Gemelli

Fondazione Policlinico Universitario Agostino Gemelli IRCCS
Università Cattolica del Sacro Cuore

IL CESAREO PERI-MORTEM

Luciano Frassanito

U.O.C. Anestesia in Ginecologia, Ostetricia e Terapia del Dolore 2

IRCCS Fondazione Policlinico A. Gemelli - Roma

luciano.frassanito@policlinicogemelli.it

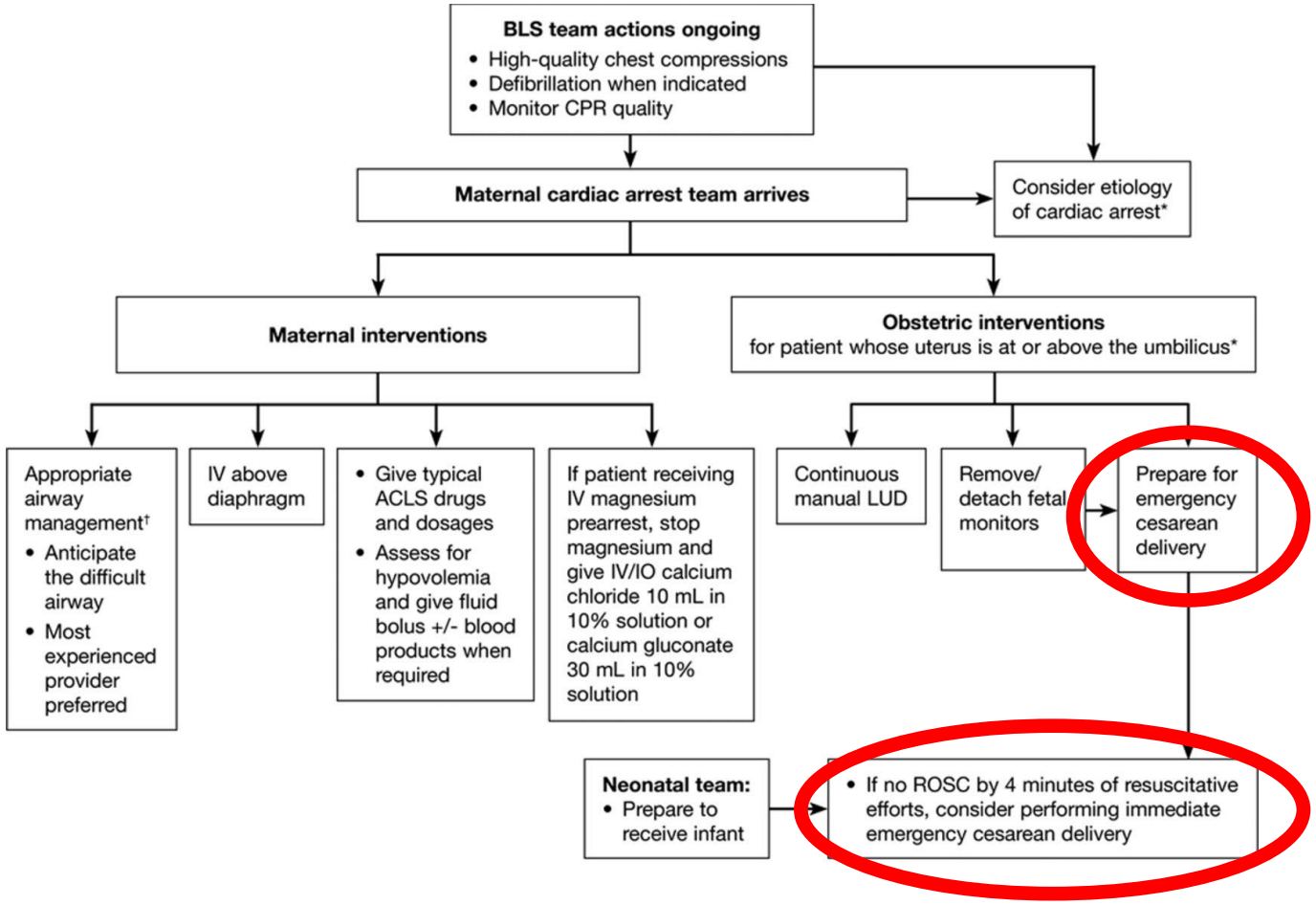
@lucianofrassan4

ESRA Cè

XXIX CONGRESSO NAZIONALE

ESRA Italian Chapter

CESENA, Cesena Fiera



*Potential etiology of maternal cardiac arrest:

