

# Amniotic fluid embolism

General view, multicenter survey  
and practical approach

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Chairman, Israel Association of Obstetric Anesthesia*

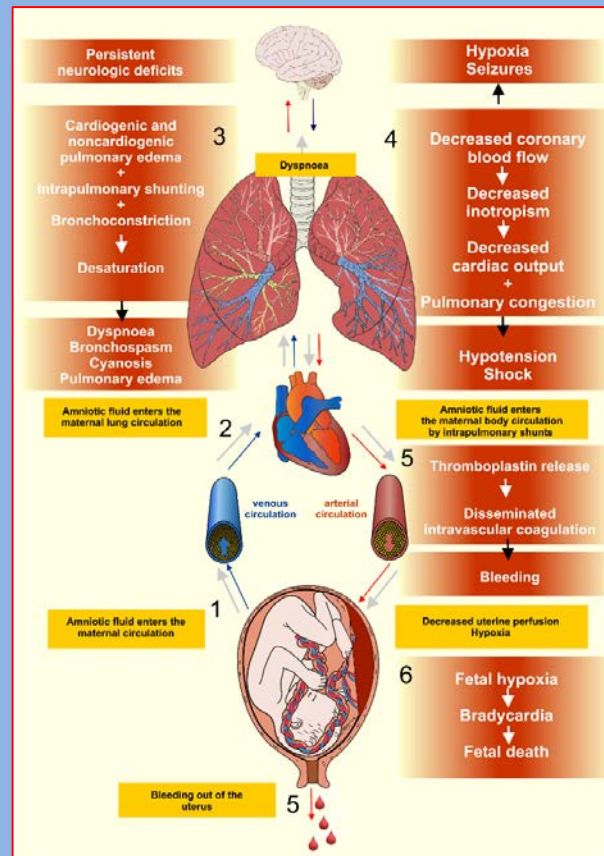


Shaare Zedek  
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האוניברסיטה העברית בירושלים  
The Hebrew University of Jerusalem



# Incidence of Amniotic Fluid Embolism: 2 - 8 cases / 100 000 births



Did you have patient S with AFE?

**Table 2** Signs and symptoms of amniotic fluid embolism

	Frequency
Hypotension	100%
Fetal distress	100%
Pulmonary oedema or ARDS	93%
Cardiopulmonary arrest	87%
Cyanosis	83%
Coagulopathy	83%
Dyspnoea	49%
Seizure	48%
Uterine atony	23%
Bronchospasm	15%
Transient hypertension	11%
Cough	7%
Headache	7%
Chest pain	2%

Adapted from Clark SL.<sup>20</sup>; ARDS: adult respiratory syndrome.

## Signs and symptoms of AFE

**TABLE 3**

**Differential diagnoses by clinical symptoms**

Clinical manifestation/symptoms	Amniotic fluid embolism	Pulmonary embolism	Myocardial infarction	Peripartal cardiomyopathy
Manifestation	During labor/birth → hours postpartum	2 to 15 times more common during labor than pregnancy	21% peripartally 34% postpartally	Third trimester: approx. 9% to 80% up to 4 months postpartum
Risk factors	+/nonspecific	+++/specific	+++/specific	+/nonspecific
Cardiac arrest	++	+ → ++	+	+
Chest pain	-	++ → +++	+++	++
Cardiac arrhythmia	+ → ++	++ → +++	+++	++
Dyspnea	+++	+ → +++	+ → ++	++
Hypotension	+++	+ → ++	+ → ++	+/-
Neurological symptoms	++	+ secondary	(+) secondary	(+) secondary
Coagulopathy	++	-	-	-
Acute fetal distress	+ → ++	(+) secondary	(+) secondary	No data

-: None or rare; +: Occasional; ++: Common; +++: Very common; Table from Rath W: Fruchtwasserembolie, Lungenembolie (Amniotic Fluid Embolism, Pulmonary Embolism). In: Feige A., Rath W., Schmidt S (eds.): Kreislauf-Kompodium, Stuttgart, New York, Thieme 2013; 142-9 (e17). Reproduced with the kind permission of Thieme Publishers

# Amniotic Fluid Embolism (AFE)

## Diagnostic criteria and Differential diagnosis

TABLE 2

### Amniotic fluid embolism diagnosis criteria

#### UK Obstetric Surveillance System (UKOSS) 2010 (3)

No other clear cause: acute cardiovascular collapse with one or more of the following signs:

- Acute fetal compromise
- Cardiac arrest
- Cardiac arrhythmia
- Coagulopathy
- Hypotension
- Maternal hemorrhage\*
- Premonitory symptoms, (e.g. restlessness, anxiety, agitation)
- Seizures
- (Sudden onset) shortness of breath

#### Benson M. et al. 2007 (18)

Pregnant women up to 48 hours after birth with one or more of the following symptoms and requiring treatment:

- Hypotension (and/or cardiac arrest)
- Respiratory distress
- Disseminated intravascular coagulation
- Coma and/or seizures
- No other medical explanation for clinical course

\* Excluding women with maternal hemorrhage as the first symptom with no evidence of early coagulopathy or cardiorespiratory compromise or in cases of postnatal evidence of fetal squames or hairs in the lung  
Modified according to (3) and (18)

### Elective CS

1 min after delivery:

- Hypotension  
(80/40 mmHg)
- Bigemini
- Agitation



Table 2. Differential Diagnosis of Amniotic Fluid Embolism

- Obstetric causes
  - Acute hemorrhage
  - Placental abruption
  - Uterine rupture
  - Uterine atony
  - Eclampsia
  - Peripartum cardiomyopathy
- Anesthetic causes
  - High spinal anesthesia
  - Aspiration
  - Local anesthetic toxicity
- Nonobstetric causes
  - Pulmonary embolism
  - Air embolism
  - Anaphylaxis
  - Sepsis/septic shock

**TABLE 1**

**Incidence of amniotic fluid embolism**

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Canada* <sup>1</sup>	1991 to 2002	6.0	13%	No data
U.K. * <sup>2</sup>	2005 to 2009	2.0	20%	13.5%
The Netherlands* <sup>2</sup>	2004 to 2006	2.5	11%	38.1%

\*<sup>1</sup> Retrospective population-based studies

\*<sup>2</sup> Case-related validation from prospective studies

Modified according to (12), Knight M. et al.: BMC Pregnancy & Childbirth 2012; 12: 7

The condition is rare – around **one in 50 000 births in the UK.**

In the UK, AFE is researched through the UK Obstetric Surveillance System (UKOSS)

Knight M, Tuffnell D, Brocklehurst P, Spark P, Kurinczuk JJ, on behalf of the UK Obstetric Surveillance System. Incidence and risk factors for amniotic fluid embolism. *Obstetrics and Gynecology* 2010; 115: 910–7.

