Ratio = 0.82 [0.70, 0.96]. X^2 = 5.6, p = 0.01. Similarly, the level of deviation by +1 to +5 days was lower when electronics application was used, but the values were not statistically significant. Similarly, the above results signify that the mechanical obstetrics wheel is less consistent, and has a higher tendency to deviate from the normal duration of pregnancy of 280 days, when used to calculate EDC.

4. DISCUSSION

When a pregnant women presents in an antenatal clinic for the first time for booking, the obstetrician ensures that the gestational age and estimated date of confinement are accurately calculated. Accurate dating of pregnancy is very essential; this is because major management decisions and intervention, including timing of delivery are based on the gestational age [1].

The age long traditional method of calculating the EDC and GA worldwide is by applying Naegle's rule. It is generally accepted as being accurate if well applied, taking into cognizance the variation in the length of the proliferative phase of the menstrual cycle [2]. However, the calculation is often cumbersome and time consuming, especially when running a very busy antenatal clinic. The introduction of the paper based obstetrics wheel decades ago; usually supplied by pharmaceutical companied, greatly relieved the mathematical burden and time wastage. In recent times, the introduction of the smart phone electronic applications have greatly revolutionized entire concept, especially with respect to speed and accuracy in calculating EDC and GA.

Table 2. Mean gestational age by Naegle's rule, paper based obstetrics wheel, and electronics apps

Naegle's Rule	Obstetrics wheel	Electronics APPS	Mean difference	t-test	p-value
27.63 ± 7.65	28.45 ± 7.67	-	0.82	2.62	0.008
27.63 ± 7.65	-	27.85 ± 7.63	0.22	0.71	0.48
-	28.45 ± 7.67	27.85 ± 7.63	0.60	1.92	0.05

Table 3. Deviation of gestational age by paper based obstetrics wheel, and electronic application from Naegle's rule

Deviation of GA in days	Paper based wheel	Electronic APPS	p value
No deviation	188(15.7)	230(19.2)	0.02
Deviation by one day	330(27.5)	322(26.8)	0.74
Deviation by two days	275(22.9)	266(22.3)	0.66
Deviation by three	26(2.3)	20(1.7)	0.37
Deviation by four days	130(10.8)	138(11.5)	0.65
Deviation by ≥ five days	251(20.9)	224(18.6)	0.17
Total	1200(100)	1200(100)	

Table 4. Deviation of EDC by paper based obstetrics wheel, and electronic apps from LMP

Deviation from LMP in days	Paper based wheel	Electronics APPS	p value
No deviation	582(48.5)	640(53.3)	0.01
Deviation by one day	420(35.0)	384(32.0)	0.13
Deviation by two days	100(8.3)	94(7.8)	0.65
Deviation by three days	90(7.5)	78(6.5)	0.33
Deviation by four days	8(0.6)	4(0.3)	0.24
Deviation by ≥ five days	-	-	
Total	1200(100)	1200(100)	

The mean maternal age among the parturients in this study was 27.0 $\pm$ 5.84 years, this was anticipated as the study was carried out among women in the reproductive age group. The educational level among the parturient was very low, as much as 75% did not go beyond secondary education. This is most probably because the study was done in Bayelsa state, which is classified as an educationally disadvantaged state in Nigeria.

Various studies from different centers have critically evaluated the accuracy, consistency and usefulness of the mechanical obstetrics wheel for calculation of EDC and GA, and its value seems to be outlived in this modern era of electronics applications [8,9,10]. Studies done in Creighton University School of Medicine, Phoenix, Arizona reported the obstetrics wheel as being very inaccurate, and that it should be abandoned [10]. while others have recommended that the paper based wheel should be validated to improve its accuracy [9].

This study has taken a critical look at the concept of inconsistency and inaccuracy of the mechanical obstetrics wheel in calculating EDD and GA, and the findings seems to be in conformity with those obtained from the studies above. In this study, there was no statistically significant mean difference between the mean GA for electronics APPS and that for Naegle's rule. Mean difference = 0.22, p = 0.48. This implies that using Naegle's rule as reference point; the electronics applications are more accurate than the mechanical obstetrics wheel in calculating gestational age. This is further buttressed by the fact that similar significant difference was obtained for EDC Odds Ratio = 0.82, p = 0.01.

Reports from various studies indicates that the mechanical obstetrics wheel has a very high tendency to deviate from the mean duration of pregnancy of 280 days, when used to assess EDC and GA. Studies done in Harbor-Ucla Medical Center in California revealed that the obstetric wheel is less accurate, and differed by an average of more than 3 days from electronically assessed EDD, with a range of + 1 to +5 days [8]. This is very similar to what was obtained in this study. Evidence emanating from this study revealed a tendency for both the paper based wheel and electronics application to deviate when used to calculate the EDC. This deviation ranged from +1 to +5 days beyond the normal duration of pregnancy of 280 days. However, at all levels of the deviation, the rates were higher with the mechanical wheel, though they were not significant when subjected to statistical analysis.

Similarly, the findings from this study did not vary widely with what was obtained in Creighton University School of Medicine, Phoenix Arizona, where the use of mechanical obstetrics wheel to calculate EDC was found to produce inconsistent results, with deviation of about + 4 to +7 days [10].

Though evidence emanating from this study indicates that the electronics applications are more accurate than the mechanical wheel in determining the expected date of confinement, it is not absolute as deviation was observed in both appliances. This observation differ sharply from the results obtained from the study in USA, where 100% of the electronic applications gave the same EDD with that obtained from Naegle's rule.

Various types of electronics applications are ubiquitous in the Android and Apple stores. However, despite the fact that reports indicate that the electronics applications are very accurate, consistent, fast, and reliable for health professionals, and are also convenient for patient's personal use, it is surprising that there are very few publications concerning this subject matter. It is very possible that its

application is not widely adopted in most obstetrics clinic worldwide. More advocacy and studies may be needed to improve this trend.

5. CONCLUSION

The electronics applications are more accurate in calculating expected date of confinement and gestational age than the mechanical or paper-based obstetrics wheel. The mechanical wheel is less precise, with a high tendency to deviate when used to calculate EDC. The electronic applications are hereby recommended as first-line tools in all antenatal clinics.

CONSENT

As per international standard or university standard, patient's written consent has been collected and preserved by the authors.

ETHICAL APPROVAL

As per international standard or university standard, written approval of Ethics committee has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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