A Anesthetic complications/accidents
B Bleeding
C Cardiovascular
D Drugs
E Embolic
F Fever
G General nonobstetric causes of cardiac arrest (H's and T's)
H Hypertension

†Appropriate airway management for pregnancy:

- 100% oxygen at ≥15 L/min and continue BLS airway strategies
- Optimally 2 attempts per technique:
  - First intubation attempt—if failed go to
  - Second intubation attempt—if failed go to
  - First supraglottic airway attempt—if failed go to
  - Second supraglottic airway attempt—if failed go to mask ventilation
  - If mask ventilation inadequate—attempt cricothyrotomy
- Avoid airway trauma
- Ventilate with 8–10 breaths/min
- Monitor capnography
- Minimize interruptions in chest compressions during advanced airway placement
- Recommend 6.0- to 7.0-mm inner diameter ETT

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Circulation

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RESEARCH ARTICLE | Originally Published 6 October 2015 | Check for updates

Cardiac Arrest in Pregnancy: A Scientific Statement From the American Heart Association

Perimortem Cesarean Delivery (PMCD)

Available online at www.sciencedirect.com

Resuscitation

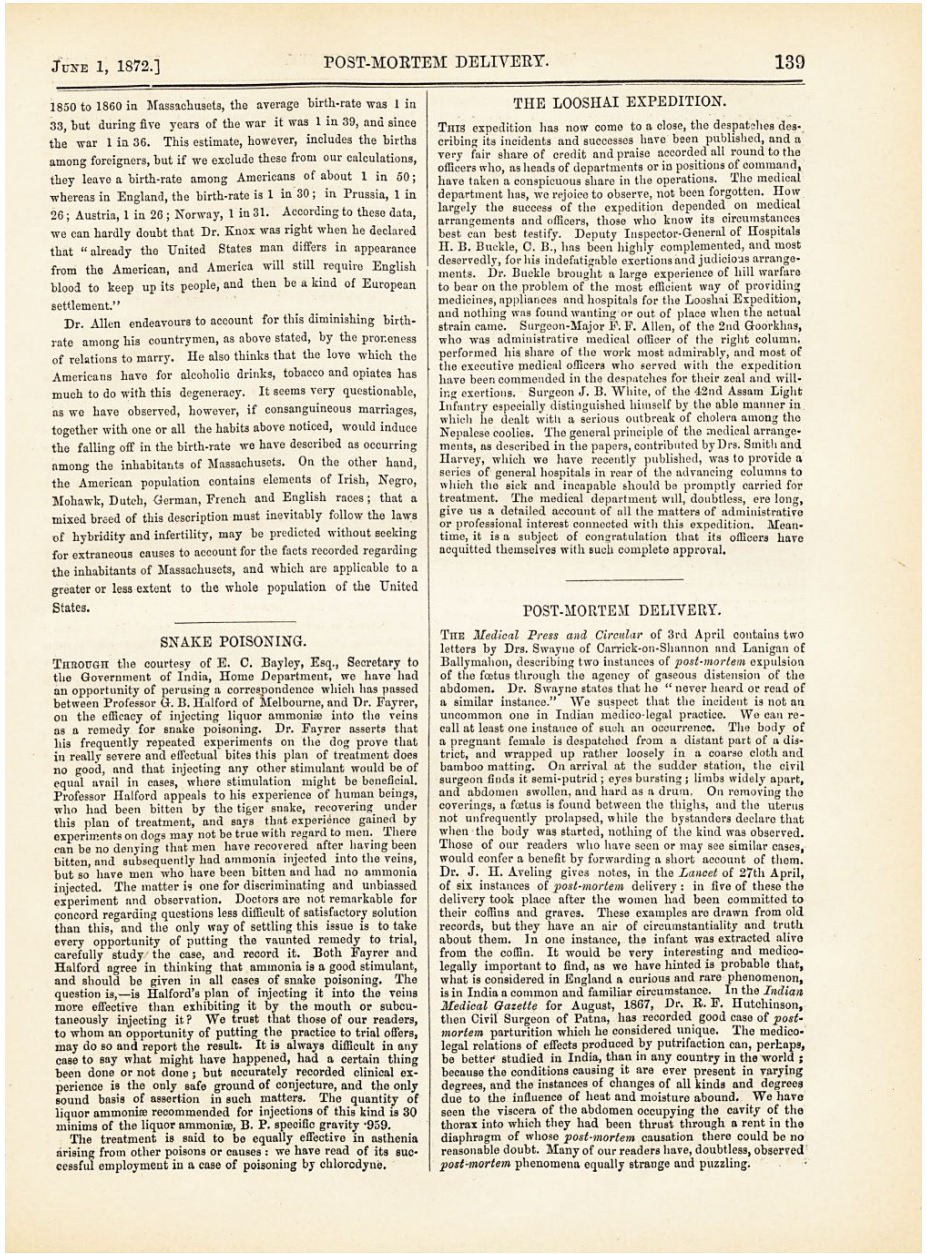
journal homepage: www.elsevier.com/locate/resuscitation