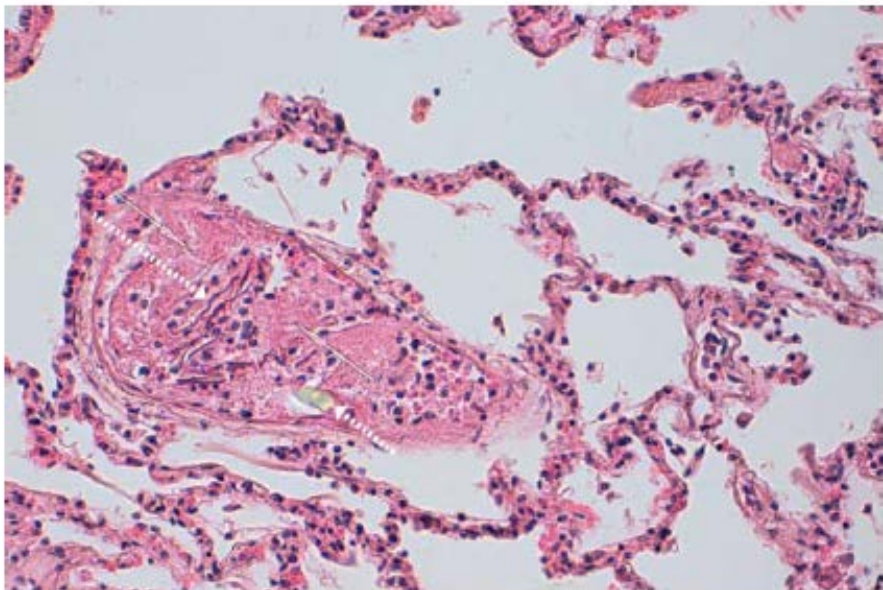
**Table 1 Incidence of amniotic fluid embolism and case fatality rates in published series**

	Year published	Incidence (per 100 000 maternities)	Case fatality rate (%)
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Oi <sup>44</sup>	2010	Not reported	48
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Samuelsson <sup>73</sup>	2007	1.9	44
Kramer <sup>74</sup>	2006	6.1	13
Tuffnell <sup>36</sup>	2005	Not reported	29.5
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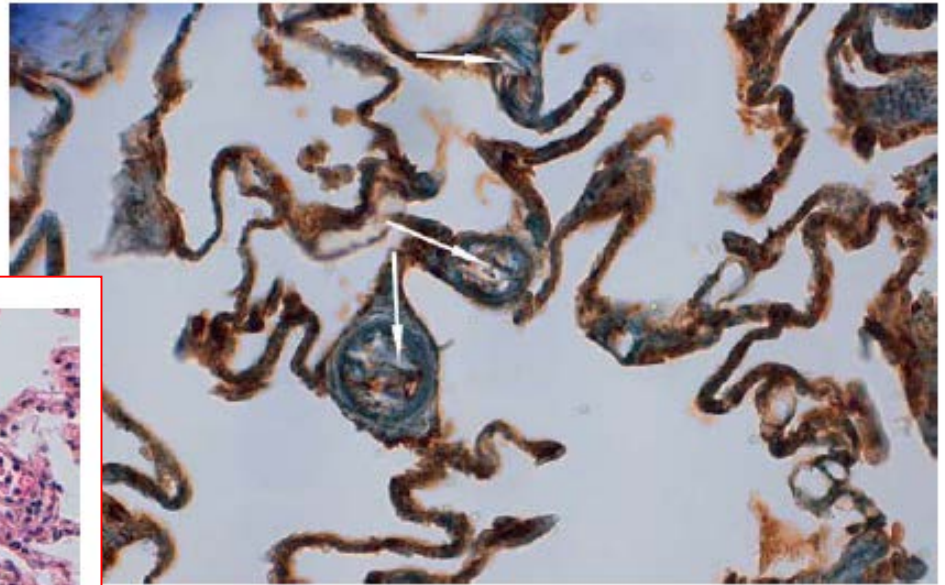
Incidence of **Amniotic Fluid Embolism** (AFE) is estimated to occur between 1 in 8000 and 1 in 80,000 deliveries.

The **true incidence is unknown** because of inaccurate diagnosis and inconsistent reporting of nonfatal cases.

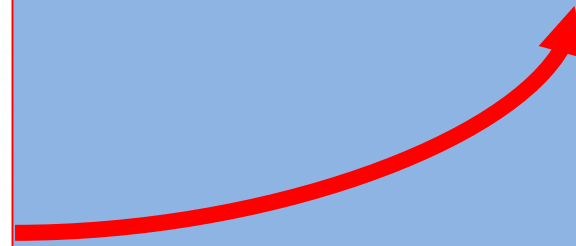
# Squamous and/or trophoblastic cells in pulmonary blood vessels as a indicator of AFE

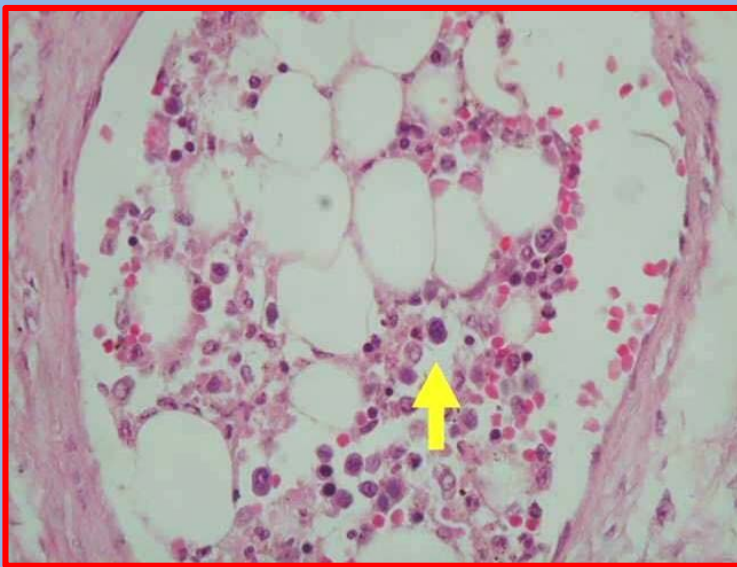


**Figure 2:** A blood vessel enclosed by lamellar epithelial squames (long dotted arrow) embedded in a fibrin thrombus (two transparent arrows). The lower part of the picture shows a transparent, cylindrical structure corresponding to a lanugo hair (short dotted arrow). Hematoxylin eosin staining; 200x. Survival time: 8 hours



Immunohistochemically marked epithelial squames in pulmonary arterioles  
Cytokeratin, 200x





Pulmonary artery blood specimens from 14 term pregnant women with severe pregnancy-induced hypertension suggest that squamous or trophoblastic cells may be normally present in the maternal pulmonary circulation during the peripartum period and that their presence is not pathognomonic of clinically significant amniotic fluid embolism.

Squamous and trophoblastic cells in the maternal pulmonary circulation identified by invasive hemodynamic monitoring during the peripartum period Wesley Lee AJOG Volume 155, Issue 5, Pages 999–1001

Clark, SL, Pavlova, Z, Greenspoon, J, Horenstein, J, Phelan, JP. **Squamous cells in the maternal pulmonary circulation.** *Am J Obstet Gynecol.* 1986;154:104.

Covone, AE, Johnson, PM, Mutton, E et al, **Trophoblastic cells in peripheral blood from pregnant women.** *Lancet.* 1984;2:841.

# “The pathogenesis of AFE is not yet fully clear.”

- Mechanical obstruction of the pulmonary vessels by amniotic fluids component
  - Anaphylactoid reaction hypothesis
- AFE is “Anaphylactoid syndrome of pregnancy”**



Lee et al, and other investigators could not reproduce the AFE-syndrome by injecting AF directly into mini-pig and monkey model circulation.

