Title: Maternal mortality is preventable in Lebanon: a case-series of maternal deaths to identify lessons learnt using the three delays model

Short title: Preventable maternal deaths in Lebanon

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Synopsis: Maternal mortality in Lebanon can be prevented by improving referral practices between healthcare facilities, ensuring essential medicines and blood products are available, and prompt recognition of clinical deterioration.

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Abstract

Objective: To identify the lessons learnt from maternal mortality cases in Lebanon during 2018-2020. *Method:* This is a case-series and synthesis of maternal deaths between 2018 and 2020 that were reported by healthcare facilities to the Lebanese Ministry of Public Health. The notes recorded from the medical records were analyzed using the three-delay model to identify preventable causes and lessons learnt. *Results*: 49 women died before, during, or after childbirth with hemorrhage being the most frequent cause (n=16). The major preventable factors included a prompt recognition of clinical severity, availability of blood for transfusion and magnesium sulphate for eclampsia, adequate transfer to tertiary care hospitals comprising specialist's care, and involvement of skilled medical staff in obstetric emergencies. *Conclusion:* Many maternal deaths in Lebanon are preventable. Better risk assessment, use of an obstetric warning system, access to adequately skilled human resources and medications, and improving communication and transfer mechanisms between private and tertiary care hospitals may avoid maternal deaths.

Introduction

Reducing maternal mortality remains a global priority as the majority of maternal deaths are avoidable. Maternal deaths occur when the care provided is "too little, too late" or "'too much too soon" (p.2176) (2) and can be attributed to multiple factors , including poorly performing health systems, lack of referral systems for high-risk pregnancies, lack of resources, medication or equipment, or lack of skilled health professionals to provide the appropriate level of care (2, 3). In addition, lack of evidence-based guidelines, non-adherence to guidelines, limited clinical skills or experience, or contextualization of guidelines can prevent high-quality care from being delivered to women during pregnancy (2, 4).

Maternal mortality was reduced globally by 38% from 2000 to 2017 (4). The United Nations Sustainable Development Goal (SDG 3.1) aims to decrease maternal mortality to less "than 70 maternal deaths per 100 000 live births" (5). The burden of maternal mortality is highly distributed among vulnerable populations, such as those who face gender and ethnic discrimination, financial problems or humanitarian crises (6). However, maternal death remains preventable in most of these scenarios. Maternal mortality reviews are a fundamental tool to improve the quality of care, identify key lessons learnt and provide opportunities to improve clinical practice (7-9).

Lebanon hosts Syrian and Palestinian refugees and migrant domestic workers of several nationalities, including an estimated ~1 million Syrian refugees, ~200,000 Palestinian refugees, and more than 250,000 migrant workers (10, 11). These vulnerable populations have access to maternity care in public hospitals and primary

health care services funded by United Nations agencies and non-governmental organizations, yet they face many restrictions and barriers.

In addition, Lebanon does not have a unified system for electronic health records, which is problematic in a healthcare system where women receive maternity care from multiple providers during pregnancy. Furthermore, in the context of a high cesarean section rate of 45 % in Lebanon, women may be transferred between healthcare facilities during childbirth, which emphasizes the requirement for clinical data to be available between health care facilities (12).

Lebanon had a low maternal mortality ratio (MMR: 14.9) between 2010 to 2018 despite the high numbers of births related to the large population of Syrian refugees (13). In Lebanon, where the vast majority of births are in hospitals, it is mandatory to report maternal deaths; however, the MMR may be underestimated as there is no internal function to enforce reporting, and there is no centralized national electronic health record. The high numbers of refugees, the political and economic crises, the COVID-19 pandemic, and discrimination faced by many communities, may have affected the factors leading to maternal deaths. In addition, these contextual issues may have also affected reporting of maternal deaths as some women, due to the increased cost of deliveries, are not fully compensated by the United Nations High Commissioner for Refugees and may not be able to access care. This study aimed to identify the lessons learnt from maternal deaths in Lebanon, including delays in accessing care and the quality of care received, in addition, we detail recommendations based on the findings.