ELSEVIER

EUROPEAN RESUSCITATION COUNCIL

European Resuscitation Council Guidelines 2021: Cardiac arrest in special circumstances

Carsten Lott[a,], Anatolij Truhlář[b,c], Annette Alfonzo[d], Alessandro Barelli[e], Violeta González-Salvado[f], Jochen Hinkelbein[g], Jerry P. Nolan[h,i], Peter Paal[j], Gavin D. Perkins[k,l], Karl-Christian Thies[m], Joyce Yeung[k,l], David A. Zideman[n], Jasmeet Soar[o], the ERC Special Circumstances Writing Group Collaborators[1]*



JUNE 1, 1872.] POST-MORTEM DELIVERY. 139

1850 to 1860 in Massachusets, the average birth-rate was 1 in 33, but during five years of the war it was 1 in 39, and since the war 1 in 36. This estimate, however, includes the births among foreigners, but if we exclude these from our calculations, they leave a birth-rate among Americans of about 1 in 50; whereas in England, the birth-rate is 1 in 30; in Prussia, 1 in 26; Austria, 1 in 26; Norway, 1 in 31. According to these data, we can hardly doubt that Dr. Knox was right when he declared that "already the United States man differs in appearance from the American, and America will still require English blood to keep up its people, and then be a kind of European settlement."

Dr. Allen endeavours to account for this diminishing birth-rate among his countrymen, as above stated, by the proneness of relations to marry. He also thinks that the love which the Americans have for alcoholic drinks, tobacco and opiates has much to do with this degeneracy. It seems very questionable, as we have observed, however, if consanguineous marriages, together with one or all the habits above noticed, would induce the falling off in the birth-rate we have described as occurring among the inhabitants of Massachusets. On the other hand, the American population contains elements of Irish, Negro, Mohawk, Dutch, German, French and English races; that a mixed breed of this description must inevitably follow the laws of hybridity and infertility, may be predicted without seeking for extraneous causes to account for the facts recorded regarding the inhabitants of Massachusets, and which are applicable to a greater or less extent to the whole population of the United States.

SNAKE POISONING.

THROUGH the courtesy of E. C. Bayley, Esq., Secretary to the Government of India, Home Department, we have had an opportunity of perusing a correspondence which has passed between Professor G. B. Halford of Melbourne, and Dr. Fayrer, on the efficacy of injecting liquor ammoniæ into the veins as a remedy for snake poisoning. Dr. Fayrer asserts that his frequently repeated experiments on the dog prove that in really severe and effectual bites this plan of treatment does no good, and that injecting any other stimulant would be of equal avail in cases, where stimulation might be beneficial. Professor Halford appeals to his experience of human beings, who had been bitten by the tiger snake, recovering under this plan of treatment, and says that experience gained by experiments on dogs may not be true with regard to men. There can be no denying that men have recovered after having been bitten, and subsequently had ammonia injected into the veins, but so have men who have been bitten and had no ammonia injected. The matter is one for discriminating and unbiassed experiment and observation. Doctors are not remarkable for concord regarding questions less difficult of satisfactory solution than this, and the only way of settling this issue is to take every opportunity of putting the vaunted remedy to trial, carefully study the case, and record it. Both Fayrer and Halford agree in thinking that ammonia is a good stimulant, and should be given in all cases of snake poisoning. The question is,—is Halford's plan of injecting it into the veins more effective than exhibiting it by the mouth or subcutaneously injecting it? We trust that those of our readers, to whom an opportunity of putting the practice to trial offers, may do so and report the result. It is always difficult in any case to say what might have happened, had a certain thing been done or not done; but accurately recorded clinical experience is the only safe ground of conjecture, and the only sound basis of assertion in such matters. The quantity of liquor ammoniæ recommended for injections of this kind is 30 minims of the liquor ammoniæ, B. P. specific gravity .959.

The treatment is said to be equally effective in asthenia arising from other poisons or causes: we have read of its successful employment in a case of poisoning by chlorodyne.

THE LOOSHAI EXPEDITION.

