Introduction

Maternal death is 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 accidental or incidental causes. To facilitate the identification of maternal deaths in circumstances in which cause of death attribution is inadequate, a new category has been introduced: Pregnancy-related death is defined as the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the cause of death (**WHO. ICD, 2010).**

The **MDG 5** incorporates targets related to improving maternal mortality in resource poor countries with universal access to reproductive healthcare. The complex interrelationship between causation and solution of these problems is expounded together with strategies of care. Healthcare modeling based on the provision of skilled birth attendants and emergency obstetric care facilities will reduce the terrible tragedy of maternal mortality. Currently 500,000 women die annually in childbirth, and the majority of these deaths are avoidable. The large majority occur in resource poor countries. With the current slow progress, it is unlikely that the necessary improvement will be achieved by 2015. Major initiatives aimed at education, increasing workforce and improving local facilities and availability of drugs will help. The solutions are simple, but progress requires political desire **(Falconer, 2010).**

Maternal deaths should be divided into two groups: *Direct obstetric* deaths are those resulting from obstetric complications of the pregnant state (pregnancy, labor and the pueperium), from interventions, omissions, incorrect treatment, or from a chain of events resulting from any of the above. *Indirect obstetric* deaths are those resulting from previous existing disease or disease that developed during pregnancy and which was not due to direct obstetric causes, but was aggravated by physiologic effects of

pregnancy (e.g., cardiac disease, psychiatric illness, hepatic disease). The drawback of this definition is that maternal deaths can escape being so classified, because the precise cause of death cannot be given even though the fact of the woman having been pregnant is known **(AbouZahr and Wardlaw, 2000).**

Direct obstetric deaths have six major causes: hypertensive disease of pregnancy, hemorrhage, infections, sepsis, thromboembolism, and in developing countries, obstructed labor and complications from illegal abortion. There are other *direct causes* of death, such as ectopic Pregnancy, complications of anesthesia, and amniotic fluid embolism. The main causes of *indirect* obstetric deaths are asthma, heart disease, type1 diabetes, systemic Lupus erythematosus and other conditions that are aggravated by pregnancy to the point of death **(Timothy et al., 2007).**

Egypt's Demographic and Health Survey 2008 has published several positive health indicators that have been attained, including decrease in maternal mortality rate by 68% between 1992 and 2008 (from 174 to 55 per 100 thousand live births) (**MOH, 2010).**

Several factors contributed to the decrease MMR in Egypt there were increases in use of health services: use of modern contraceptives, hospital deliveries and use of trained birth attendants. For most indicators the changes were greater in Upper Egypt than Lower Egypt. Since year, 1992-1993 efforts by the government of Egypt and donors to improve access to and the quality and utilization of services can be linked to a greatly reduced MMR (**Reginald Gipson et al., 2005).**

Substandard care was identified in many deaths and categorized into *first* not recognizing warning signs either due to failure of junior staff to refer to a senior, or failure of general practitioner to refer to hospital. *Second*: failure of senior staff, as no attendance, inappropriate delegation and or not referring to, or seeking advice from other speciality early enough when

appropriate. *Third*: lack of clear guideline for major emergencies such as eclampsia, hemorrhage, pulmonary embolism. *Forth*, lack of team works **(Anthony and Kaye, 2001)**.

The specific target for maternal health is to reduce each country's 1990 maternal mortality ratio (MMR) by three quarters by 2015. This will require the involvement of health systems, communities, and families globally, and necessitate addressing political, economic, social, technical, and environmental factors contributing to maternal morbidity and mortality (**Haywood L Brown et al., 2012).**

Other maternal health factors were found to affect the maternal mortality and categorized as five interlinked causes: poverty low socioeconomic status of women, poor nutrition and general health, poor availability of good quality health services and inadequate contraceptive reproductive choices **(Maine, 2001).**

Aim of The Study

This is a retrospective study of maternal mortality analysis, in Ain Shams Maternity Hospital (emergency unit), during the period, from beginning of 2008 to year 2012.

