

The use of Paper Based Obstetrics Wheel and Electronic Applications for Calculation of Estimated Date of Confinement and Gestational Age, which is more Accurate?

Abstract

Background

When looking after a pregnant woman during the antenatal period, one of the first things an obstetrician does is to ensure that the gestational age and expected date of confinement, are accurately calculated. While the gestational age is indispensable when taking major management decisions and interventions, the expected date of confinement is very important for timing of delivery and birth plan. In most antenatal clinics globally, expected date of confinement and gestational age are calculated using the Naegle's rule, but other methods often employed are the use of mechanical or paper based obstetrics wheel, and more 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 Method

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 from May 2010 and April 2013, at the antenatal clinic of the department of obstetrics and gynaecology, Niger Delta University Teaching Hospital, Southern Nigeria. Approval to use the hospital records was granted by the ethical committee of the hospital.

Women who presented in the antenatal clinic on the booking visit were identified, and Verbal 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. 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 analyzed.

33 Results

34 The mean gestational age obtained by calculating expected date of confinement and
 35 gestational age by Naegle's rule was 27.63 ± 7.65 , while that for mechanical obstetrics
 36 wheel and electronics applications were 28.45 ± 7.67 and 27.85 ± 7.63 respectively. Using
 37 the mean gestational age by Naegle's as control, the mean gestational age obtained by
 38 mechanical obstetrics wheel and electronics application were compared respectively using
 39 the student's t-test. The difference was statistically significant for the paper based wheel, $t =$
 40 2.62 , $p = 0.08$ $[0.21, 1.43]$, while that for the electronics applications was not significant, $P =$
 41 0.48 .

42 In 230(19.2%) of the parturients, the use of electronics application to calculate gestational
 43 age coincided accurately with that calculated by using Naegle's rule. But with the paper
 44 based obstetrics wheel, only 188(15.7%) coincided accurately. The difference was
 45 statistically significant. Odds Ratio = 0.78 $[0.63, 0.96]$, $p = 0.02$. Similar findings were also
 46 obtained for expected date of confinement: Odds Ratio = 0.82 $[0.70, 0.96]$, $p = 0.01$.

47 There was a higher tendency for the paper based wheel to deviate when used to calculate
 48 the expected date of confinement. This deviation ranged from +1 to +5 days beyond the
 49 normal duration of pregnancy of 280 days.

50 Conclusion

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

56
 57 **Key words:** *pregnant women, antenatal care, booking visit, calculation of expected date of*
 58 *confinement and gestational age, obstetrics wheel and electronics apps.*

59 Introduction

60 During pregnancy, Naegle's rule is by far the method mostly employed worldwide to
 61 calculate the gestational age and expected date of confinement.^{1, 2} It is very accurate if the
 62 rules establishing it are well applied. It is a well known fact that the follicular phase of the
 63 menstrual cycle is variable, while the luteal phase is always 14 days.^{2,3} It implies that
 64 menstruation will occur 14 days after ovulation, therefore the variations in length of
 65 menstrual cycle in women is determined by the length of the follicular phase.

66 In calculating the expected date of confinement (EDC) and gestational age (GA), the
 67 Naegle's rule assumes that the woman's menstrual cycle is approximately 28 days, and
 68 ovulation occurs on the 14th day. Therefore, for women with menstrual cycle longer or
 69 shorter than 28 days, the difference must be added or subtracted for the calculated EDC to
 70 be accurate.³ The mean duration of pregnancy is 280 days or 40 weeks from the first day of

the last normal menstrual period (NLMP). The 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.^{4,5}

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 by Ross MG, 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

Studies done by Smout EM et al 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 there are several reports validating their accuracy, in addition to the fact that they have been in existence for years. What is consistently used is 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.

108 **METHODOLOGY**

109 **Study Site**

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

112 **Study Design and Subjects**

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

116 **Inclusion Criteria**

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

120 **Exclusion Criteria**

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

126 **Training Workshop on the Use of Obstetrics Wheel and Electronics Apps**

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

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

132 Applying Naegle's rule, the EDC was calculated based on the fact that the mean duration of
133 pregnancy was 280 days or 40 weeks from the last normal menstrual period (LMP). This is
134 equivalent to 9 calendar months plus 7 days from the first day of the LMP. The EDC was
135 therefore calculated by counting back 3 months and adding 7 days to the first day of the last
136 menstrual period. The gestational age (GA) was calculated in weeks from the first day of the
137 normal last menstrual period.

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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.

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).

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%.

Data Collection

Women who presented in the antenatal clinic on the booking visit were identified, and Verbal 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.

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.

176 **RESULTS**

177 **Bio-Data**

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179 **Maternal Age**

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

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

206 Majority of the women 364(30.3%) were 30 – 34 years old, with a mean maternal age of
207 27.0 ± 5.84 years. Most of the participants 750(62.5%) were multiparous, and only 7.5%
208 were grand multiparous. With respect to educational level, a great majority 874(72.8%)

attained secondary education, and the women were predominantly unemployed (43.2%).