Clark SL, Hankins GD, Dudley DA, Dildy GA, Porter TF: Amniotic fluid embolism: analysis of the national registry. *AJOG* 1995; 172: 1158–67.

Clark SL: Amniotic fluid embolism. *Clin Obstet Gynecol* 2010; 53: 322–8.

Spence MR, Mason KG. Experimental amniotic fluid embolism in rabbits. *Am J Obstet Gynecol* 1974;119:1073–8  
Stolte L, van Kessel H, Seelen J, Eskes T, Wagatsuma T. Failure to produce the syndrome of amniotic fluid embolism by infusion of amniotic fluid and meconium into monkeys. *Am J Obstet Gynecol* 1967;98:694–7



# Coagulopathy

“The cause of DIC in AFE is as yet unclear...”

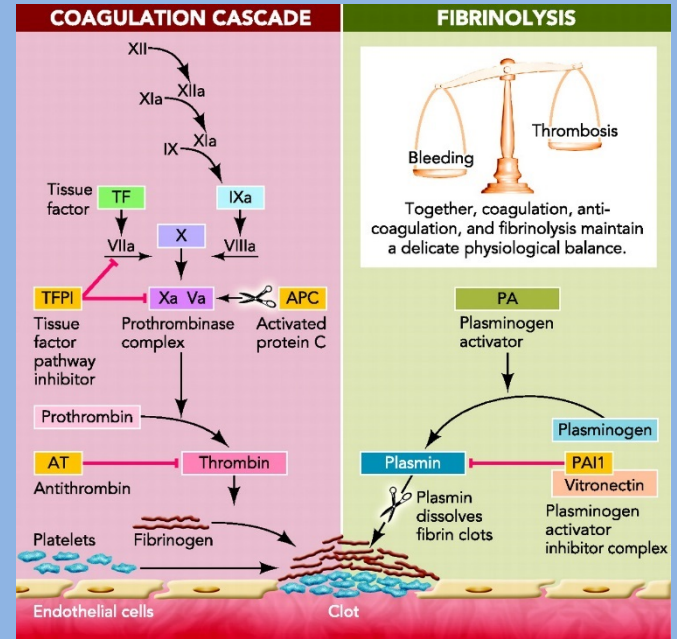
- 1-st – **Procoagulant theory**

AF contains many procoagulant substances (tissue factor and phosphatidylcerine) which can lead **directly or indirectly** (via cytokines or complement activation) **to DIC with consumptive coagulopathy.**

- 2 –nd - **Fibrinolytic theory**

**DIC as a result of massive fibrinolysis**, as AF also contains increased concentration of urokinaselike plasminogen activators.

Prosper SC, Goudge CS, Lupo VR. Recombinant factor VIIa to successfully manage disseminated intravascular coagulation from amniotic fluid embolism. *Obstet Gynecol* 2007;109:524–5



Unfortunately, not a great deal has changed in our understanding of the pathophysiology in the last 10 years.

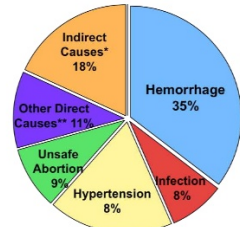


Anaesthesia

Journal of the Association of Anaesthetists of Great Britain and Ireland

Anaesthesia, 2011, 66, pages 1–9

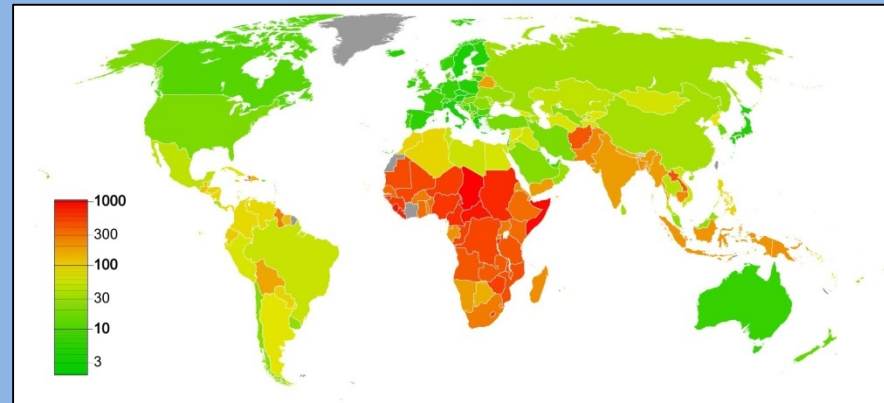
## Causes of Maternal Mortality



\*Malaria, HIV, accident etc..  
\*\*Obstructed labor, embolism etc..

CRCHUM

Source: Countdown to 2015, 2010.



According to statistics, it is the **AFE**

- **most common** cause of maternal death in Australia and Germany ( in 2011 - **8 out of 12 cases**)
- **second-most common** in the USA and the U.K.

Clark SL, Belfort MA, Dildy GA: Maternal death in the 21<sup>st</sup> century prevention and relationship to caesarean delivery. AJOG 2008; 199: 36.

The Confidential Enquiry into Maternal and Child Health (CEMACH): Saving Mother's lives reviewing maternal deaths to make childhood safer 2003–2006. London: CEMACH 2007.

AG „Mütterliche Todesfälle“ 2011: AQUA-Institut für angewandte Qualitätsförderung und Forschung im Gesundheitswesen 2012.

## The identified risk factors for AFE are:

- **Maternal age 35 and above** (odds ratio [OR] 1.86)
- **Cesarean section** (OR 12.4)
- **Placenta previa** (OR 10.5)
- **Multiple pregnancy** (OR 8.5) (In Vitro Fertilisation)

PubMed search 2000-2003

**Amniotic Fluid Embolism: an Interdisciplinary Challenge**  
Epidemiology, Diagnosis and Treatment  
Werner H.  
Dtsch Arztebl Int 2014; 111(8): 126–32

International Journal of Obstetric Anesthesia (2013) 22, 329–336  
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<http://dx.doi.org/10.1016/j.ijoa.2013.08.004>



REVIEW ARTICLE

**Amniotic fluid embolism: a leading cause of maternal death yet still a medical conundrum**

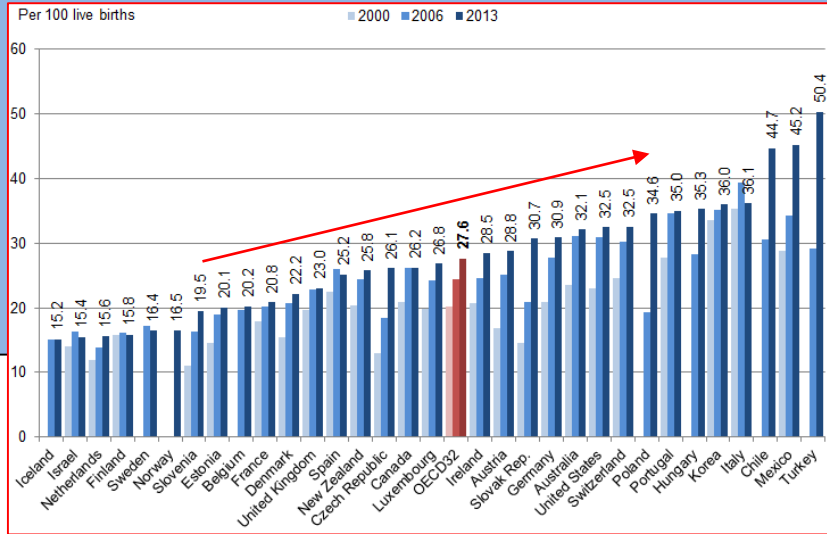
Rate of AFE



Rate of AFE



Why?



