International Journal of Gynecology and Obstetrics 129 (2015) 142–145

Contents lists available at ScienceDirect

International Journal of Gynecology and Obstetrics

journal homepage: www.elsevier.com/locate/ijgo

CLINICAL ARTICLE

Maternal bacteremia and the Irish maternity early warning system

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ARTICLE INFO

Article history:
Received 29 July 2014
Received in revised form 13 November 2014
Accepted 24 January 2015

Keywords:
Ireland
Maternal bacteremia
Maternal sepsis
Obstetric early warning system

ABSTRACT

Objective: To assess whether introduction of the Irish maternity early warning system (IMEWS) in 2013 has improved the recording of vital signs among women with proven maternal bacteremia. *Methods:* In a mixed retrospective and prospective study at a single center in Dublin, Ireland, the patient records of all cases of maternal bacteremia between January 1, 2009, and March 31, 2014, were reviewed. The IMEWS chart was applied retrospectively to records of vital signs from January 2009 to March 2013, and prospectively from April 2013 to March 2014. *Results:* For the 61 cases from the period before IMEWS introduction, vital signs were recorded inconsistently on multiple pages. The frequency of recordings was not standardized. Respiratory rate, in particular, was under-recorded. Among the 17 cases between April 2013 and March 2014 that were eligible for IMEWS chart use, 14 women had vital signs recorded on an IMEWS chart. As compared with the period before IMEWS introduction, there was an improvement in respiratory rate recording as part of the first set of observations. *Conclusion:* Among pregnant women with proven bacteremia, introduction of IMEWS has been associated with an improvement in the recording of vital signs, particularly respiratory rate.

1. Introduction

Early identification of a critically ill adult is a key goal in acute medical care, which led to the introduction of scoring systems such as APACHE II in the 1980s [1,2]. The intention of such systems is to initiate treatment earlier in the hope of decreasing morbidity and avoiding deaths. In 2012, a standardized national early warning score (NEWS) was introduced in Ireland for non-pregnant adults, and a national clinical guideline for acute hospitals was published in 2013 [3].

Obstetric EWS have been advocated for use among pregnant women [4]. A national audit in 2012 found that 10 out of 19 Irish maternity units were using an obstetric EWS, but there was no consistency in usage of the charts and no standardization in the triggers or escalation guidelines [5]. In light of this, the Irish maternity early warning system (IMEWS) was introduced nationally in April 2013 [5].

Sepsis is an important preventable cause of maternal death and serious morbidity, and its adverse consequences are a major concern in contemporary obstetrics [4]. Early detection of systemic infection with subsequent intervention improves clinical outcome for non-pregnant adults [6,7]. There is potential to decrease the incidence of maternal morbidity and mortality by using a system whereby the early signs of maternal illness are recognized and appropriate action is taken. A recent study examined the design and validation of an obstetric EWS, but only in a critical care setting and not in a ward setting [8].

The Coombe Women and Infants University Hospital (CWIUH) is a tertiary referral university teaching hospital that accepts women from all socioeconomic groups and both urban and rural regions. As one of the largest maternity hospitals in Europe, it delivers more than 8500 neonates weighing 500 g or more per annum [9]. The hospital is staffed on a 24-hour basis by in-house residents in obstetrics, anesthesiology, and neonatology. Senior staff are available for emergencies on a daily basis. The aim of the present study was to assess whether the introduction of IMEWS has improved the recording of vital signs among women with proven maternal bacteremia at the CWIUH.

2. Materials and methods

In a mixed retrospective and prospective study, use of IMEWS was examined for all cases of maternal bacteremia at CWIUH, Dublin, Ireland, between January 1, 2009, and 31 March, 2014. The IMEWS chart was applied retrospectively to cases before April 1, 2013, and applied prospectively to cases in the following 12 months. The CWIUH Research Ethics Committee approved the study and written informed consent was not required.

The CWIUH has a regularly reviewed formulary with guidance for clinicians on antimicrobial prescribing based on local pathogenic bacteria sensitivities. Hospital guidelines recommend a clinical review and septic screen, including blood cultures, for women with a temperature of 38 °C or more. Perioperative antibiotic prophylaxis is routinely given to women undergoing cesarean delivery. Women are not screened

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http://dx.doi.org/10.1016/j.ijgo.2014.11.022
0020-7292/

routinely for carriage of *Streptococcus agalactiae* (β-hemolytic, Lancefield group B), but there are hospital guidelines for intrapartum prophylaxis for a fetus at risk of vertical transmission.

All cases of maternal bacteremia during the study period were identified from the laboratory database. Diagnosis of bacteremia was based on the finding of bacterial growth on blood culture. Samples that were probably contaminated (according to laboratory protocol) were excluded. After identification of the cases, charts were retrieved from the CWIUH's records department. One researcher (P.J.M.) reviewed all case notes and, in particular, the notes for the admission during which bacteremia occurred.

For the period which pre-dated introduction of the IMEWS chart, vital signs were recorded in narrative clinical notes, on adult observation charts, and on partograms for women in labor. A local obstetric EWS chart was also introduced in 2012. In the present study, temperature, heart rate, blood pressure, and respiratory rate were considered the four basic parameters necessary for a full set of observations. All recorded vital signs, whether on a dedicated observation chart or in the narrative clinical notes, were entered retrospectively by the researcher on an IMEWS chart.

Since the introduction of IMEWS, vital signs have been recorded on an IMEWS chart, where they are color-coded according to their value (Table 1). The chart is used from the time of diagnosis of pregnancy until 6 weeks after delivery [5]. It is not used during admissions to the labor ward, operating theatre, postoperative recovery room, high-dependency unit (HDU), or intensive care unit (ICU), except for recording the last set of observations before transfer to a general ward. The chart sets out an escalation policy whereby women with one vital signs value in the red range or two values in the yellow range require medical review [5]. The escalation guideline also states that, even in the setting of normal vital signs, medical review should be requested if staff have any concerns about a woman's condition.