THIS expedition has now come to a close, the despatches describing its incidents and successes have been published, and a very fair share of credit and praise accorded all round to the officers who, as heads of departments or in positions of command, have taken a conspicuous share in the operations. The medical department has, we rejoice to observe, not been forgotten. How largely the success of the expedition depended on medical arrangements and officers, those who know its circumstances best can best testify. Deputy Inspector-General of Hospitals H. B. Buckle, C. B., has been highly complemented, and most deservedly, for his indefatigable exertions and judicious arrangements. Dr. Buckle brought a large experience of hill warfare to bear on the problem of the most efficient way of providing medicines, appliances and hospitals for the Looshai Expedition, and nothing was found wanting or out of place when the actual strain came. Surgeon-Major F. F. Allen, of the 2nd Goorkhas, who was administrative medical officer of the right column, performed his share of the work most admirably, and most of the executive medical officers who served with the expedition have been commended in the despatches for their zeal and willing exertions. Surgeon J. B. White, of the 42nd Assam Light Infantry especially distinguished himself by the able manner in which he dealt with a serious outbreak of cholera among the Nepalese coolies. The general principle of the medical arrangements, as described in the papers, contributed by Drs. Smith and Harvey, which we have recently published, was to provide a series of general hospitals in rear of the advancing columns to which the sick and incapable should be promptly carried for treatment. The medical department will, doubtless, ere long, give us a detailed account of all the matters of administrative or professional interest connected with this expedition. Meantime, it is a subject of congratulation that its officers have acquitted themselves with such complete approval.

POST-MORTEM DELIVERY.

THE *Medical Press and Circular* of 3rd April contains two letters by Drs. Swayne of Carrick-on-Shannon and Lanigan of Ballymahon, describing two instances of *post-mortem* expulsion of the fœtus through the agency of gaseous distension of the abdomen. Dr. Swayne states that he "never heard or read of a similar instance." We suspect that the incident is not an uncommon one in Indian medico-legal practice. We can recall at least one instance of such an occurrence. The body of a pregnant female is despatched from a distant part of a district, and wrapped up rather loosely in a coarse cloth and bamboo matting. On arrival at the sudder station, the civil surgeon finds it semi-putrid; eyes bursting; limbs widely apart, and abdomen swollen, and hard as a drum. On removing the coverings, a fœtus is found between the thighs, and the uterus not unfrequently prolapsed, while the bystanders declare that when the body was started, nothing of the kind was observed. Those of our readers who have seen or may see similar cases, would confer a benefit by forwarding a short account of them. Dr. J. H. Aveling gives notes, in the *Lancet* of 27th April, of six instances of *post-mortem* delivery: in five of these the delivery took place after the women had been committed to their coffins and graves. These examples are drawn from old records, but they have an air of circumstantiality and truth about them. In one instance, the infant was extracted alive from the coffin. It would be very interesting and medico-legally important to find, as we have hinted is probable that, what is considered in England a curious and rare phenomenon, is in India a common and familiar circumstance. In the *Indian Medical Gazette* for August, 1867, Dr. R. F. Hutchinson, then Civil Surgeon of Patna, has recorded good case of *post-mortem* parturition which he considered unique. The medico-legal relations of effects produced by putrifaction can, perhaps, be better studied in India, than in any country in the world; because the conditions causing it are ever present in varying degrees, and the instances of changes of all kinds and degrees due to the influence of heat and moisture abound. We have seen the viscera of the abdomen occupying the cavity of the thorax into which they had been thrust through a rent in the diaphragm of whose *post-mortem* causation there could be no reasonable doubt. Many of our readers have, doubtless, observed *post-mortem* phenomena equally strange and puzzling.

Perimortem Cesarean Delivery

Resuscitative hysterotomy / perimortem Caesarean section (PMCS) / perimortem Caesarean delivery (PMCD): hysterotomy performed to resuscitate a woman in middle to late pregnancy who has entered cardiac arrest.

Post-Mortem Delivery. Ind Med Gaz. 1872 Jun 1;7(6):139.
Duer EL. Post-mortem delivery. Am J Obstet Gynecol. 1879. 12:1.
Ritter JW. Postmortem cesarean section. JAMA. 1961 Feb 25;175:715-6.
Katz VL et al. Peri-mortem cesarean delivery. Obstet Gynecol. 1986 Oct;68(4):571-6.

MCPA

Complex medical situation

Cognitive factors

Emotional circumstances

EXPEDIENTLY BALANCE COMPETING MATERNAL AND FETAL PRIORITIES

Jeejeebhoy FM et al. Circulation. 2015 Nov 3;132(18):1747-73.