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Case related maternal mortality from AFE **37% in the UK registry 2005** and **20% in the UK in 2009**

Tuffnell DJ. United Kingdom amniotic fluid embolism register. *BJOG* 2005;112:1625–9

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Incidence of **Amniotic Fluid Embolism** (AFE) is estimated to occur between 1 in 8000 and 1 in 80,000 deliveries.

The **true incidence is unknown** because of inaccurate diagnosis and inconsistent reporting of nonfatal cases.

I Survive AFE!!!

**“Maternal morbidity is also high (up to 60%) and **only 15% of survivors may be neurologically intact.**”**

Clark SL. Amniotic fluid embolism: analysis of the national registry. Am J Obstet Gynecol 1995;172:1158–67



**“One of the most devastating long-term consequences of AFE is neurologic dysfunction. **As many as 85% of survivors demonstrate residual neurologic deficits**”.**

Moore J, Baldisseri MR. Amniotic fluid embolism. Crit Care Med. 2005;33(Suppl 10):S279–85.

WHO, UNICEF, UNFPA, World Bank Group, and the United Nations Population Division. Trends in Maternal Mortality: 1990 to 2015. Geneva, World Health Organization, 2015

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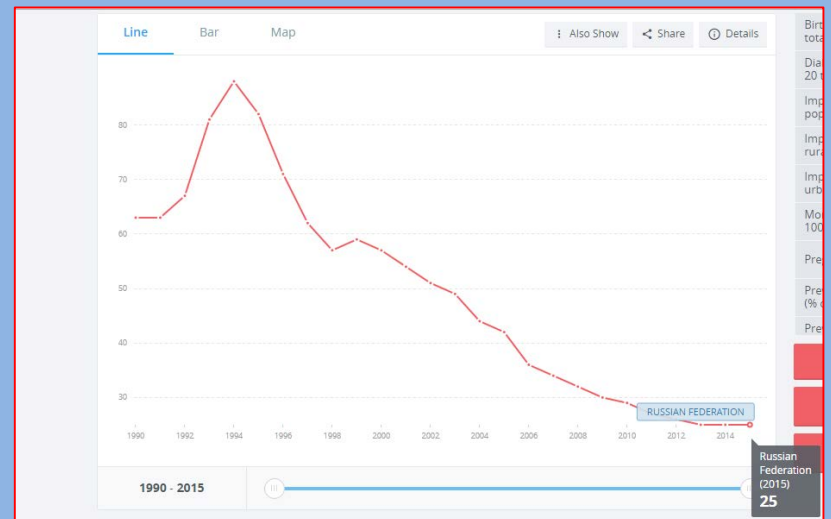


**2015**  
**5:100.000**

Overview per country

Country	1990	2015
Israel	11	5

**In Israel**  
**6-8 annually**  
**maternal death**  
  
**2/3 as a result of AFE**



# Our data

- **Retrospective chart review 2005-2015**
- 5 Hospitals with total 50.000 labors annually
  - Hospitals with 6-16.000 labors annually

- **20 cases of AFE**

- **Maternal age – 34.4 ± 4.9 (25-40)**

- In Israel mean maternal age in 2014 was 30.5
- OECD Family Database <http://www.oecd.org/els/family/database.htm>

- Gravity 4.1 (1-9)
- Parity 2.4 (0-5)
- 38-41w (out of 2 cases - 21 and 22w)
- No : HTN, DM, Hypo/Hypercoagulation
- Toxemia
- No allergies **No placenta previa**
- **2 (10%) cases after IVF** All cases – singleton , 1 post CS
- 2 (10%) macrosomia and 3 (15%) - polyhydramnios

The main risk factors for AFE are as follows (3): maternal age 35 years or above (odds ratio [OR]: 1.86; 95% confidence interval [95% CI]: 0.99 to 3.48), Cesarean delivery (OR: 12.4; 95% CI: 6.5 to 23.6), placenta previa (OR: 10.5; 95% CI: 0.94 to 117.2), and multiple pregnancy (OR: 8.5; 95% CI: 2.92 to 24.6). Despite discrepancies between studies (4, 5, 22), a recent prospective study proposed that induction of labor increases the risk of AFE by 35% (3). The increasing

Dtsch Arztebl Int 2014; 111(8): 126–32

2 (10%) – no labor    13 (65%) – active labor    1 (5%) – postpartum  
3 (15%) – emergency CS    1 (5%) – elective CS    **(CS – 4 cases 20%)**  
**No cases with induction of labor**

The main risk factors for AFE are as follows (3):  
maternal age 35 years or above (odds ratio [OR]: 1.86; 95% confidence interval [95% CI]: 0.99 to 3.48),  
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### **Analgesia/Anesthesia before AFE**

11 (55%) Epidural analgesia in labor  
2 (10%) Conversion epidural for CS  
1 (5%) General anesthesia for Em CS  
1 (5%) Spinal for elective CS

### **Preceding event to AFE**

3 (15%) – rupture of membrane  
1 (5%) – tetania of uterus  
3(15%) – “baby out”





## Resuscitation

Intubation – 18 (90%) 0-90 min

Chest compression - 12 (60%) 0-12 min ; max 40 min

Defibrillation – 7 (35%) 0-15 min; max 6 time

CS + Perimortem CS – 11 (55%)

time “baby out” – 0 -20 min (10.3min) Neonatal Outcome ?

TEE – 10 (50%)

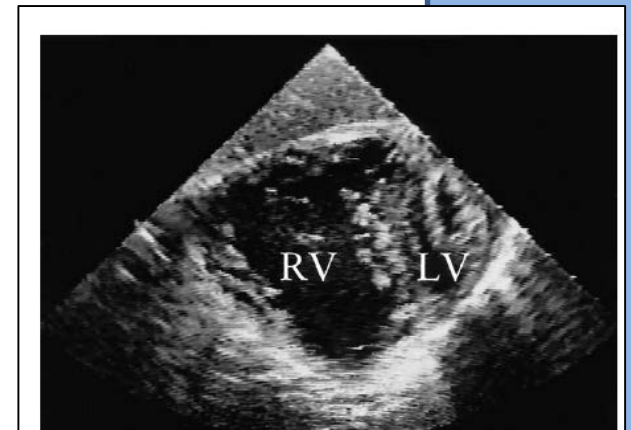
TTE – 2 (10%)

Signs of **Acute R V failure** – 11 (55%)

Arterial line - 14 (70%)

Central line – 9 (45%)

“High flow” line – 9 (45%)



ECMO – 4 (20%); time to connection- 90 – 300 min

## Early maternal complication

**Seizures – 5 (25%)**

**Uterine atonia – 17 (85%)**

**Coagulopathy – 19 (95%)**

**Reoperation (for hysterectomy) – 5 (25%)**

**RF -1 (5%) TRALI – 1 (5%) MOF – 2 (10%)**



**Die – 3 (15%)**

**Severe neurologic injury – 3 (15%)**

**Minor neurologic injury – 5 (25%)**

**ICU 0-30 dais**

**Hospital – up to 80 dais**

**9 (45%) – no residual complication**

# Neonatal Outcome



Perinatal mortality – 20-25%

With only 50% of surviving neonates being neurologically intact.