The aim of this study is to determine outline and asses the magnitude and the factors contributing to maternal mortality, especially the avoidable factors and to evaluate the possibility of prevention of such factors, to decrease the incidence of maternal mortality to the least possible value, and finally to make some recommendations and comments for possible preventive measures .

Indices

The death of any 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 accidental or incidental causes (**WHO. ICD 2010**).

Direct maternal deaths is defined as deaths resulting from obstetric complications of pregnant state (pregnancy, labor, and the pueperium) from interventions, omissions, incorrect treatment or from a chain of events ,resulting, from any of the above **(Hoyert Dl, 2007).**

Indirect maternal deaths are also defined as deaths resulting from previous existing disease that developed during pregnancy and which was aggravated by the physiological effects of pregnancy (**Hoyert, 2007).**

Late maternal deaths are defined as the death of a woman from direct or indirect causes more than 42 days but less than one year after termination of pregnancy(after, abortion, miscarriage or delivery) **(Hoyert, 2007).**

Pregnancy associated death the death of a woman while pregnant while or within 1 year of termination of pregnancy, irrespective of cause **(Berg et al., 2001).**

Pregnancy related death: the death of a woman while pregnant or within 1 year of termination of pregnancy irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by her pregnancy or its management but not from accidental or incidental causes (**Berg et al., 2001).**

Maternal mortality ratio (MMR): Number of maternal deaths during a given time period per 100 000 live births during the same time period.

Maternal mortality rate (MMRate): Number of maternal deaths in a given period per 100 000 women of reproductive age during the same time period.

Adult lifetime risk of maternal death: The probability that a 15-49year-old women will die eventually from a maternal cause.

The proportion of maternal deaths among deaths of women of reproductive age (PM): The number of maternal deaths in a given time period divided by the total deaths among women aged 15–49 years (**WHO Library, 2012).**

The fifth MDG aims to improve maternal health, with a target of reducing the MMR by 75% between 1990 and 2015. The 10 countries that had achieved MDG 5 by 2010 are Estonia (95%), Maldives (93%), Belarus (88%), Romania (84%), Bhutan (82%), Equatorial Guinea (81%), Islamic Republic of Iran (81%), Lithuania (78%), Nepal (78%) and Vietnam (76%). For the remaining countries, one way to gauge progress is to examine if they have had the expected average annual decline of 5.5% in the MMR from 1990 to 2010.Accordingly, countries with MMR ≥100 in 1990 have been categorized as "on track ,"making progress", "insufficient progress" or "no progress" in improving maternal health (**WHO, 2012).**

A country is considered "on track" if the average annual percentage decline between 1990 and 2010 is 5.5% or more. If the annual decline in MMR is between 2% and 5.5%, the country is considered to be making progress. Countries with an annual decline of less than 2% are considered to have made "insufficient progress" and countries with rising MMR have been categorized as making "no progress". Given the difficulty in reducing MMR further for Countries that had low MMR (<100) in 1990, those countries have not been categorized (**WHO, 2012).**

Nine countries are "on track", meaning they have shown an average annual percentage decline of 5.5% or more in MMR between 1990 and 2010. These nine countries are Eritrea

(6.3%), Oman (6.2%), Egypt (6.0%), Timor-Leste (6.0%), Bangladesh (5.9%), China (5.9%), Lao People's Democratic Republic (5.9%), the Syrian Arab Republic (5.9%) and Cambodia (5.8%) (***Table1***) **(WHO, 2012).**

Table (1): Progress of MMR from 1990-2010/ developing countries.

