Near-miss cases admitted to a maternal intensive care unit, Alexandria, Egypt

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دراسة للحالات التي شارفت على الوفاة وأُدخلت وحدة العناية المركزة للأمهات، الإسكندرية، مصر

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الخلاصة: تُعرف النجاة من مضاعفات الحمل الحادة باسم الحالات المشرفة على الوفاة؛ إلا أن الدراسات المتعلقة بالحالات المشرفة على الوفاة أثناء الحمل وحول الولادة قليلة العدد في إقليم شرق المتوسط. ولتحديد العوامل المعرِّضة وتشخيص الحالات المشرفة على الوفاة، تم تقييم المريضات اللاتي تم إدخالهن "وحدة العناية المركزة للأمهات" بمستشفى الشاطبي الجامعي في الإسكندرية بمصر. وأجري مسح استباقي تضمن مقابلات مع 448 حالة استوفت معايير منظمة الصحة العالمية المتعلقة بالمشرفة على الوفاة أثناء الحمل وحول الولادة وتم إدخالها "وحدة العناية المركزة للأمهات" بمستشفى الشاطبي خلال عام 2014 واستعراض سجلاتها ومتابعتها لتقييم نتائجها. وارتبط انخفاض مستوى تعليم الأمهات وعدم كفاية الرعاية في فترة ما قبل الولادة ارتباطاً ذا دلالة بمعدل وفيات الأمهات. وشكل تسمم الحمل الشديد والنزف التالي للوضع أكثر الأسباب شيوعاً لإدخال الأمهات لوحدة الرعاية المركزة (40.2 ٪ و23.8 ٪ على التوالي). وبلغ مؤشر الوفيات 8.5 ٪. وعُدّ انخفاض مستوى التعليم وعدم كفاية الرعاية في مرحلة ما قبل الولادة محددين مهمين لوفيات الأمهات. وشكّل التسمُّم وخلل الأعضاء المتعدِّد منبّئين مهمين لوفيات الأمهات.

ABSTRACT Survival of severe pregnancy complication is known as maternal near-miss; however, studies on maternal near-miss are few in the Eastern Mediterranean Region. To identify the predisposing factors and diagnoses of near-miss cases, patients admitted to the maternal intensive care unit of El-Shatby University Hospital in Alexandria, Egypt, were assessed. A prospective survey was conducted where 448 cases that fulfill the WHO criteria of near-miss and admitted to El Shatby maternal intensive care unit during 2014 were interviewed, their records were reviewed and were followed up to assess their outcome. Low maternal education and inadequate antenatal care were significantly associated with maternal mortality. Severe pre-eclampsia and post-partum hemorrhage were the most common causes of admission (40.2% and 23.8% respectively). Mortality index was 8.5%. Sepsis and multiple organ dysfunction were significant predictors of maternal mortality.

Étude des cas de décès évités de justesse admis en unité de soins maternels intensifs à Alexandrie (Égypte)

RÉSUMÉ Les études portant sur les cas de survie à des complications sévères de la grossesse, encore appelés « décès maternels évités de justesse », sont peu nombreuses dans la Région de la Méditerranée orientale. Pour identifier les facteurs et diagnostics prédisposants dans les cas de décès maternels évités de justesse, des patientes admises à l'unité de soins maternels intensifs de l'hôpital universitaire El-Shatby d'Alexandrie (Égypte) ont été examinées. Dans une enquête prospective portant sur 448 cas répondant aux critères OMS de décès évité de justesse et admis à l'unité de soins maternels intensifs de l'hôpital universitaire El-Shatby au cours de l'année 2014, les dossiers ont été examinés et les patientes ont été interrogées puis suivies afin d'évaluer l'évolution de leur état de santé. Le faible niveau d'éducation des mères et l'inadéquation des soins prénatals étaient associés de manière significative à la mortalité maternelle. La pré-éclampsie sévère et l'hémorragie du postpartum étaient les causes d'hospitalisation les plus fréquentes (40,2 % et 23,8 %, respectivement). L'indice de mortalité s'élevait à 8,5 %. La septicémie et les dysfonctionnements organiques multiples étaient des facteurs prédictifs significatifs de la mortalité maternelle.