**Table 3.** Fetal/infant outcomes among confirmed AFE cases  
(*n* = 120 for stillbirths, *n* = 54 for neonatal outcomes\*)

Outcome	<i>n</i> (%)	Adjusted OR (95% CI)
Stillbirth	5 (4.2)	5.9 (2.0–17.4)
Asphyxia	15 (27.8)	36.0 (18.6–69.7)
Mechanical ventilation	17 (31.5)	11.8 (6.0–23.4)
Bacterial sepsis	5 (9.3)	5.0 (1.8–14.0)
Seizure	8 (14.8)	22.8 (9.7–53.3)
Jaundice (nonimmune haemolytic/traumatic)	9 (16.7)	1.4 (0.6–3.2)
Length of stay >7 days	18 (33.3)	18.5 (8.5–40.2)

\*Based on linked maternal and infant file available since 2001/02.

Gist RS, Stafford IP, Leibowitz AB,  
Beilin Y. Amniotic fluid  
embolism. *Anesth  
Analg.* 2009;108:1599–602.

Neonatal outcome in Peri mortem CS for viable baby (> 25 w)

Place of peri mortem CS	Time of Baby Out	Apgar 1 min	Apgar 5 min	Sex	Die
Delivery Suite	13	0	1	M	
Operation Room	14	2	9	F	
Operation Room	17	2	4	M	
Operation Room	10	5	9	M	
Operation Room	12	1	3	NI	
Operation Room	20	8	10	M	
Operation Room	10	1	3	M	
Delivery Suite	5	3	10	F	
Operation Room	4	6	10	NI	

Consider performing PMCD within 4 min of cardiac arrest if there is no ROSC in pregnant patients beyond 20 wk of gestation.

Our data

**2 y a population –based descriptive study**

Estimated rate **5.4 cases /100.000**

46% in DS and 46% in OR

**42% induction or augmentation of labor**

67% underwent of CS

24% after IVF

**42% had full resuscitation**

18% had hysterectomy

**ECMO – no cases**

**85% - Blood or blood products /  
 Recombinant Factor VIIa -24%**

**15% woman died**

7% neonatal mortality

**10 y five hospitals survey**

Estimated rate **4 cases /100.000**

55% in DS and 35% in OR

**No cases of induction or augmentation**

55% underwent of CS

No cases after IVF

**50% had full resuscitation**

25% Hysterectomy

**20% ECMO**

**85% - Blood or blood products/  
 Recombinant Factor VIIa – 5%**

**15% woman died**

No final data about neonatal mortality

# Monitoring and Resuscitation in case of AFE

## AHA Scientific Statement

### Cardiac Arrest in Pregnancy

A Scientific Statement From the American Heart Association

(*Circulation*. 2015;132:1747-1773.

#### Recommendations

1. Chest compressions should be performed at a rate of at least 100 per minute at a depth of at least 2 in (5 cm), allowing full recoil before the next compression, with minimal interruptions, and at a compression-ventilation ratio of 30:2<sup>51</sup> (Class IIa; Level of Evidence C).
2. Interruptions should be minimized and limited to 10 seconds except for specific interventions such as insertion of an advanced airway or use of a defibrillator<sup>51</sup> (Class IIa; Level of Evidence C).
3. The patient should be placed supine for chest compressions (Class I; Level of Evidence C).
4. There is no literature examining the use of mechanical chest compressions in pregnancy, and this is not advised at this time.

**1** - Chest compression 100/min  
5 cm with minimal interruption  
Compress/Ventilation ratio 30:2

**2** – interruption just for 10 sec for  
intubation or defibrillation  
No problem with defibrillation, take  
out the internal (scalp) monitor

**3** – Supine position !!!

**4** – Just manual chest compression

1. Continuous manual LUD should be performed on all pregnant women who are in cardiac arrest in which the uterus is palpated at or above the umbilicus to relieve aortocaval compression during resuscitation (*Class I; Level of Evidence C*).
2. If the uterus is difficult to assess (eg, in the morbidly obese), attempts should be made to perform manual LUD if technically feasible (*Class IIb; Level of Evidence C*).

## Left Uterine Displacement



**Figure 4.** Manual left uterine displacement by the 2-handed technique from the left of the patient.



**Figure 3.** Manual left uterine displacement by the 1-handed technique from the right of the patient during adult resuscitation.

# Perimortem cesarean delivery (PMCD)

Both resuscitation and obstetric guidelines suggest that:

**Perimortem cesarean delivery** be considered within  
**4 minutes** of maternal collapse  
if there is no return of spontaneous circulation (ROSC)  
with the delivery of the fetus within  
**5 minutes** in women beyond 20 weeks of gestation.

**Optimal “Baby out time” < 5 min**  
**<5 min from arrest to delivery – 70% perinatal survival**  
**6-15 min from arrest to delivery – 12% perinatal survival**

Vanden Hoek TL, Morrison LJ, Shuster M, Donnino M, Sinz E, Lavonas EJ, et al. Part 12: cardiac arrest in special situations: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation* 2010;122:S829–61.

Soar J, Perkins GD, Abbas G, Alfonzo A, Barelli A, Bierens JJ, et al. European Resuscitation Council Guidelines for Resuscitation 2010 Section 8. Cardiac arrest in special circumstances: Electrolyte abnormalities, poisoning, drowning, accidental hypothermia, hyperthermia, asthma, anaphylaxis, cardiac surgery, trauma, pregnancy, electrocution. *Resuscitation* 2010;81:1400–33.



## PMCD Technique

The procedure should be performed at the site of the maternal resuscitation. Time should not be wasted moving the patient.

**Table 2. Recommended Equipment for Perimortem Cesarean Section\***

---

Equipment Contents of the Emergency Cesarean Delivery Tray

---

Scalpel with No. 10 blade

Lower end of a Balfour retractor

Pack of sponges

2 Kelly clamps

Needle driver


Russian forceps

Sutures and suture scissors

---

\*The items listed in this table represent suggestions. The contents should be selected to meet the specific needs, preferences, and skills of the practitioner and healthcare facility.

## Perimortem Cesarean Kit

- 
- Knife handle with #10 blade
  - Kelly clamps
  - Mayo scissors
  - Bandage scissors
  - Tooth forceps
  - Needle holders
  - Sutures
  - Laparotomy sponges
  - Clear plastic abdominal drape
  - IV pitocin
  - Normal saline vials
  - Syringes with needle

# ***Echocardiography*** as a part of management of **AFE**

**From 1999**

...Transesophageal echocardiography revealed **normal left ventricular contractility** and **gross enlargement of the right ventricle** and **main pulmonary trunk**, consistent with **acute right ventricular pressure overload** and **underloading of the left ventricle**. Despite resuscitative efforts, the patient died three hours postoperatively

**Amniotic fluid embolism: early findings of transesophageal echocardiography.**

[Anesth Analg.](#) 1999 Dec;89(6):1456-8

[Shechtman M](#)<sup>1</sup>, [Ziser A](#), [Markovits R](#), [Rozenberg B](#)

Department of Anesthesiology, Rambam Medical Center, Haifa, Israel.