Country	MMR[a]					% change in MMR between 1990 and 2010	Average annual % change in MMR between 1990 and 2010[b]	Range of uncertainty on annual % change in MMR		Progress towards improving maternal health[c]
	1990	1995	2000	2005	2010			Lower estimate	Upper estimate	
Cuba	63	61	63	67	73	16	0.7	0	1.5	
Cyprus	17	17	15	12	10	–42	–2.7	–8.0	3.1	
Czech Republic	15	9	7	7	5	–65	–5.1	–7.1	–3.1	
Democratic People's Republic of Korea	97	140	120	85	81	–16	–0.9	–6.0	4.6	
Democratic Republic of the Congo	930	870	770	660	540	–42	–2.7	–4.0	–1.4	making progress
Denmark	13	19	8	7	12	–3	–0.1	–3.6	3.3	
Djibouti	290	290	290	220	200	–31	–1.9	–6.9	3.3	insufficient progress
Dominican Republic	220	170	130	130	150	–32	–1.9	–2.5	–1.4	insufficient progress
Ecuador	180	150	130	110	110	–42	–2.7	–3.2	–2.3	making progress
Egypt	230	150	100	78	66	–71	–6	–6.9	–5.2	on track
El Salvador	150	130	110	94	81	–46	–3.1	–3.8	–2.4	making progress
Equatorial Guinea	1200	1000	450	270	240	–81	–7.9	–12.8	–2.9	on track
Eritrea	880	550	390	300	240	–73	–6.3	–7.0	–5.6	on track
Estonia	48	46	28	23	2	–95	–14	–16.8	–11.1	
Ethiopia	950	880	700	510	350	–64	–4.9	–5.5	–4.4	making progress
Fiji	32	33	31	29	26	–18	–1.0	–1.4	–0.6	
Finland	7	5	5	6	5	–30	–1.7	–5.1	1.8	
France	13	13	10	8	8	–35	–2.1	–3.0	–1.1	
Gabon	270	260	270	260	230	–15	–0.8	–2.2	1.2	insufficient progress
Gambia	700	650	520	430	360	–50	–3.4	–8.2	2.0	making progress

table1

Incidence

The majority of maternal deaths occurring in the world occur in developing countries (99%).The differences in maternal mortality between rich (mortality risk 1 in 4000-10,000) and poor countries (mortality risk 1 in 15-50) is one of the highest in public health. PPH, eclampsia and sepsis are the leading causes for maternal deaths in the developing countries. It is estimated that about 500,000 mothers die annually in the world or 1600 maternal deaths per year or about one maternal death per minute, of these it's estimated that 100,000-200,000 are related to poorly performed or illegal abortions .Of these 26% are estimated to be preventable by introducing antenatal community –based interventions. Access to quality, essential obstetrical care can prevent another 48% of maternal deaths. It is cost effective to invest in policy markers that reduce maternal mortality in the most efficient manner possible **(Khan et al., 2006).**

It is also noted that rates rise with parity and maternal age. Maternal and infant death rates in the U.S are much higher than in many developed countries. One of the six health–related Millennium Development Goals set by WHO is to reduce the maternal mortality ratio (**Hill et al., 2006)**.

The US **CDC** and prevention notes that maternal mortality in the US has declined significantly during the 20th century but little progress has been made during the last 20 years .So the actual maternal mortality death rates per 100,000 live births had a rapid decline between the years 1900and 1950 **(CDC, 2004).**

There has been a plateau in the mortality rate since 1960. An important and impressive decline in Maternal Mortality occurred during the first 50 years of 20th century between (1900 and 1950). This decline was observed in all ethnic groups, and is attributed to the significant improvement in medical and technological advances including the use of antibiotics. Data obtained from death certificates complied by the CDCS national center for health indicates however that the annual MM ratio

plateau to approximately 7.5 deaths per 100,000live births during 1982-1996 (**CDC, 2004).**

Unfortunately, recent estimates published by the year 2000, show that there is a great disparity in maternal mortality in different parts of the world. The highest rates of maternal mortality are found in Africa, more specifically in Sub- Saharan Africa, followed by Asia, Latin America and Oceania. During the last 50 years, this overall trend in maternal mortality has also been observed in transitional countries with some achieving a decline of almost 75%.Thailand decreased *MM* ratio from 400 deaths per 100,000 live births in 1960 to 50 per 100.000 live births in 1984. Similar declines were observed in Malaysia, Srilanka, Egypt, Honduras and Bangladesh **(Ronsmans and Graham, 2006).**