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Introduction

Maternal death is defined by the World Health Organization (WHO) as "death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and the site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management, but not from accidental or incidental causes" (*1*). Maternal death is used for evaluation of health services' quality as well as the socioeconomic development of a population (*2*).

Globally, there were 289 000 maternal deaths in 2013 with more than 1 life lost every 2 minutes. In Egypt, about 860 Egyptian women died from complications related to pregnancy and childbirth in 2013 with a maternal mortality ratio of 45 maternal deaths per 100 000 live births and a lifetime risk of maternal death of 1 in 710 (*3*).

Despite these high national figures, the number of maternal deaths is low at the hospital level. This therefore does not allow for proper identification of the risk factors and the quality of care at the local level (*4*). In view of this, WHO proposed the evaluation of maternal near-misses, meaning "a woman who nearly died but survived a complication that occurred during pregnancy, childbirth or within 42 days of termination of pregnancy" (*1*).

WHO developed a definition of and identification criteria for maternal near-miss cases in 2009. This was followed by the "WHO near-miss approach for maternal health" in 2011 (*5,6*). According to WHO, the identification of maternal near-miss cases is based on 2 components:

- Identification of specific complications such as severe pre-eclampsia and/or critical interventions such as blood transfusion.
- Identification based on organ dysfunction criteria including clinical, laboratory and management-based criteria (*1*).

Few studies on maternal near-misses have been conducted in the Middle East and North Africa (*3,7*). The aim of this study was to identify the factors associated with maternal near misses and the diagnoses on admission to the intensive care unit (ICU) of a university hospital in Alexandria, Egypt, in relation to the outcome.

Methods

Study design and setting

A prospective study was carried out in the maternal ICU of El Shatby University Hospital in Alexandria, Egypt. The study was conducted over 1 year from 1 January to 31 December 2014.

Study participants

All women (448 women) admitted to the ICU in the study period were included.

Data collection

The women were interviewed to identify potential predisposing factors and causes of maternal near-miss. For severely ill women, one of their relatives (husband, mother or sister) was interviewed instead. Then, all recruited women were followed up to assess their outcome.

Data were collected using an interview questionnaire that enquired about: sociodemographic characteristics, medical history, past and current obstetric histories and antenatal care received. The admission and medical records of the women were also reviewed.

Data analysis

Data were analysed using *SPSS*, version 20. Data are presented as numbers and percentages for categorical variables and means and standard deviations (SD) for continuous variables (age of women, inter-pregnancy interval and length of stay in the ICU). For comparisons between died and survived women, the Student *t*-test was used for normally distributed quantitative variables and the Mann–Whitney test for non-normally distributed variables. For qualitative variables, the chi-squared, Fisher exact, and Monte Carlo tests were used.

Multiple logistic regression analysis was done to determine the predictors of maternal death. The independent variables tested were: maternal age, education, inter-pregnancy interval, presence of co-morbid condition/s, sepsis, pre-eclampsia, organ dysfunction, attending less than 4 antenatal care visits, delivery by caesarean section and postpartum haemorrhage. To avoid multi-colinearity, all independent variables were tested for inter-correlations before being included in the regression analysis. Significant correlation between maternal age and parity resulted in the exclusion of parity.

All results were interpreted at the 5% level of significance.

Ethical considerations

Official approvals for the study were obtained from Ethical Committee of the Faculty of Medicine, University of Alexandria, the head of the maternal ICU and the Director of El Shatby University Hospital in Alexandria.

The objectives of the study and types of information to be obtained were explained to the women (or their husband, mother or sister) and their informed consent was taken. Confidentiality of data was assured.

Results

Of the 448 women admitted to the ICU and included in the study, 410 survived and 38 died.

Table 1 shows the sociodemographic characteristics of the women. Their ages ranged from 16 to 40 years with a mean age of 27.17 (SD 5.42) years. The mean age of the women who survived was 27.09 (SD 5.34) years

compared with 27.45 (SD 6.04) years among the women who died ($P > 0.05$).