## Our experiens

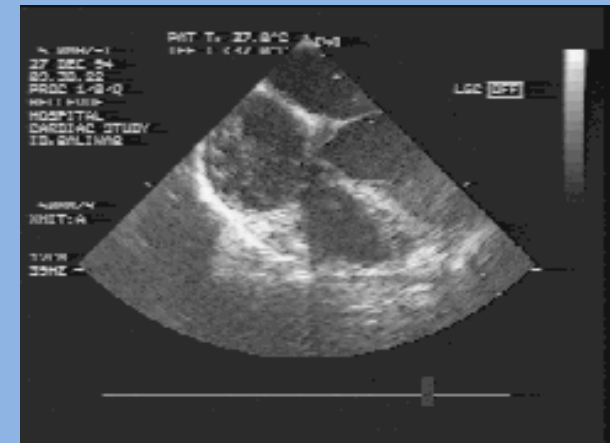
TEE – 10 (50%)

TTE – 2 (10%)



12 cases

Signs of **Acute R V failure** – 11



# From 1999 to 2016

“**Any dyspnea, chest pain, syncope or collapses** must alert women health care providers to engage rapidly the diagnosis process and emergent treatment of the cardio-circulatory failure. The **larger competence of the obstetric anesthetists to perform echocardiographic diagnosis at the parturient bedside helps to a more rapid management** than previously.”

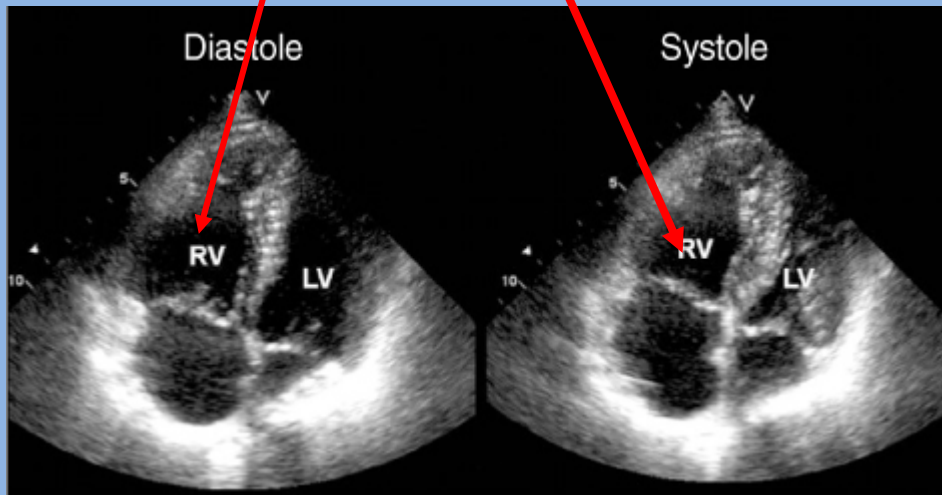
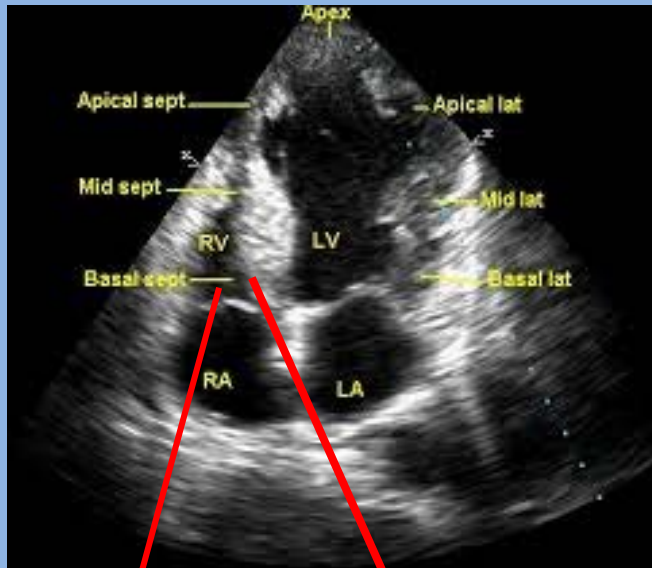
[Anaesth Crit Care Pain Med.](#) **2016 Jul 5.**

**Cardiovascular emergencies and cardiac arrest in a pregnant woman.**

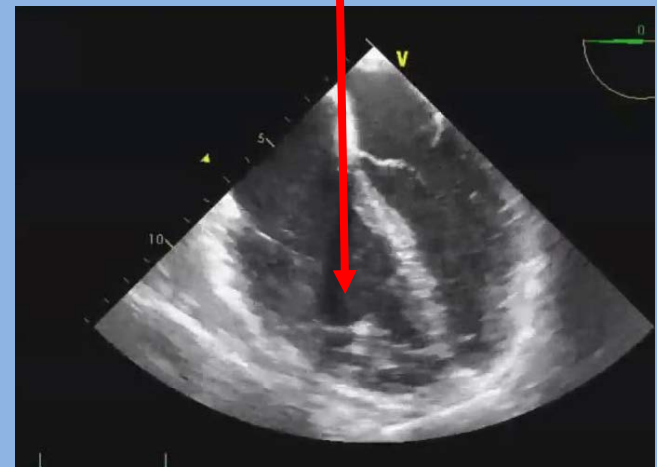
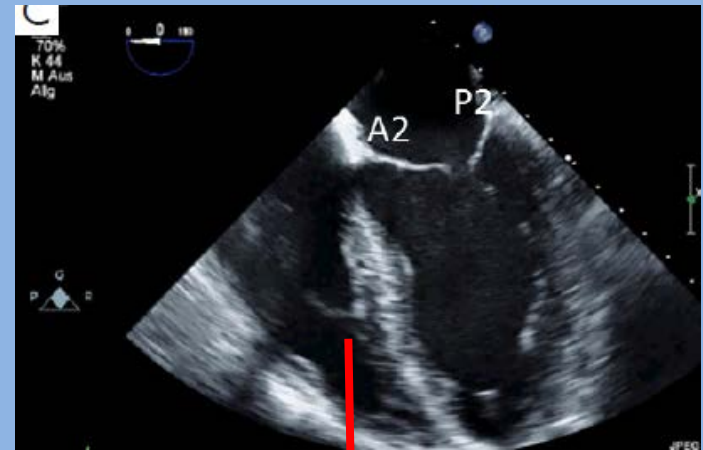
[Ducloy-Bouthors AS](#)