Hemorrhage was the joint cause of maternal death in Africa and Asia (>30% of deaths). Hypertensive disorders represent the highest cause of death in Latin America and the Caribbean. There was also wide variation within regions. Other important regional differences included HIV/AIDS causing about 6% of deaths in Africa, and anemia and obstructed labor each causing about a tenth of deaths in Asia. Abortion related mortality was highest in Latin America and the Caribbean. Ectopic pregnancy was recorded as the cause in less than 1% of deaths in developing countries and almost 5% in developed countries ***(fig.1) (*Khan et al., 2006).**

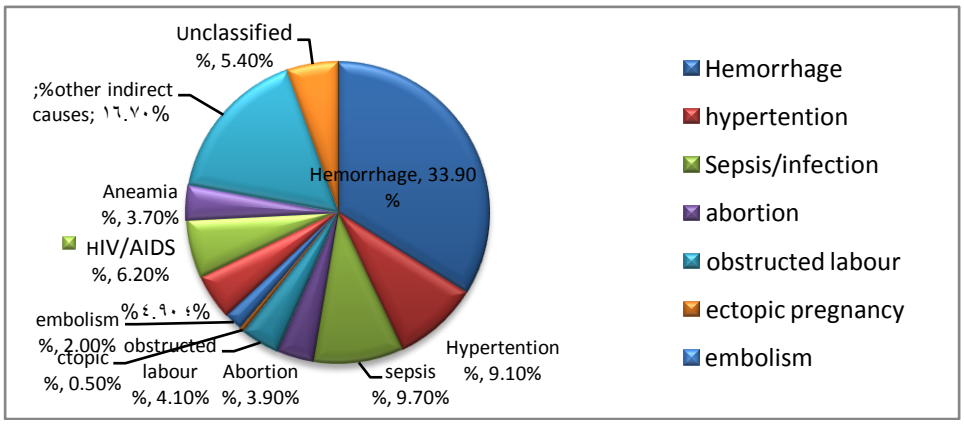

Figure 1: Common causses of MMR.

Table (2): World population prospects: the 2010 revision. New York, Population Division, Department of Economic and Social Affairs, United Nations Secretariat, 2011.

Maternal mortality in 1990-2010

WHO, UNICEF, UNFPA,The World Bank and UN Population Division Maternal Mortality Estimation Inter-Agency Group

Egypt

Year	Maternal mortality ratio (MMR)	Maternal deaths	Live births	Proportion of maternal deaths among deaths of females of reproductive age (PM)	Lifetime risk of maternal death
	Per 100 000 live births (lb)	Numbers	Thousands	Percent	1 in
2010	66 (40–100)	▪ 1,200 (750–2,000)	1,878	5.2 (3.2–8.2)	490
2005	78 (47–120)	▪ 1,400 (850–2,200)	1,819	6.3 (3.9–10.0)	390
2000	100 (61–160)	▪ 1,800 (1,100–2,800)	1,746	7.9 (4.9–12.5)	280
1995	150 (93–240)	▪ 2,600 (1,600–4,200)	1,719	10.3 (6.4–16.5)	170
1990	230 (140–370)	▪ 4,100 (2,500–6,800)	1,811	14.6 (9.0–23.5)	95

Annual % change	
1990-2000	-7.9
2000-2010	-4.1
1990-2010	-6.0

Etiology and Classification

In most developing countries, women of reproductive age (15-49) constitute a little more than one fifth of the total population. These women are exposed repeatedly to the risk of pregnancy and child bearing and under the existing socio-economic conditions and the inadequacy of the medical and health facilities, are at a great risk of morbidity and mortality from causes related to pregnancy. The death of woman, who in most developing countries plays the principles role in the rearing of children and the management of family affairs, is a significant social and personal tragedy (**Stephens et al., 2006).**

According to ICD-10, maternal deaths should be divided into two groups: *Direct obstetric* deaths are those resulting from obstetric complications of the pregnant state (pregnancy, labor and the pueperium), from interventions, omissions, incorrect treatment, or from a chain of events resulting from any of the above. *Indirect obstetric* deaths are those resulting from previous existing disease or disease that developed during pregnancy and which was not due to direct obstetric causes, but was aggravated by physiologic effects of pregnancy (e.g., cardiac disease, psychiatric illness, hepatic disease). The drawback of this definition is that maternal deaths can escape being so classified, because the precise cause of death cannot be given even though the fact of the woman having been pregnant is known **(AbouZahr and Wardlaw, 2000).**