There was a statistically significant relation between education level and outcome: 9.4% of uneducated women and 11.8% of those with basic education died compared with 1.7% of the women with secondary or higher education ($P = 0.006$). Occupation of the husband was also significantly associated with death: 23.5% of the women whose husbands were not working and 12.4% of those married to manual workers died compared with 5.3% of those married to professionals and 5.4% of those married to skilled workers ($P = 0.01$).

The medical history of the women is shown in Table 2. One quarter of the women (25.2%) had 1 or more chronic disease, with heart disease being the most common; of those with a chronic disease, 47.8% had a heart condition, 18.6% had hypertension and 15.9% had diabetes mellitus. Death among women with chronic diseases was not significantly different from those without a chronic disease; 8.0% and 8.7% died respectively ($P = 0.85$).

Table 3 shows the obstetric history of the women according to outcome. More than half (54.5%) of the parous women had a history of caesarean section. Of these, 8% died compared with 16.5% of those who had not had a previous caesarean section and this difference was statistically significant ($P = 0.036$).

The interval between current pregnancy and the preceding delivery ranged from 3 to 192 months with a mean of 33.8 (SD 25.1) months. The mean current inter-pregnancy interval for surviving women was significantly longer than that of the women who died (34.8 and 26.6 months respectively) ($P = 0.026$). More than a quarter (27.6%) of the women with an inter-pregnancy interval of less than 1 year died compared with 10.5% of those with an interval of 1–4 years and 7.5% of those with an interval of 5 years or more ($P = 0.017$).

With regard to antenatal care, 16.5% of the studied women did not receive antenatal care during their current pregnancy while 32.1% had had 1–4 visits and 51.3% had had 4 visits or more. More than a third (35.1%) of the women who did not have any antenatal care died compared with 5.6% and 1.7% respectively of those who had had 1–4 visits and 4 visits or more (Table 3). These differences were statistically significant ($P < 0.001$).

The admission data of the women are shown in Table 4. On admission to the maternal ICU, 40.8% of the women had severe pre-eclampsia or eclampsia and 23.2% had severe postpartum haemorrhage. On comparing the women's admission diagnoses and outcome, 77.8% of the women admitted with sepsis died compared with 3.8% of those admitted with either severe postpartum haemorrhage or severe pre-eclampsia/eclampsia ($P < 0.001$). The mean length of stay in the maternal ICU was 3.07 (SD 3.33) days. The mean

Table 1 Distribution of the studied women according to their sociodemographic characteristics and outcome

Sociodemographic characteristic	Survived ($n = 410$)		Died ($n = 38$)		Total ($n = 448$)		*P*-value
	No.	%	No.	%	No.	%	
Age (years)							
Mean (SD)	27.09 (5.34)		27.45 (6.04)		27.17 (5.42)		0.69[1]
Range	16–40		16–39		16–40		
Level of education							
Illiterate/read and write	115	90.6	12	9.4	127	100.0	0.006[2]
Primary/preparatory	179	88.2	24	11.8	203	100.0	
Secondary/higher	116	98.3	2	1.7	118	100.0	
Working status							
Working	28	96.6	1	3.4	29	100.0	0.49[3]
Not working	382	91.2	37	8.8	419	100.0	
Husband's occupation							
Manual worker	134	87.6	19	12.4	153	100.0	0.01[4]
Skilled worker	191	94.6	11	5.4	202	100.0	
Professional	72	94.7	4	5.3	76	100.0	
Not working	13	76.5	4	23.5	17	100.0	
Wanted pregnancy							
Yes	375	91.0	37	9.0	412	100.0	0.35[3]
No	35	97.2	1	2.8	36	100.0	

[1]*t = –0.39;* [2]*Chi-squared = 10.07;* [3]*Fisher exact test;* [4]*Monte Carlo test.*
SD = standard deviation.