Gestational Age by Naegle's Rule, Paper Based Obstetrics Wheel, and Electronics Apps

Naegle's Rule value	Obstetrics wheel	Electronics APPS	Mean Difference	t-test	p-value
Mean Gestational Age					
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

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 = 0.08, while that for the electronics APP was not significant, P = 0.48.

Similarly, comparing the mean GA obtained by obstetrics wheel and electronics APPS yielded significant results. t = 1.92, p = 0.05.

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			

238	Deviation by two days	275(22.9)	266(22.3)
239	0.66		
240	Deviation by three	26(2.3)	20(1.7)
241	0.37		
242	Deviation by four days	130(10.8)	138(11.5)
243	0.65		
244	Deviation by $\geq$ five days	251(20.9)	224(18.6)
245	0.17		
246	Total	1200(100)	1200(100)

247
 248 In 230(19.2%) of the parturients, the use of electronics application to calculate gestational
 249 age coincided accurately (no deviation) with that calculated by LMP using Naegle's rule. But
 250 with the paper based obstetrics wheel, only 188(15.7%) coincided accurately. The difference
 251 was statistically significant. Odds Ratio = 0.78 [0.63, 0.96]. $X^2 = 5.11$, $p = 0.02$. Also, the level
 252 of deviation by +1 to +5 days was lower when the electronics application was used, but the
 253 values were not statistically significant.

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256 **DEVIATION OF EDC BY PAPER BASED OBSTETRICS WHEEL, AND ELECTRONIC APPS FROM**
 257 **LMP**

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260	Deviation from LMP in days	Paper based wheel	Electronics APPS	p value
261	No deviation	582(48.5)	640(53.3)	0.01
262				
263	Deviation by one day	420(35.0)	384(32.0)	0.13
264				
265	Deviation by two days	100(8.3)	94(7.8)	0.65
266				
267	Deviation by three days	90(7.5)	78(6.5)	0.33
268	Deviation by four days	8(0.6)	4(0.3)	0.24

269	Deviation by $\geq$ five days	—	—
270	Total	1200(100)	1200(100)

271 In 640(53.3%) of the women, the use of electronics application to calculate expected date of
 272 confinement (EDC) coincided accurately (no deviation) with that calculated by LMP. But with
 273 the paper based obstetrics wheel, only 582(48.5%) coincided accurately. The difference was
 274 statistically significant. Odds Ratio = 0.82 [0.70, 0.96]. $X^2 = 5.6$, $p = 0.01$. Similarly, the level
 275 of deviation by +1 to +5 days was lower when electronics application was used, but the
 276 values were not statistically significant.

277 **DISCUSSION**

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

283 The age long traditional method of calculating the EDC and GA worldwide is by applying
 284 Naegle's rule. It is generally accepted as being accurate if well applied, taking into
 285 cognizance the variation in the length of the proliferative phase of the menstrual cycle.²

286 However, the calculation is often cumbersome and time consuming, especially when
 287 running a very busy antenatal clinic. The introduction of the paper based obstetrics wheel
 288 decades ago; usually supplied by pharmaceutical companied, greatly relieved the
 289 mathematical burden and time wastage. In recent times, the introduction of the smart
 290 phone electronic applications have greatly revolutionized entire concept, especially with
 291 respect to speed and accuracy in calculating EDC and GA.

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

297 Various studies from different centers have critically evaluated the accuracy, consistency
 298 and usefulness of the mechanical obstetrics wheel for calculation of EDC and GA, and its
 299 value seems to be outlived in this modern era of electronics applications.^{8, 9, 10} Studies done
 300 in Creighton University School of Medicine, Phoenix, Arizona reported the obstetrics wheel
 301 as being very inaccurate, and that it should be abandoned.¹⁰ while others have
 302 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 from other researchers. The mean GA for the mechanical obstetrics wheel was compared with that for electronics APPS, using the mean gestational age by Naegle's rule 27.63 ± 7.65 as control. There was no statistically significant mean difference between the mean GA for electronics APPS and that for Naegle's rule. Mean difference = 0.22, $p = 0.48$. However, there was significant mean difference with the paper based obstetrics wheel. Mean difference = 0.82, $t = 2.62$, and $p = 0.008$ [0.21, 1.43].

Another evidence in support of the above subject matter is the fact that in 19.2% of the parturients, the use of electronics application to calculate GA coincided accurately with that calculated by LMP using Naegle's rule. But with the paper based obstetrics wheel, only 15.7% coincided accurately. The difference was statistically significant. Odds Ratio = 0.78 [0.63, 0.96], $p = 0.02$. Similar findings were also obtained for EDC: Odds Ratio = 0.82 [0.70, 0.96], $p = 0.01$.

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 Similar results were 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

However, in contrast to results obtained from the study in USA, where 100% of the electronic applications gave the same EDD, 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.

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.

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