Materials and methods

Study design, study population and sampling

This was a case-series and synthesis of maternal deaths from Lebanon between 2018 and 2020. Maternal deaths were defined using the World Health Organization definition: "the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from unintentional or incidental causes" (p.8)(4). The case series included all available and reported maternal deaths in Lebanon during 2018-2020.

Data source for maternal mortality in Lebanon

Maternal deaths are reported through the maternal death surveillance system established by the Lebanese Ministry of Public Health (MOPH) (13). Public and private hospitals' staff are legally required to inform the Primary Care Department of the MOPH about all maternal deaths through an online-based charting system every month. Maternity care in Lebanon is provided by obstetricians and/or midwives depending on the type of health facility and antenatal care is provided by obstetricians in private clinics or outpatient departments. Every case is reported to the MOPH via a focal point in the specific hospital or region, then it is investigated by an obstetrician, who would be a member of the expert group, through interviews with the medical team and hospital management, and extensive review of medical records. The expert physician completed a data collection form using the medical records and interviews with those who provided medical care to the women. The data collection form includes the agreed cause of

death, secondary factors, and a narrative description of the events that lead to death (See supplementary material 1). The reported cases are then discussed within the national committee on safe motherhood for feedback and recommendation. This report is presented every year to the maternal mortality committee and stored at the MOPH Statistics Department (13).

Data synthesis

The maternal mortality review committee classifies the cause of every reported maternal death. All maternal mortality review notes were examined for preventable factors, including delays and barriers in obtaining care, and the quality of care given using the three-delays model and our developed conceptual framework presented in figure 1 (14, 15). Figure 1 was adapted from a clinical pathway of major obstetric hemorrhage and represents our consensus of the clinical pathway for maternal death (16). For each maternal death, we built a timeline, identified risk factors and preventable factors based on the three types of delays through review of the report from the maternal mortality committee. Extracted factors were grouped into three types including phase 1 "delay to seek medical care", phase 2 "delay to reach the hospital", and phase 3 "delay to receive appropriate care at the hospital" (15). The conceptual framework and three delays model provided a lens in which to conduct a narrative synthesis across all maternal mortality cases notes to identify lessons learnt. Aligned with the findings, important messages to improve maternal health care outcomes in Lebanon were identified and extracted from our review, while referring to international recommendations and previous maternal mortality reviews (8, 14, 17-26).

Ethical approval: We received an exemption from requiring Institutional Review Board approval from the American University of Beirut. The medical records were anonymized before data were analyzed.

Figure 1. Conceptual framework for the analysis of maternal mortality

Results

During 2018-2020, a total of 49 maternal deaths were reported to the MOPH during a period of 349,932 live births (27). The causes of death are presented in Table 1. The main causes of maternal death were postpartum hemorrhage (PPH) n=16 (33%) followed by infections n=10 (20%), hypertensive disorders of pregnancy n=4 (8%), pulmonary embolism n=4 (8%), amniotic fluid embolism n=4 (8%), epilepsy n=2 (4%), and other causes n=5 (10%). Four maternal deaths had an unknown cause of death n = 4 (8%).

Women who died between 2018 and 2020 were Syrian n=26 (53%), Lebanese n=20 (41%) and had other nationalities (Ethiopian n=1 (2%), Bangladesh n=1 (2%), or Palestinian n=1 (2%)).

All 49 women who died were between 17 to 47 years old, with a mean age of 31.6 at a median gestational age of 32 weeks. Most women who died had a median gravida of three and a median parity of two. Of all 49 women who died, 14 gave birth by cesarean section (29%), 10 had a normal vaginal delivery (20%), 1 had an instrumental vaginal birth (2%) and 1 woman had a septic abortion (2%). Twenty-three women had an undocumented mode of birth (47%). Out of the 49 maternal mortality notifications to the MOPH, this analysis was based on 22 detailed case notes.