Table 2 Distribution of the studied women according to their medical history and outcome

Medical history	Survived (*n* = 410)		Died (*n* = 38)		Total (*n* = 448)		*P*-value
	No.	%	No.	%	No.	%	
Yes	104	92.0	9	8.0	113	100.0	0.85[2]
Diabetes mellitus	17	16.3	1	11.1	18	15.9	
Hypertension	19	18.3	2	22.2	21	18.6	
Heart disease	53	51.0	1	11.1	54	47.8	
Other diseases[1]	32	30.8	5	55.6	37	32.7	
No	306	91.3	29	8.7	335	100.0	

[1]*Others include liver diseases, renal diseases, bronchial asthma, thyroid diseases, systemic lupus erythematosus, chronic cholecystitis, epilepsy, deep vein thrombosis, leukaemia and HIV.*
[2]*Chi-squared = 0.052.*

length of stay of the surviving women was significantly shorter than that of the women who died ($P < 0.001$). More than half (57.4%) of women were admitted to the maternal ICU after delivery while the rest were still pregnant on admission. Mortality was significantly higher among the women admitted to the maternal ICU after delivery ($P = 0.034$).

Regarding organ dysfunction, cardiovascular dysfunction was the most common organ dysfunction among the women (48.9%) followed by coagulation/haematological and hepatic

Table 3 Distribution of the studied women according to their obstetric history and outcome

Variable	Survived (*n* = 410)		Died (*n* = 38)		Total (*n* = 448)		*P*-value
	No.	%	No.	%	No.	%	
Gravidity							
Primigravid[a]	149	94.9	8	5.1	157	100.0	0.06[2]
2–4	199	88.4	26	11.6	225	100.0	
≥ 5	62	93.9	4	6.1	66	100.0	
Parity							
Nullipara	184	94.4	11	5.6	195	100.0	0.09[3]
1–4	194	87.8	27	12.2	221	100.0	
≥ 5	32	100.0	0	0.0	32	100.0	
Current inter-pregnancy interval (months)							
< 12	21	72.4	8	27.6	29	100.0	0.017[4]
12–59	153	89.5	18	10.5	171	100.0	
≥ 60	49	92.5	4	7.5	53	100.0	
Mean (SD)	34.8 (25.7)		26.6 (23.0)		33.8 (25.1)		0.026[5]
Range	6–192		3–108		3–192		
Previous caesarean delivery							
Yes	127	92.0	11	8.0	138	100.0	0.036[6]
No	96	83.5	19	16.5	115	100.0	
Type of current delivery[1]							
Vaginal delivery	51	89.5	6	10.5	57	100.0	0.61[3]
Caesarean section	287	91.7	26	8.3	313	100.0	
Number of antenatal care visits							
None	48	64.9	26	35.1	74	100.0	< 0.001[7]
< 4	136	94.4	8	5.6	144	100.0	
≥ 4	226	98.3	4	1.7	230	100.0	

[1]*Cases of abortion (n = 78) were excluded.*
[2]*Chi-squared = 5.56;* [3]*Fisher exact test;* [4]*chi-squared = 8.09;* [5]*Mann–Whitney Z = –2.22;* [6]*chi-squared = 4.39;* [7]*chi-squared = 82.78.*
SD = standard deviation.

Table 4 Distribution of the studied women according to admission data and outcome

Admission data	Survived (*n* = 410)		Died (*n* = 38)		Total (*n* = 448)		*P*-value
	No.	%	No.	%	No.	%	
Admission diagnosis							< 0.001[2]
Severe pre-eclampsia/eclampsia	176	96.2	7	3.8	183	40.8	
Severe postpartum haemorrhage	100	96.2	4	3.8	104	23.2	
Severe systemic infection or sepsis	4	22.2	14	77.8	18	4.0	
Ruptured uterus	9	81.8	2	18.2	11	2.5	
Other diagnoses[1]	121	91.7	11	8.3	132	29.5	
Length of stay in ICU (days)							< 0.001[3]
Mean (SD)		2.56 (1.7)		8.71 (8.21)		3.07 (3.33)	
Range		1–14		1–34		1–34	
Pregnancy state on admission							0.034[4]
Pregnant	181	94.8	10	5.2	191	42.6	
Delivered	229	89.1	28	10.9	257	57.4	