**Transesophageal or  
Focused transthoracic echography**

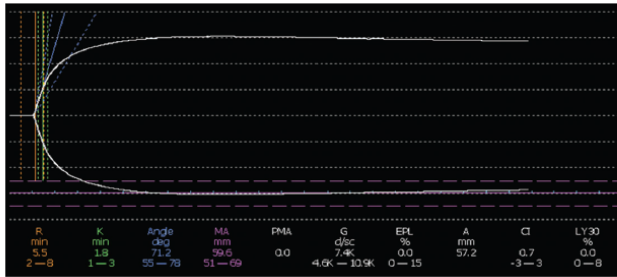
# Focused TTE



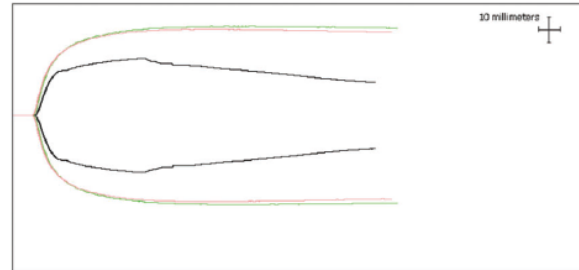
# TEE



# Thromboelastography for management of AFE



**Figure 1** Normal thromboelastography tracing. The normal ranges of its parameters are R (4-8 s), K (0-4 s), angle (47°-74°), and maximal amplitude (54-72 mm).

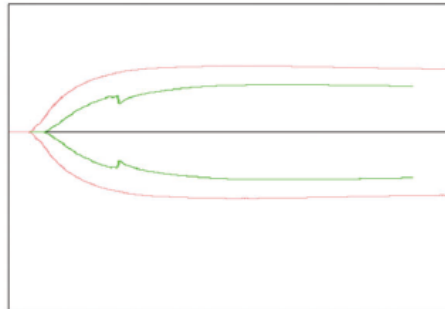


	Hour	R (min)	K (min)	Angle (deg)	MA (mm)	PLT	INR	PTT	FIB
1	05:17	5.8	2.1	68.7	42.8	209	1.36	1.15	279
2	05:56	5.2	1.5	73.2	66.6	229	1.36	1.15	233
3	12:48	5.1	1.4	73.9	64.7	147	1.41	0.9	313

**Figure 2** Thromboelastography (TEG) of the first case. Trace 1 (black) was measured during administrating 8 units of plasma, 16 units of platelets, and 20 units of cryoprecipitate to the patient. It shows a decrease in the strength of the clot (low maximal amplitude). The second trace 2 (green) was recorded about 40 min later and it shows TEG parameters within normal limits. The third trace (red) was taken after the patients received 2 units of plasma, 5 units of platelets, and 10 units of cryoprecipitate. It is similar to the second trace.

8u FFP  
16u PLT  
20u Cryo

2u FFP  
5u PLT  
10u Cryo



2u FFP  
10u Cryo  
-----  
10u Cryo

	Hour	R	K	Angle	MA	PLT	INR	PTT	FIB
1	12:35	362	NA	NA	NA	60	NA	NA	NA
2	16:14	8.4	8.8	48.1	24.1	42	1.85	1.2	72
3	18:44	5.0	4.8	54.6	43.2	57	1.37	0.97	220

**Figure 3** Thromboelastography (TEG) of the second case. The first trace (black) was taken before any blood product was administered to the patient. It shows that no coagulation was detected by the fact that it is a straight line and the international normalized ratio, partial thromboplastin time, and fibrinogen could not be measured. Trace number 2 (green) was taken about 3.5 h later, after administrating to the patient 2 units of plasma and 10 units of cryoprecipitate. Here there is a prolongation of R and K and decrease of the angle. These correspond to a delay in the initiation of the clot and of its propagation. Furthermore, the maximal amplitude severely decreased, aiming towards a weaker clot. The last trace (red) was taken after the patient received 10 units of cryoprecipitate. Although the R normalized, and there is improvement in the other parameters, there is still coagulopathy.

DE GRUYTER

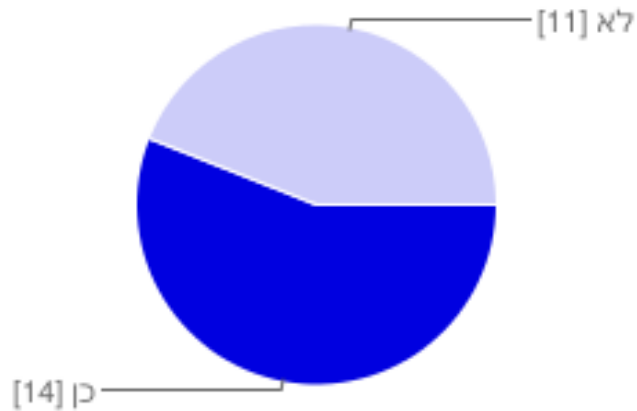
Case Rep. Perinat. Med. 2014; aop

Yigal Helviz<sup>a</sup>, Sharon Einav<sup>a</sup>, Moshe Hersch, Henry Shapiro and Alexander Ioscovich\*

## Thromboelastography as a part of management of amniotic fluid embolism

## TEG for Massive bleeding in CS in Israel

שימוש ב-TEG



Yes	14	56%
No	11	44%

Unpublished data  
2014  
Ioscovich, Weiniger

From 0% in 2006 to 56% from all Obstetric Units in  
2014

# Cardio Pulmonary Bypass or Extra Corporal Membrane Oxygenation as a part of a management of AFE

## ECMO and Intraaortic contrapulsation

Hsieh YY, Chang CC, Li PC, Tsai HD, Tsai CH. Successful application of extracorporeal membrane oxygenation and intraaortic counterpulsation as lifesaving therapy for a patient with amniotic fluid embolism. *Am J Obstet Gynecol* **2000**;183:496–7

Amniotic Fluid Embolism  
Causing Catastrophic Pulmonary  
Vasoconstriction: Diagnosis  
by Transesophageal  
Echocardiogram and Treatment  
by Cardiopulmonary Bypass

Russell D. Stanten, MD, Leigh I. G. Iverson, MD,  
Terrance M. Daugharty, MD,  
Stuart M. Lovett, MD, Crystal Terry, MD, and  
Edward Blumenstock, MD

2003

*Summit Medical Center, Oakland, California*

## Cardiopulmonary Bypass for treatment of AFE

53 min after AFE she was placed on  
CPB

After 83 min - disconnection from  
CPB

# Cardio Pulmonary Bypass or Extra Corporal Membrane Oxygenation as a part of a management of AFE

. The majority of deaths now are in women who do not survive the acute phase: only three of the 12 women who died in the UK series reached the intensive care unit

Incidence and risk factors for amniotic fluid embolism. *Obstetrics and Gynecology* 2010; 115: 910–7.

## Amniotic fluid embolism: incidence, risk factors, and impact on perinatal outcome

MS Kramer,<sup>a</sup> J Rouleau,<sup>b</sup> S Liu,<sup>b</sup> S Bartholomew,<sup>b</sup> KS Joseph<sup>c</sup> for the Maternal Health Study Group of the Canadian Perinatal Surveillance System

<sup>a</sup> Departments of Pediatrics and of Epidemiology, Biostatistics, and Occupational Health, and <sup>b</sup> Maternal and Infant Health Section, Health Surveillance and Control, Public Health Agency of Canada, Ottawa, ON, Canada <sup>c</sup> Department of Pediatrics, Centre of British Columbia, and School of Population and Public Health, Vancouver, BC, Canada  
Correspondence: MS Kramer, 2300 Tupper Street (Les Tourelles), Montreal, QC, Canada

Accepted 25 February 2012. Published Online 24 April 2012.