On the basis of the IMEWS escalation guideline, the nature and time of the first trigger for medical review (recorded on the retrospectively completed IMEWS chart for the period before April 2013 and on the prospectively filled IMEWS chart for the period after April 2013), as well as the completeness of vital signs recordings, were assessed. The times of medical review, blood culture specimen collection, and intravenous antibiotic administration were also assessed.

Statistical analysis was performed with Excel 2007 (Microsoft, Redmond, WA, USA). Two-sample *t* test and Fisher exact test were used to compare groups as appropriate. A *P* value of less than 0.05 was considered to be statistically significant.

3. Results

During the study period, 47 571 women delivered a neonate weighing 500 g or more. The characteristics of the study population are shown in Table 2. The microbiology laboratory examined 3316 blood culture specimens during the study period. Of these, 81 (2.4%) women had positive blood cultures.

Among 11 women who had a spontaneous abortion, four had prepartum bacteremia and one had postnatal bacteremia in the hours following the abortion at 22 weeks of gestation. There were three intrauterine fetal deaths before the diagnosis of bacteremia: two in the intrapartum bacteremia group and one in the postpartum group. There were no neonatal deaths. The clinical details of the first 58 cases have been previously published in a clinical review of maternal bacteremia [10].

Table 2
Characteristics of the study population.[a]

Characteristic	Bacteremia cases (n = 81)	Total obstetric population (n = 47 571)	*P* value
Age, y	30.0 ± 6.0	30.7 ± 5.6	0.122
Primigravida	30 (37.0)	19 552 (41.1)	0.523
Current smoker	3 (3.7)	7040 (14.8)	0.007
Unemployed	18 (22.2)	14 842 (31.2)	0.105
BMI	26.7 ± 5.5	25.6 ± 5.0	0.172
BMI >29.9	13 (16.0)	7992 (16.8)	0.862
Preterm delivery (<37 wk)	11 (13.6)	3092 (6.5)	0.018
Cesarean delivery	23 (28.4)	12 749 (26.8)	0.841

Abbreviation: BMI, body mass index (calculated as weight in kilograms divided by the square of height in meters).
[a] Values are given as number (percentage) or mean ± SD.

For the 61 women with bacteremia in the period before IMEWS introduction, the vital signs were recorded in different sections of the medical charts, which made a review of the trends in recorded vital signs challenging. Among the 61 cases, observations were recorded as a narrative in the clinical notes for 82.0% (n = 50), on observation charts for 39.3% (n = 24), on partograms for 41.0% (n = 25), and on local obstetric EWS charts for 19.7% (n = 12). Note that only laboring women admitted to the delivery suite were eligible to have partograms filled out during this period. In all 61 of the clinical records reviewed, the observations were recorded in more than one place; in particular, four women had recordings at different times in their narrative clinical notes, as well as on a partogram and on an adult observation chart. There was no standardization with regard to the frequency of the recordings, and often the four key parameters were not reported at the same time.

The triggers for medical review on the IMEWS chart were determined after retrospective application of IMEWS to the 61 cases of bacteremia before April 2013. Table 3 shows that women with bacteremia most frequently triggered on the basis of pyrexia (n = 49). Triggering of IMEWS for pyrexia of 38.0 °C or more was associated with a shorter trigger to intravenous antibiotic interval as compared with triggers for other parameters (81 minutes versus 282 minutes; $P < 0.001$). Regarding the time from IMEWS trigger to antibiotic administration, it should be noted that tachycardia, tachypnea, or hypotension might have been missed for the women for whom full sets of observations were not recorded regularly.

There were 20 cases of maternal bacteremia from April 1, 2013, to March 31, 2014, after the introduction of IMEWS. The triggers for medical review in these women are also shown in Table 3. Two women with no IMEWS trigger had blood cultures sent and received intravenous antibiotics on clinical grounds. As compared with the 61 cases prior to IMEWS introduction, there was a reduction in the interval

Table 1
Ranges of vital signs triggers on the IMEWS chart.

Vital signs	Normal	Yellow trigger[a]	Red trigger[b]
Heart rate, beats per min	60–99	≥100 or <60	≥120 or <50
Systolic blood pressure, mm Hg	100–139	≥140 or <100	≥160 or <90
Diastolic blood pressure, mm Hg	50–89	≥90 or <50	≥100 or <40
Temperature, °C	36.0–37.4	≥37.5 or <36.0	≥38.0 or <35.1
Respiratory rate, breaths per min	11–19	≥20	≥25 or ≤10

Abbreviation: IMEWS, Irish maternity early warning system.
[a] Two yellow triggers prompt a call for medical review in the IMEWS escalation guideline.
[b] One red trigger prompts a call for medical review in the IMEWS escalation guideline.

Table 3
IMEWS triggers for medical review in cases of maternal bacteremia.[a]

Trigger	Pre-IMEWS (n = 61)	Post-IMEWS (n = 20)
Temperature (hyperthermia)	49 (80.3)	13 (65.0)
Heart rate (tachycardia)	9 (14.8)	4 (20.0)
Blood pressure (hypotension)	1 (1.6)	3 (15.0)
Respiratory rate (tachypnea)	0	0

Abbreviation: IMEWS, Irish maternity early warning system.
[a] Four women with no IMEWS trigger had blood cultures and received intravenous antibiotics on clinical grounds. Some women had more than one trigger at the same time. Values are given as number (percentage).