[1]Other diagnoses include heart diseases with pregnancy, acute fatty liver of pregnancy, respiratory complications, antepartum haemorrhage, ectopic pregnancy, complications of abortion, vesicular mole, systemic lupus erythematosus, diabetic ketoacidosis and deep vein thrombosis.
[2]Chi-squared = 120; 3Mann-Whitney Z = -4.61; 4Monte Carlo test.
ICU = intensive care unit, SD = standard deviation.

dysfunction, which were found in 23.4% and 22.1% of the women respectively. Table 5 shows that 32.4% of the women had multiple organ dysfunction. Of these, 17.9% died compared with only 5.2% and 3.5% of those without or with single organ dysfunction respectively ($P < 0.001$).

The total number of deliveries in El Shatby Hospital in 2014 was 11 982 (5 678 vaginal and 6 304 caesarean deliveries). These data were used to calculate the maternal near-miss indicators as shows in Box 1.

Results of the multiple logistic regression analysis showed that the significant predictors of maternal mortality were sepsis (OR = 32.6, 95% CI: 8.73–51.77, $P < 0.001$) and multiple organ dysfunction (OR = 3.94, 95% CI: 1.39–11.08, $P = 0.009$) (Table 6). Women admitted with severe pre-eclampsia were significantly less likely to die than those who did not have pre-eclampsia or had mild pre-eclampsia and were admitted with other diagnoses (OR = 0.14, 95% CI: 0.02–0.83, $P = 0.030$).

Discussion

Our study included women admitted to El-Shatby maternal ICU during 2014 and compared the women who survived (410 women) with those who died (38 women). The mean age of the women was about 27 years. This almost coincides with the mean age of childbearing in Egypt (27.8 years) and in the Middle East region as recorded by the United Nations in 2011 (*8*).

We found a significant association between women's level of education and husband's occupation and maternal death. This relation between low socioeconomic status and mortality may be explained by a lack of proper health awareness and inability to perceive threatening signs and symptoms and consequently longer delays in deciding to seek and reach care (*9*).

A quarter of the women in our study had one or more chronic disease. This is similar to a study in Saudi Arabia in 2011 where 16% of obstetric admissions to the ICU had underlying diseases (*10*). Heart diseases were the most prevalent chronic disease representing 47.8% of the co-morbid conditions. This result is consistent with a Brazilian study in 2012 in which cardiovascular diseases were the most common non-obstetric cause

Box 1.

$$\text{ICU admission rate in 2014} = \frac{\text{Cases admitted to ICU}}{\text{Total number of deliveries}} \times 100\,00 = 3\,739/100\,000 \text{ deliveries or nearly } 4\%$$

Maternal near-miss mortality ratio = maternal near-miss cases:maternal deaths = 10.8:1

$$\text{Mortality index} = \frac{\text{Maternal deaths}}{(\text{Maternal near-miss cases} + \text{Maternal deaths})} \times 100\,00 = 8.5\%$$

of ICU admission of pregnant women (*11*). In studies on women giving birth in El-Shatby Hospital in 2009 and 2015, cardiovascular diseases were present in 8.2% and 3.1% respectively (*12,13*). This reflects the importance of heart disease as a risk factor for ICU admission.

The mean interval between current pregnancy and the preceding delivery was significantly shorter among the women who died in our study. These results are in agreement with a review in the United States of America (USA) in 2012 (*14*). This may be explained by maternal depletion hypothesis which suggests that women who become pregnant after a short interval are susceptible to poor nutrition, greater exposure to disease and other physical and emotional stress resulting from negative energy balance and/or micronutrient deficiencies from the burden of frequent reproductive cycles (*15,16*).