Figure 2. Flow diagram of causes for all women who had maternal mortality notified to

MOPH between 2018-2020

Table 1. Specific causes of delays using the three delays model for maternal deaths in Lebanon during 2018-2020

Phase 1 delay: to seek medical help	Phase 2 delay: to reach a healthcare facility	Phase 3 delay: to receive adequate care in the healthcare facility
1. Limited awareness and knowledge among women about symptoms: hypertensive disorders of pregnancy, epileptic status, anemia, status asthmaticus. 2. Unawareness among women, partners, and families of the high-risk pregnancy due to no or limited antenatal care attendance. 3. Lack of health insurance and finances to cover antenatal care. 4. Fear of stigmatization and deportation among undocumented Syrian refugees. 5. Delay in women seeking help despite worsening symptoms.	1. Lack of awareness of deterioration of clinical situation requiring a higher level of care. 2. No formal referral mechanism between health facilities in Lebanon. 3. Delay in transferring women to a higher care facility after progression of symptoms. 4. No transfer of hemorrhaging women in an ambulance equipped for trauma care. 5. Lack of health insurance resulting in not being admitted to a healthcare facility.	1. Delay in recognizing the severity of the clinical situation. 2. Lack of situational awareness of the deterioration of the women's stability. 3. Incomplete medical history taking. 4. Incorrect diagnosis of the cause of haemorrhage or obstetric emergency. 5. Lack of equipment and medications for obstetric emergencies, e.g., $MgSO_4$ or antihypertensives. 6. No obstetric warning system. 7. No blood transfusion due to unavailability of blood products. 8. No available anesthetists. 9. No available intensive care unit (ICU)-trained staff.
Other relevant factors that contributed to maternal deaths in Lebanon		
Health system: There is no centralization and unified access of antenatal care medical notes in Lebanon. **Lack of continuity of care:** Lack of communication and direct follow-up between primary health care/private clinic and referral center. **Antenatal care uptake:** Incomplete or lack of antenatal care uptake, delayed booking of antenatal care visits.		

Table 2. Key themes of factors by cause of death that led to maternal deaths in Lebanon during 2018-2020

Postpartum haemorrhage	1. Lack of health insurance. 2. Did not attend antenatal care or had limited uptake of antenatal care. 3. Knowledge of symptoms: the woman was unaware of worsening symptoms and delayed seeking healthcare. 4. Delay in reaching medical care. 5. Delayed recognition of severe hemorrhage. 6. Delay and late referral to a higher care facility. 7. No formal referral mechanism between health facilities and a lack of knowledge transfer between facilities. 8. Inadequate equipment and skilled medical personnel for transfer between healthcare facilities, i.e., ambulance lacked skilled staff, equipment, and medication for major obstetric emergencies and trauma. 9. The initial cause of PPH was not correctly identified. 10. High-risk pregnancies, e.g., placenta previa, high parity, were delivered in low risk centers without a skilled multidisciplinary team, medication, or blood transfusion. 11. Lack of equipment including blood components and other resuscitative resources in the hospital. 12. Lack of skilled medical staff with appropriate expertise in the level of complexity of care in a maternal collapse. 13. Delayed and limited communication between medical personnel, and unavailable consultants for obstetric emergencies.
Sepsis	1. Delay in transferring to a higher care facility after progression of symptoms. 2. Inadequate initial assessment. 3. Inability to find the source of infection and causes after cesarean section.
Hypertensive disorders	1. Lack of health insurance. 2. Did not attend antenatal care or had limited uptake of antenatal care. 3. Lack of blood pressure and urine measurements on admission, leading to unawareness of hypertension and pre-eclampsia. 4. The healthcare facility did not enact a pre-eclampsia protocol. 5. Lack of medication in these hospitals, including $MgSO_4$ and antihypertensives.
Amniotic Fluid Embolus	1. Inadequate resuscitative measures. 2. Lack of skilled and experienced medical and intensive care staff in prompt and effective responses to sudden maternal collapse.

Epilepsy	1. Limited knowledge of the woman about her epilepsy severity and severe anemic status. 2. Infrequent/inadequate antenatal care visits. 3. No clear communication between the neurology and obstetric teams.