Direct obstetric deaths have six major causes: hypertensive disease of pregnancy, hemorrhage, infections, sepsis, thromboembolism, and in developing countries, obstructed labor and complications from illegal abortion. There are other *direct causes* of death, such as ectopic pregnancy, complications of anesthesia, and amniotic fluid embolism. The main causes of *indirect* obstetric deaths are asthma, heart disease, type1 diabetes, systemic Lupus erythematosus and other conditions

that are aggravated by pregnancy to the point of death **(Timothy et al., 2007).**

Women die because of complications during and following pregnancy and childbirth. Most of these complications develop during pregnancy. Other complications may exist before pregnancy, but are worsened during pregnancy. The major complications that account for 80% of all maternal deaths are:

- Severe bleeding (mostly bleeding after childbirth).
- Infections (usually after childbirth).
- High blood pressure during pregnancy (pre-eclampsia and eclampsia).
- Unsafe abortion.

The remainder are caused by or associated with diseases such as malaria, and AIDS during pregnancy.

Maternal health and newborn health are closely linked. More than three million newborn babies die every year, and an additional 2.6 million babies are stillborn (**Cousins et al., 2011).**

Poor women in remote areas are the least likely to receive adequate health care. This is especially true for regions with low numbers of skilled health workers, such as Sub-Saharan Africa and South Asia. While levels of antenatal care have increased in many parts of the world during the past decade, only 46% of women in low-income countries benefit from skilled care during childbirth. This means that a midwife, a doctor or a trained nurse does not assist millions of births (**WHO. Fact sheets, 2012).**

In high-income countries, virtually all women have at least four antenatal care visits, are attended by a skilled health worker during childbirth and receive postpartum care. In low-income countries, just over a third of all pregnant women have the recommended four antenatal care visits.

Other factors that prevent women from receiving or seeking care during pregnancy and childbirth are:

- Poverty
- Distance
- Lack of information
- Inadequate services
- Cultural practices.

To improve maternal health, barriers that limit access to quality maternal health services must be identified and addressed at all levels of the health system (**WHO. Fact Sheets, 2012).**

I- Direct Obstetric Causes:-

1. Hemorrhage:

There is no consensus on a definition of major obstetric hemorrhage. Up to 1000 ml blood loss is not uncommon in the peripartum period and may be of little clinical significance. Blood loss >1500 ml; decrease in hemoglobin of more than 4 g/dl; or an acute transfusion requirement of more than 4 units of packed red blood cells are suggested criteria. Definitions based on hemodynamic deterioration are unhelpful as maternal physiology often allows compensation until hemorrhage is advanced. Careful clinical observation and a high index of suspicion are required to detect bleeding early **(ATOTW, 2012).**

The recognition of major obstetric hemorrhage can be challenging. Blood loss may be concealed and can be difficult to quantify due to dilution with amniotic fluid. In addition, the physiological changes of pregnancy may mask the normal clinical signs of hypovolemia. The blood flow to the placenta is approximately 700 ml/min at term and hence bleeding can be rapid and may quickly become life threatening (**ATOTW, 2012)**.

Researchers in France investigated the reasons, why women were dying from PPH**.** They found that these women had received substandard care, this substandard care occurred in hospitals, in places without a 24-hrs on site anesthetist and in places with low volume of deliveries **(Bouvier-Colle MH et al., 2001)**

APH is defined as bleeding from the vagina after 24 weeks gestation and has an estimated incidence of between 2–5% of all pregnancies. Complications include maternal shock; fetal hypoxia; premature labor and fetal death. Causes include: Placenta praevia, Placental abruption, uterine rupture and trauma (**ATOTW, 2012)**.