More than half (54.5%) of the parous women had had a previous caesarean section. Similarly, a study in Baghdad in 2013 reported a history of previous caesarean section among 44.5% of near-miss women (*17*). We found a statistically significant association between having a previous caesarean section and survival. This finding was consistent with the results of the WHO's 2005 global survey on maternal and perinatal health (*18*). This could be explained by more compliance of women with previous caesarean section with attending antenatal visits and close monitoring by the medical practitioners for co-morbid conditions. Furthermore, regarding the current delivery in our study, a lower percentage of the women who underwent a caesarean section died (8.3%) compared with those who delivered vaginally (10.5%). However, this difference was not statistically significant. Nonetheless, it is important to remember that in situations found in the present study, a caesarean section may be interpreted either as a solution for cases of morbidity or as a determining factor of morbidity (*19*).

The present study found a statistically significant association between attending antenatal care and survival; 35.1% of the women who did not have any antenatal care visits during their pregnancy died compared with only 5.6% of those who had 1–4 visits and 1.7% of those who had 4 visits or more. Other studies confirm that antenatal care is an important and modifiable factor in maternal mortality and showed antenatal care was significantly less frequent among women who died (*10,20,21*).

In our study, the most common diagnoses for admission to the maternal ICU were severe pre-eclampsia or eclampsia followed by severe postpartum haemorrhage. Together, they were the reasons for admission for 64% of the women. This finding is consistent with earlier studies (*22–25*). The high incidence of hypertensive disorders of pregnancy in the studied women may be due to poor dietary habits, lack of exercise and more stressful conditions in pregnancy. Moreover, these results expose a weakness in early detection of pre-eclampsia; possibly due to poor antenatal care and follow-up.

The disease profile for near-miss morbidity in our study differed from that of maternal mortality. While the most common types of near-miss cases were due to severe hypertensive disorders or severe haemorrhage, their mortality indexes were only 3.8% each. At the same time, while sepsis was an uncommon cause of near-miss (4%), it had a significantly higher mortality index of 77.8% reflecting a significant threat to the survival of affected women. These results are in agreement with previous studies. A study in the Syrian Arab Republic in 2010 reported mortality indexes of 0.4% and 2.8% for severe hypertensive disorders and severe haemorrhage respectively while sepsis showed a relatively high mortality index of 7.4% (*7*). Similarly, a study in Sudan in 2011 found that despite the high morbidity from haemorrhage and hypertensive disorders (40.8% and 18% respectively), their mortality indexes were lower than that of sepsis (10% and 8.8% respectively compared with 22.2% for sepsis) (*26*). The significantly lower mortality from haemorrhage and pre-eclampsia/eclampsia in the present study may be attributed to effective management upon arrival at the hospital by appropriate interventions within an adequate timeframe, such as the availability of blood bank services, timely interruption of the pregnancy or the proper use of magnesium sulfate for the prevention of eclampsia in women with severe pre-eclampsia and for the treatment of women with eclampsia, as recommended by WHO (*1*).

The mean length of stay of women in the ICU was about 3 days which concurs with findings of previous studies (*7,19,23*). Moreover, the mean length of stay for the surviving women was significantly shorter than that of the women who died. The need for interventions to manage severely ill patients can explain the longer period of hospitalization.

As regards the pregnancy state on ICU admission, 57.4% of studied women were admitted after delivery. This is consistent with previous studies. A study in India in 2011 reported that 83.3% of the patients were admitted in the postpartum period (*25*). In a study in Brazil in 2012, the majority of women (87.3%) were admitted to the ICU following delivery (*19*). Our study showed a statistically significant association between the pregnancy state on ICU admission and outcome: 10.9% of the women admitted after delivery died compared with only 5.2% of those admitted during pregnancy. These results are in agreement with studies in India and Tanzania (2013) (*27,28*). These results may be due to the higher incidence of sepsis in the postpartum period following surgical caesarean delivery or as a complication of postpartum haemorrhage.