Postpartum hemorrhage

Among the 16 women who died from PPH, the initial underlying cause of PPH was reported in each case note by the treating physicians as follows: uterine atony n=4 (25%), placental abruption n=3 (19%), uterine rupture n=2 (13%),placenta percreta n=1 (6%), placenta previa n=1 (6%), cervical laceration n=1 (6%), and other n=4 (25%). Women who died from PPH were more often multigravida (n=6 (38%) vs n=10 (63%) had unknown/undocumented parity), had Syrian nationality (n=13 (81%) vs n=3 (19%) were Lebanese), and had normal vaginal delivery (n=8 (50%) vs n=5 (31%) by cesarean section vs n=3 (19%) undocumented mode of delivery).

Deaths from PPH were mostly due to either a delay in getting to the healthcare facility (phase 2 delay) or delay in receiving adequate care in the healthcare facility (phase 3 delay). Two women arrived late to the hospital including one who had a uterine rupture. One woman was transferred after a delay to a higher level of healthcare facility without recognition and proper documentation of the severity of the bleed at the referring facility and no communication between these hospitals. One woman did not receive blood transfusion due to unavailable blood products, and another woman was inadequately resuscitated due to the absence of appropriate equipment, medications, and trained medical staff in obstetric emergencies. The remaining cases of maternal deaths that resulted from PPH were incompletely documented.

Recurring themes were the lack of awareness of the amount of blood loss and incomplete documentation of timing and amount of bleeding. The cause of PPH was often not discovered in a timely manner, and there was limited communication between health professionals, which prevented appropriate management of the PPH. Furthermore, the lack of availability of blood products, ICU equipment, medications, skilled clinical staff, and ambulances for transfer to higher care facilities contributed to the death of three women.

Sepsis and other infectious causes

Among women who died from infectious causes, five died of sepsis n=5 (50%), four of acute respiratory distress syndrome post-COVID-19 n=4 (40%), and one of malaria during pregnancy (10%) which she acquired outside Lebanon. This woman later came to Lebanon for further medical management. The type of malaria she acquired was unknown and not mentioned in her case notes. Of all 10 women who died from infections, 5 had avoidable risk factors (50%), 3 had none (30%), and 2 had unknown risk factors (20%).

The key themes in women who had infectious causes were inadequate initial assessment, delay in transferring women to a higher care facility after progression of symptoms, and an inadequate final diagnosis made in the higher care hospital. Type 1 delay: one woman with COVID-19 delayed seeking medical help when severe symptoms started and another woman with COVID-19 was transferred late to the ICU after symptoms progressed. One woman initially had a cerclage due to her previous history of recurrent pregnancy losses. She develops sepsis, after which the cerclage was removed. However, after removal of the cerclage, she refused hospitalization to

manage her sepsis (this could have been the result of lacking insurance or money for the costs of the hospitalization). A woman had severe malarial infection with multi-end-organ damage following a delay in seeking medical help in Lebanon as she migrated from abroad.

One woman died of septic shock as the initial diagnosis of sepsis was not considered. Two women died of acute respiratory distress syndrome as a complication of COVID-19. One woman died of sepsis two weeks post-cesarean section performed for failure to progress. It was unclear whether she received prophylactic antibiotics before cesarean section.

Hypertensive disorders

All 4 women who died from hypertensive disorders of pregnancy were diagnosed with eclampsia n=3 (75%) and preeclampsia n=1 (25%). Half of the women who died from hypertensive disorders were primiparas n=2 (50%) and delivered by cesarean section n=2 (50%).

The key themes identified were inadequate antenatal care attendance, no follow-up on blood pressure (BP) and urine measurements, lack of medications, women's unawareness of symptoms, and incomplete implementation of pre-eclampsia protocol to prevent eclamptic complications. It was unclear from the review notes whether these women had attended all antenatal visits, had prenatal or upon admission BP or urine checks, or received antihypertensive medications or magnesium sulphate. Limited or incomplete medical history taking may have also contributed to the limited information on attendance of antenatal care and adequate prenatal assessment.

Other causes of maternal deaths

One woman died of what was presumed to be amniotic fluid embolism and the contributing factors to maternal death were inadequate resuscitative measures and a delay in responding to the obstetric emergency. The diagnosis was established by the treating physicians with no histologic confirmation. One woman died from sudden unexpected death in epilepsy. She had limited attendance to antenatal care visits, and it was unclear whether she was managed by a neurologist or was compliant with her antiepileptic medications.