PPH can be classified as primary or secondary. Primary PPH occurs during the first 24 hours whilst secondary PPH refers to hemorrhage occurring between 24 hours to 6 weeks after delivery. The four 'T's pneumonic is useful to aid recall the major causes of primary PPH:

Tone – uterine atony

Tissue – retained products of conception

Trauma – genital tract injury

Thrombin – inherited or acquired coagulopathy **(ATOTW, 2012).**

Authors have gone on to suggest that mortality due to hemorrhage could be used as indicator of health quality as it reflects the appropriateness of obstetrical care. Enhanced methods to identify pregnancy – related deaths are essential; they need to be linked to birth and death certificates and extended for up to 1 year after the end of pregnancy **(Wildman K& Bouvier-Colle MH, 2004).**

FIND=Finland. **FRA**=France. **MASS**=Massachusetts. **N.CARO=** North Carolina

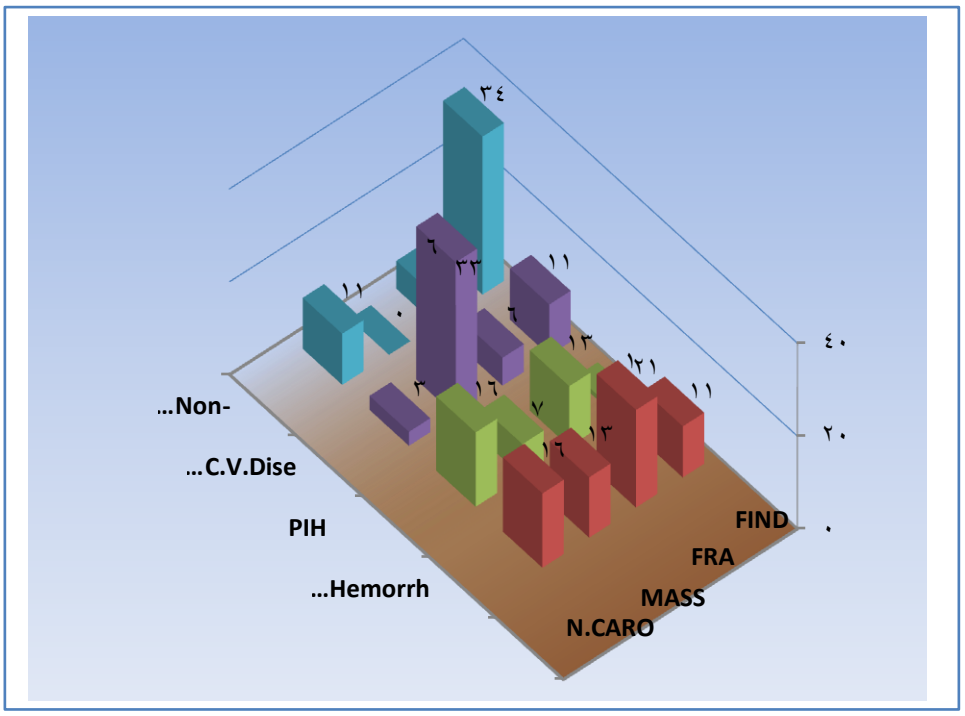

Figure (2): All causes of maternal mortality for one decade (1990-2000) for Massachusetts, North Carolina, Finland, and France. Adapted from **(Deneux-Tharaux et al., 2005).**

Four-hundred-and-four pregnancy-associated deaths were identified and reviewed. Underestimation of mortality causally related to pregnancy based on International Classification of Diseases cause-of-death codes alone varied from 22% in France to 93% in Massachusetts. Underreporting was greater in the regions with lower initial maternal mortality ratios. The distribution of causes of pregnancy-related mortality was specific to each region. The leading causes of death were cardiovascular conditions in Massachusetts; hemorrhage, pregnancy-induced hypertension, and peripartum cardio-myopathy in North Carolina; noncardiovascular medical conditions, in Finland; and hemorrhage in France ***(figure 2) (Deneux-Tharaux et al., 2005).***

Local institutions in the US have established protocols to manage major obstetric hemorrhage. One particular hospital