Table 5 Distribution of the studied women according to organ dysfunction and outcome

Organ dysfunction	Survived (n = 410)		Died (n = 38)		Total (n = 448)		P-value
	No.	%	No.	%	No.	%	
None	73	94.8	4	5.2	77	17.2	
Single	218	96.5	8	3.5	226	50.4	< 0.001[1]
Multiple	119	82.1	26	17.9	145	32.4	

[1]*Chi-squared = 24.86.*

Half of the women in our study had a single organ dysfunction and about a third had multiple organ dysfunction. Near-misses with organ failure represent the most severe forms of maternal morbidity because they face the highest risk of death and they only survive because of the quality of maternal care they receive. However, using only organ dysfunction as the identification criteria for near-misses may lead to an underestimation of the true burden of near-misses. A systematic review of the prevalence of maternal near-misses in 2012 showed that the prevalence of near-misses was much lower when the identification criteria was based on organ dysfunction (*4*). Furthermore, the progression from organ failure to death may be very fast. Therefore, a disease-based approach might be most suitable for identification of near-miss cases in low-resource settings that have higher burdens of maternal ill-health and mortality (*29*).

Based on our results, we calculated maternal near-miss indicators which reflect the overall standard of obstetric care. The maternal near-miss mortality ratio was 10.8:1 and the mortality index was 8.5%. These indicators are similar to those reported in studies in Tanzania and Malawi where the range was 5–12:1 (*28,30*). On the other hand, very high ratios of 117–223:1 were reported in studies from Western Europe which used similar case definition criteria (*22,31*). This difference may be attributed to the difference in standards of care or the severity of admitted cases. It is important to note that improvements in standards of care will be associated with an increase in the maternal near-miss mortality ratio. So, yearly estimation of this ratio in the study setting can be used to monitor the effects of changes in standards of care carried out and direct improvement plans.

Our study has some limitations. It was difficult to involve a larger number of cases in the study due to limited capacity of the unit (only 5 beds) and decreased turnover of cases as some women occupied their bed for long time. In addition, the time needed to complete the questionnaire was relatively long for severe and exhausted cases. The questionnaire was completed on several visits depending on the woman's condition; if a woman was too ill to be interviewed, her relatives were interviewed instead.

Conclusion

The results of our study show that low level of education, short inter-pregnancy interval and inadequate antenatal care are important determinants of maternal

Table 6 Predictors of maternal mortality: results of multivariate logistic regression analysis

Variable	B	*P*-value	OR	95% CI
Age	0.025	0.729	1.03	0.89–1.18
Low level of education	0.361	0.397	1.44	0.26–7.99
Short inter-pregnancy interval	–	0.303	0.98	0.95–1.02
Presence of co-morbid condition/s	-0.603	0.397	0.55	0.14–2.21
Postpartum haemorrhage	–	0.746	0.75	0.13–4.24
Severe pre-eclampsia	–	0.030*	0.14	0.02–0.83
Sepsis	3.480	< 0.001*	32.61	8.73–121.77
Attending < 4 antenatal visits	0.182	0.843	0.83	0.19–4.03
Delivery by caesarean section	–	0.851	0.84	0.14–5.02
Multiple organ dysfunction	1.370	0.009*	3.94	1.39–11.08
Model chi-squared (*P*)		72.295 (< 0.001*)		
Constant (*P*)		91.404 (0.007*)		

**Statistically significant at P ≤ 0.05.*
B = regression coefficient, OR = odds ratio, CI = confidence intervals.

mortality. The commonest diagnoses for admission to the maternal ICU were severe pre-eclampsia, eclampsia and severe postpartum haemorrhage. However, the risk of maternal death was highest for women with sepsis, although admission with sepsis was infrequent.

The majority of women admitted to the maternal ICU improved when they left the ICU. The maternal near-miss mortality ratio was 10.8:1 and mortality index 8.5%.

It is recommended that the WHO approach to maternal near-misses using WHO criteria for maternal near-miss be applied in the Egyptian national health system to evaluate and improve the quality of care provided during pregnancy and delivery. Training of health care providers on the use of maternal near-miss criteria and indicators in the management of cases and the use of referral criteria is needed. Studies on maternal near-misses in other maternal ICUs in other governorates would be useful to provide a further data.

The association between low level of education, short inter-pregnancy interval and inadequate antenatal care and the risk of death highlights the need to provide population-wide preconception and antenatal education about reproductive health and family planning.

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