Table 3. Summary of selected maternal mortality case notes in Lebanon from 2018-2020

(1) Postpartum hemorrhage	A multigravida woman, at 34 weeks of gestation with placenta previa, was referred late from a private clinic to a tertiary care hospital where she arrived with severe hemorrhage. It was unclear if her antenatal care notes were communicated to tertiary care. She underwent cesarean section in the higher care facility where no blood products were available. After cesarean delivery, she was transferred to the ICU where her condition deteriorated. She developed hypovolemic shock and had a cardiac arrest.
(2) Postpartum hemorrhage	A multigravida woman had placental abruption followed by severe PPH and hypovolemic shock, after which she had a cardiac arrest. She was managed by a junior doctor and no intensive care medicine specialists were available. Barriers faced were no escalation of care to the level of a consultant, absence of physicians specialized in high-risk pregnancies,, and lack of lifesaving equipment and medications.
(3) Postpartum hemorrhage	A multigravida woman was initially delivered at a private clinic where she developed severe PPH. After staying in the clinic for several hours without any investigation for the cause of PPH, her clinical condition worsened. She was taken by her family to a public hospital without an ambulance. During her transfer, she had no access to lifesaving medication, fluids, or trained healthcare workers. Upon arrival at the emergency department, she had disseminated intravascular coagulation. Despite receiving packed red blood cells and fresh frozen plasma on arrival, she deteriorated rapidly.
(1) Infections	One woman died of sepsis two weeks post-cesarean section which was indicated due to failure to progress. She initially developed fever a few days after cesarean delivery. Wound inspection, blood and urine tests did not indicate infection. She was started on a broad-spectrum cephalosporin antibiotic and was readmitted two weeks postpartum with non-resolving fever. She was later transferred to the ICU with hypotension and metabolic acidosis. A chest x-ray and CT scans for her abdomen and pelvis were negative for a source of infection. Several hours later, she died from cardiopulmonary arrest.
(1) Hypertensive disorders	A primigravid woman was admitted to the hospital at 35 weeks of gestation for severe dyspnea and high BP. Her pregnancy was complicated by hypertension and proteinuria. She underwent a cesarean section after which she developed severe cardiac insufficiency and eclampsia. She was urgently transferred to the ICU where she died after a cardiac arrest. . She did not receive any antihypertensive medication or $MgSO_4$.

(2) Hypertensive disorders	A primigravid woman was admitted to the hospital at 35 weeks of gestation for high BP and visual problems. She received no antenatal care and delayed seeking medical help when her symptoms started. She was diagnosed with preeclampsia and underwent urgent cesarean section. She developed eclampsia due to severe uncontrolled hypertension and had a cardiac arrest. She did not receive any antihypertensive medication or $MgSO_4$.
Epilepsy	A woman with unknown parity had sudden unexpected death in epilepsy. She presented to the emergency department at 29 weeks of gestation due to discomfort. Fetal echography revealed an intrauterine fetal demise without placental or fluid changes. She suddenly lost consciousness, had bradycardia and generalized muscles contractions. Despite immediate resuscitation, she died of cardiopulmonary arrest.

From this review, there are several key messages and lessons identified. These learning messages are based on key components of suboptimal quality of care identified in our reviewed cases. Twenty-seven of the 49 women who died in Lebanon between 2018 and 2020 had absent data on potential risk factors resulting in their deaths. Among women with detailed available data, maternal death could have been prevented in 64% of women (14/22).

Discussion

Main findings

Discussion

In Lebanon during 2018-2020, PPH, infections, and hypertensive disorders were the most common causes of maternal death. This review identified numerous lessons learnt for clinical care and health system structuring. There were multiple preventable factors that contributed to maternal deaths in Lebanon, which included adequate receipt of antenatal care, communication between healthcare providers, understanding the underlying cause of clinical deterioration, managing high-risk pregnancies by multidisciplinary teams in equipped centers, removing barriers to receiving timely lifesaving care, blood products, and medications including magnesium sulphate. Death could have been prevented in almost two thirds of women in Lebanon during this time period.