Canada 2012  
120 cases  
No data about ECMO

Germany 2015

Australia 2015

No data about ECMO



## Early Application of Extracorporeal Membrane Oxygenation in a Patient with Amniotic Fluid Embolism

Chang-Hsun Ho, Kuen-Bao Chen, Shih-Kai Liu, Yu-Fang Liu, Hung-Chun Cheng, Rick Sai-Chuen Wu\*

*Department of Anesthesia, Pain Management and Critical Care Medicine,  
China Medical University Hospital, Taichung, Taiwan, R.O.C.*

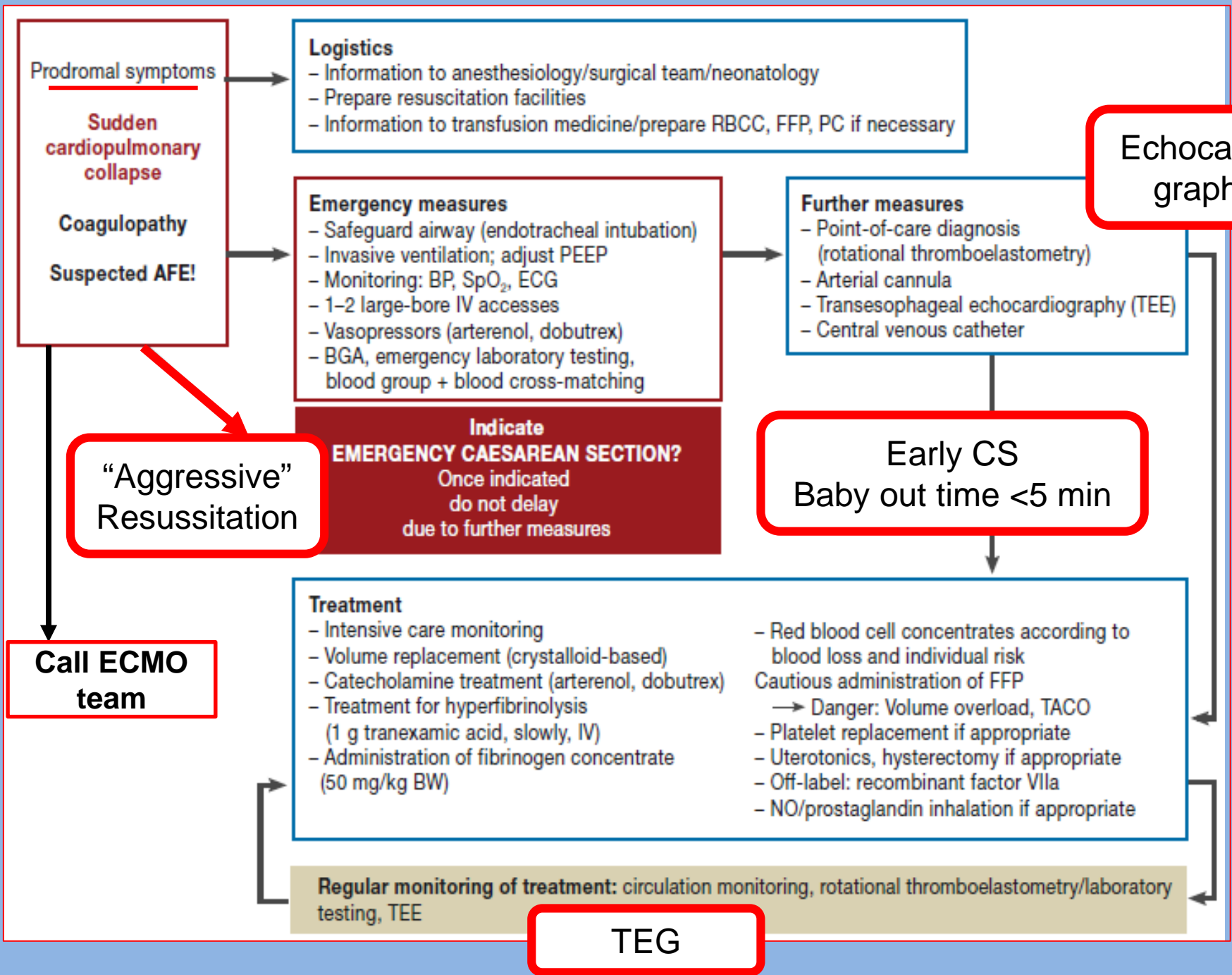


Neurologic sequel

In our case series  
4 patients were connected to ECMO:  
**2 patients die**  
**1 had major neurologic sequel**  
**1 was intact**, but she was connected to ECMO 5h after acute stage of AFE,  
secondary to heard failure

**Inhaled nitric oxide has been used**  
in the treatment of right-sided heart  
failure and pulmonary hypertension.

McDonnell NJ, Chan BO, Frenley RW. Rapid reversal of critical haemodynamic compromise with nitric oxide in a patient with amniotic fluid embolism. *Int J Obstet Anesth* 2007;16:269–73



**Prodromal symptoms**

**Sudden cardiopulmonary collapse**

**Coagulopathy**

**Suspected AFE!**

**Logistics**

- Information to anesthesiology/surgical team/neonatology
- Prepare resuscitation facilities
- Information to transfusion medicine/prepare RBCC, FFP, PC if necessary

**Emergency measures**

- Safeguard airway (endotracheal intubation)
- Invasive ventilation; adjust PEEP
- Monitoring: BP, SpO<sub>2</sub>, ECG
- 1-2 large-bore IV accesses
- Vasopressors (arterenol, dobutrex)
- BGA, emergency laboratory testing, blood group + blood cross-matching

**Further measures**

- Point-of-care diagnosis (rotational thromboelastometry)
- Arterial cannula
- Transesophageal echocardiography (TEE)
- Central venous catheter

**Echocardiography**

**“Aggressive” Resuscitation**

**Indicate EMERGENCY CAESAREAN SECTION?**

Once indicated do not delay due to further measures

**Early CS**  
Baby out time <5 min

**Call ECMO team**

**Treatment**

- Intensive care monitoring
- Volume replacement (crystalloid-based)
- Catecholamine treatment (arterenol, dobutrex)
- Treatment for hyperfibrinolysis (1 g tranexamic acid, slowly, IV)
- Administration of fibrinogen concentrate (50 mg/kg BW)
- Red blood cell concentrates according to blood loss and individual risk
- Cautious administration of FFP  
→ Danger: Volume overload, TACO
- Platelet replacement if appropriate
- Uterotonics, hysterectomy if appropriate
- Off-label: recombinant factor VIIa
- NO/prostaglandin inhalation if appropriate

**Regular monitoring of treatment: circulation monitoring, rotational thromboelastometry/laboratory testing, TEE**

**TEG**



# Welcome to Israel!

**The 24<sup>th</sup> International Conference of**  
The Israel Society of Anesthesiologists jointly with  
The Israel Society of Critical Care Medicine  
**Anesthesia in the Modern Era: Anytime, Anywhere**

**November 7-8, 2017, Tel –Aviv**



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