Results in context

These findings are similar to previous confidential enquires where many of the maternal deaths were preventable by early recognition of clinical severity and the correct diagnosis, and by accessing appropriate and quality care (8, 20). Similar to our findings, obstetric hemorrhage was the primary cause of maternal mortality (23). Similar to other confidential enquiries, deaths from hemorrhage and sepsis were mostly preventable. They occurred due to delays in identifying the underlying cause, transfer of hemodynamically unstable women, limited communication between healthcare

providers and no escalation to more experienced colleagues who manage obstetric emergencies (8, 14, 20).

Recommendations at the health system level

By financing antenatal care for the population and making it more freely accessible, the health system can overcome the phase 1 delay and encourage women to seek timely medical attention. A national electronic health database across Lebanon would allow information and knowledge to be transferred between private clinics, primary and tertiary care centers with ease, thus facilitating communication and referral actions between these centers.

Delay in reaching the hospital can be avoided by establishing mechanisms that can secure transfers between low-risk and high-risk maternity centers. Providing fast and efficient transfers to higher care facilities that have operating rooms for lifesaving cesarean deliveries, anesthetic material, and blood products would ensure that appropriate care is provided in a timely manner We would recommend creating national guidelines to apply a unified obstetric warning system across the country for all medical centers. This would suggest that all healthcare facilities use a unified scoring tool that would be recorded in electronic medical charts. This warning system would score the risk of clinical deterioration and would prompt faster and adequate management and referrals (26). In addition, refusing the provision of medical care for obstetric emergencies must be made illegal and upheld by the judicial system in Lebanon.

Recommendations at the patient level

Women must recognize the importance of consistent antenatal care follow-up visits, how to identify symptoms that require medical investigation and be aware of their pregnancy risk assessment. In the context of Lebanon, it may also be recommended that women carry their medical records on a portable device so information can be shared through each facility she visits. Women living in rural areas may have limited mobility and transportation which would reduce their ability to access hospitals. This phase 2 delay could be addressed by implementing an internal system for easy and accessible transfers between hospitals. These transfers would follow detailed protocols on the management of life-threatening obstetric emergencies before reaching the health facility.

Cause-specific recommendations

Recommendations for the management of postpartum hemorrhage

If a woman has severe PPH outside the hospital or in a setting other than the delivery unit, immediate transfer to a higher care facility must be done to provide adequate resuscitation, medications, and blood products. Prompt recognition of the cause of hemorrhage is essential for faster transfer and appropriate delivery of care, whether medical or surgical management. We would strongly suggest developing national guidelines that require every hospital in the country to follow detailed major obstetric hemorrhage protocols, thus, being a step closer to resolving phase 3 delay. Due to the high usage of cesarean section in Lebanon, any woman with previous cesarean section or history of placenta accreta should be treated as high risk for placenta accreta spectrum (18). Women with a previously established risk factor for PPH such as

placenta accreta or percreta should be planned for cesarean delivery and hysterectomy in referral centers designated by the MOPH (18).

Recommendations for the management of sepsis and infection

To manage septic women, it is advised to quickly identify the signs and symptoms of sepsis, immediately transfer to higher care facilities, start antibiotics early, and consult a high-risk specialized obstetrician and an infectious disease specialist (8). With the ongoing COVID-19 pandemic, it is highly recommended that all physicians encourage pregnant women to have their COVID-19 and influenza vaccinations to prevent COVID-19 and influenza related deaths (21).

Recommendations for the management of hypertensive disorders

Consistent antenatal care uptake should be emphasized to all women to all prompt recognition of hypertensive disorders and risk of escalation to preeclampsia (22). Antepartum monitoring includes baseline BP measurements and urine assessment for proteinuria, followed by regular BP observations, frequent fetal ultrasounds, blood and urine tests (24). The phase 1 delay can be limited through medical education so that women have a good knowledge of their condition, the risks of having uncontrolled BP and can recognize alarming symptoms, including severe headache, abdominal pain, or blurry vision. These actions would prompt women to seek immediate medical help and potentially overcome any delay. In Lebanon, every maternity center must have access to a supply of antihypertensive medications and magnesium sulphate to prevent deaths related to preeclampsia.

Recommendations for the management of epilepsy

Women with epilepsy should be followed up with a neurologist and high-risk pregnancy specialist at the start of the pregnancy (19). In addition, they require to have frequent access to antenatal care, assessment for compliance to antiepileptic drugs, and assessment for predictors of seizures including stress and insomnia (8, 19, 28). Information about the risks of noncompliance with antiepileptic drugs should be communicated with the women (19). If a woman with epilepsy is assessed to be at high risk of developing a seizure at the time of delivery, she requires to have a planned delivery in a higher care facility under the care of a multidisciplinary team, including neonatologists (19).

Recommendations for the management of cardiac arrest

Some aspects of cardiovascular life support are altered in obstetric cardiac arrest and should be considered by the clinical team (17). After 20 weeks of gestation, the inferior vena cava and abdominal aorta may be compressed by the gravid uterus (17). To increase the chance of successful resuscitation, the gravid uterus can be moved to the left side to relieve the compression on the aorta and vena cava (17, 25). If this maneuver fails and the woman is not responding, a perimortem cesarean delivery is advised to increase the chances of a successful cardiac resuscitation (17).

Limitations

Our study was limited as some of the case notes lacked missing data regarding the medical history, antenatal care, and details about the management in some cases. Furthermore, it is possible that important details about the events that led to the

maternal death were not identified due to missing data. We recommend that the MOPH implements an electronic data collection system to capture standardized details on maternal deaths. In addition, Lebanon does not currently conduct its maternal mortality review as a confidential enquiry, which might impact recall of the events.

Conclusion

Learning from the factors that led to these maternal deaths in Lebanon is fundamental to prevent future deaths. Access to timely and quality maternity care for all women living in Lebanon is required to prevent maternal mortality and morbidity. Strengthening high-quality obstetric care, improving referrals between private and tertiary care facilities, and following evidence-based protocols through proactive and responsive management of obstetric emergencies are lifesaving measures for women during childbirth. Addressing the individual, clinical and structural factors related to maternal death identified in this review will save women's lives in Lebanon.

References

1.   World Health Organization. Maternal Mortality. Geneva, Switzerland   2014. https://apps.who.int/iris/bitstream/handle/10665/112318/WHO_RHR_14.06_eng.pdf. Accessed February 2, 2023

2.   Miller S, Abalos E, Chamillard M, et al. Beyond too little, too late and too much, too soon: a pathway towards evidence-based, respectful maternity care worldwide. *Lancet*. 2016;388(10056):2176-92.

3.   United Nations Children's Fund. Maternal Mortality. 2019. https://data.unicef.org/topic/maternal-health/maternal-mortality/. Accessed February 2, 2023

4.   World Health Organization. *Trends in maternal mortality 2000 to 2017: estimates by WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division*. Geneva: World Health Organization; 2019.

5.   Maternal Health Task Force. The Sustainable Development Goals and Maternal Mortality. 2015. https://www.mhtf.org/topics/the-sustainable-development-goals-and-maternal-mortality/. Accessed February 2, 2023

6.   Campbell OM, Calvert C, Testa A, et al. The scale, scope, coverage, and capability of childbirth care. *Lancet*. 2016;388(10056):2193-208.

7.   de Graaf J, Schutte J, Poeran J, van Roosmalen J, Bonsel G, Steegers E. Regional differences in Dutch maternal mortality. *BJOG: An International Journal of Obstetrics & Gynaecology*. 2012;119(5):582-8.

8.   Knight M, Bunch K, Tuffnell D, et al., on behalf of MBRRACE-UK. *Saving Lives, Improving Mothers' Care - Lessons learned to inform maternity care from the UK and Ireland Confidential Enquiries into Maternal Deaths and Morbidity 2016-18*. Oxford: National Perinatal Epidemiology Unit, University of Oxford; 2020.

9.   United Nations High Commissioner for Refugees. Guideline for Reviewing Maternal Deaths. 2010. https://www.unhcr.org/47f38de12.pdf. Accessed February 2, 2023

10.   Amnesty International. End Kafala: Justice for Migrant Domestic Workers in Lebanon. 2022. https://www.amnesty.org/en/latest/campaigns/2019/04/lebanon-migrant-domestic-workers-their-house-is-our-prison/. Accessed February 2, 2023

11.   Human Rights Watch. World Report 2020: Lebanon Events of 2019. 2020. https://www.hrw.org/world-report/2020/country-chapters/lebanon. Accessed February 2, 2023

12.   Moussawi F, Nakkash R, Jamal D, El-Jardali F. *K2P Briefing Note: Reducing Rates of Unnecessary Cesarean Sections in Lebanon*. Beirut, Lebanon: Knowledge to Policy (K2P) Center; 2015.

13.   El-Kak F, Kabakian-Khasholian T, Ammar W, Nassar A. A review of maternal mortality trends in Lebanon, 2010-2018. *Int J Gynaecol Obstet*. 2020;148(1):14-20.

14.   Nyfløt LT, EllingsenL, Yli BM, Øian P, Vangen S. Maternal deaths from hypertensive disorders: lessons learnt. *Acta Obstet Gynecol Scand*. 2018;97:976-87.

15.   Calvello EJ, Skog AP, Tenner AG, Wallis LA. Applying the lessons of maternal mortality reduction to global emergency health. *Bull World Health Organ*. 2015;93(6):417-23.

16.   McCall S. *Improving the prevention and outcomes of severe complications of pregnancy through international collaborative and comparative studies*. Oxford: University of Oxford; 2019.

17.   Chu J, Johnston TA, Geoghegan J, on behalf of the Royal College of Obstetricians and Gynaecologists. Maternal Collapse in Pregnancy and the Puerperium: Green-top Guideline No. 56. *BJOG*. 2020;127(5):e14-e52.

18.   Jauniaux ERM, Alfirevic Z, Bhide AG, et al., on behalf of the Royal College of Obstetricians and Gynaecologists. Placenta Praevia and Placenta Accreta: Diagnosis and Management. Green-top Guideline No. 27a. *BJOG*. 2018:e1-e48.

19.   Royal College of Obstetricians and Gynaecologists. Epilepsy in Pregnancy. Green-top Guideline No. 68. 2016. https://www.rcog.org.uk/media/rzldnacf/gtg68_epilepsy.pdf. Accessed February 2, 2023

20.   Kemp B, Knight M. Maternal mortality in the UK: an update. *Obstetrics, Gynaecology & Reproductive Medicine*. 2016;26(1):26-8.

21.   Engjom H, van den Akker T, Aabakke A, et al. Severe COVID-19 in pregnancy is almost exclusively limited to unvaccinated women – time for policies to change. *The Lancet Regional Health - Europe*. 2022;13:100313.

22.   American College of Obstetricians and Gynecologists. ACOG Committee Opinion No. 736: Optimizing Postpartum Care. *Obstet Gynecol*. 2018;131(5):e140-e50.

23.   Say L, Chou D, Gemmill A, et al. Global causes of maternal death: a WHO systematic analysis. *Lancet Glob Health*. 2014;2(6):e323-33.

24.   American College of Obstetricians and Gynecologists. Gestational Hypertension and Preeclampsia: ACOG Practice Bulletin, Number 222. *Obstet Gynecol*. 2020;135(6):e237-e60.

25.   American Heart Association. Part 10.8: Cardiac Arrest Associated With Pregnancy. *Circulation*. 2005;112(24_supplement):IV-150-IV-3.

26.   Friedman AM, Campbell ML, Kline CR, Wiesner S, D'Alton ME, Shields LE. Implementing Obstetric Early Warning Systems. *AJP Rep*. 2018;8(2):e79-e84.

27.   Republic of Lebanon Ministry of Public Health. Maternal and Neonatal Health: Selected indicators 2018-2020. 2022. https://www.moph.gov.lb/en/DynamicPages/index/8. Accessed February 2, 2023

28.   Macêdo P, Oliveira PS, Foldvary-Schaefer N, Gomes MDM. Insomnia in people with epilepsy: A review of insomnia prevalence, risk factors and associations with epilepsy-related factors. *Epilepsy Res.* 2017;135:158-67.