Rose CH et al. Am J Obstet Gynecol. 2015 Nov;213(5):653-6.

Purpose of timely PMCD

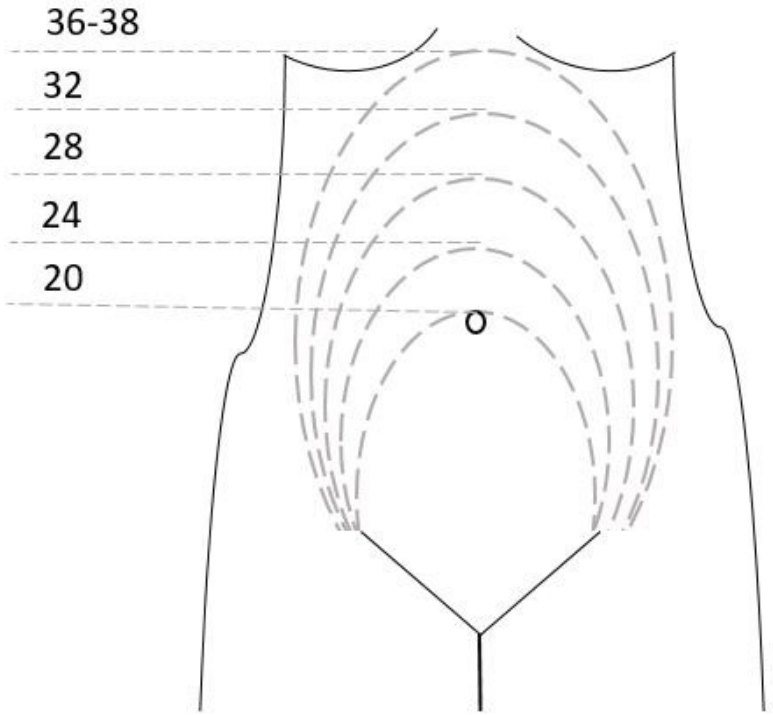
1) ***GE > 24 weeks*** **-** Early delivery of the baby with a decreased risk of permanent neurological damage from anoxia.
2) ***GE > 20 weeks*** **-** Facilitation of resuscitation increasing chances of maternal ROSC (if maternal uterus extends to or above the umbilicus):
   - relieving aortocaval compression,
   - reducing uterine blood flow,
   - relieving diaphragmatic pressure.
3) ***GE < 20 weeks*** - PMCD should not be considered.

ACLS should be underway.

Available online at www.sciencedirect.com
Resuscitation
journal homepage: www.elsevier.com/locate/resuscitation
EUROPEAN RESUSCITATION COUNCIL

European Resuscitation Council Guidelines 2021: Cardiac arrest in special circumstances

Carsten Lott[a,], Anatolij Truhlář[b,c], Annette Alfonzo[d], Alessandro Barelli[e], Violeta González-Salvado[f], Jochen Hinkelbein[g], Jerry P. Nolan[h,i], Peter Paal[j], Gavin D. Perkins[k,l], Karl-Christian Thies[m], Joyce Yeung[k,l], David A. Zideman[n], Jasmeet Soar[o], the ERC Special Circumstances Writing Group Collaborators[†]*



Katz VL et al. Obstet Gynecol. 1986 Oct;68(4):571-6.
Rose CH et al. Am J Obstet Gynecol. 2015 Nov;213(5):653-6.
Lott C et al. Resuscitation. 2021 Apr;161:152-219.

Perimortem cesarean delivery: Were our assumptions correct?

PMCD should be commenced at 4 minutes and completed by 5 minutes to optimize fetal outcome.

*"For obvious reasons, the theory on which the 4-minute recommendation for perimortem delivery is based **cannot be tested in clinical trials**. Also, for obvious reasons, the sooner an infant is delivered after a mother arrests, the greater the likelihood of intact survival."*

- **difficulties of accomplishing delivery within 5 minutes in actual scenarios;**
- **transitioning from the mind-set of maternal resuscitation to a laparotomy seems barbaric and teleologically indicative of forfeiture of further attempts at maternal salvage;**
- **the term PMCD implies eventual mortality of the mother and prioritization of fetal status at potential maternal expense, a fetocentric perspective.**

Katz V et al. Am J Obstet Gynecol. 2005 Jun;192(6):1916-20.

Rose CH et al. Am J Obstet Gynecol. 2015 Nov;213(5):653-6.

Call to Action

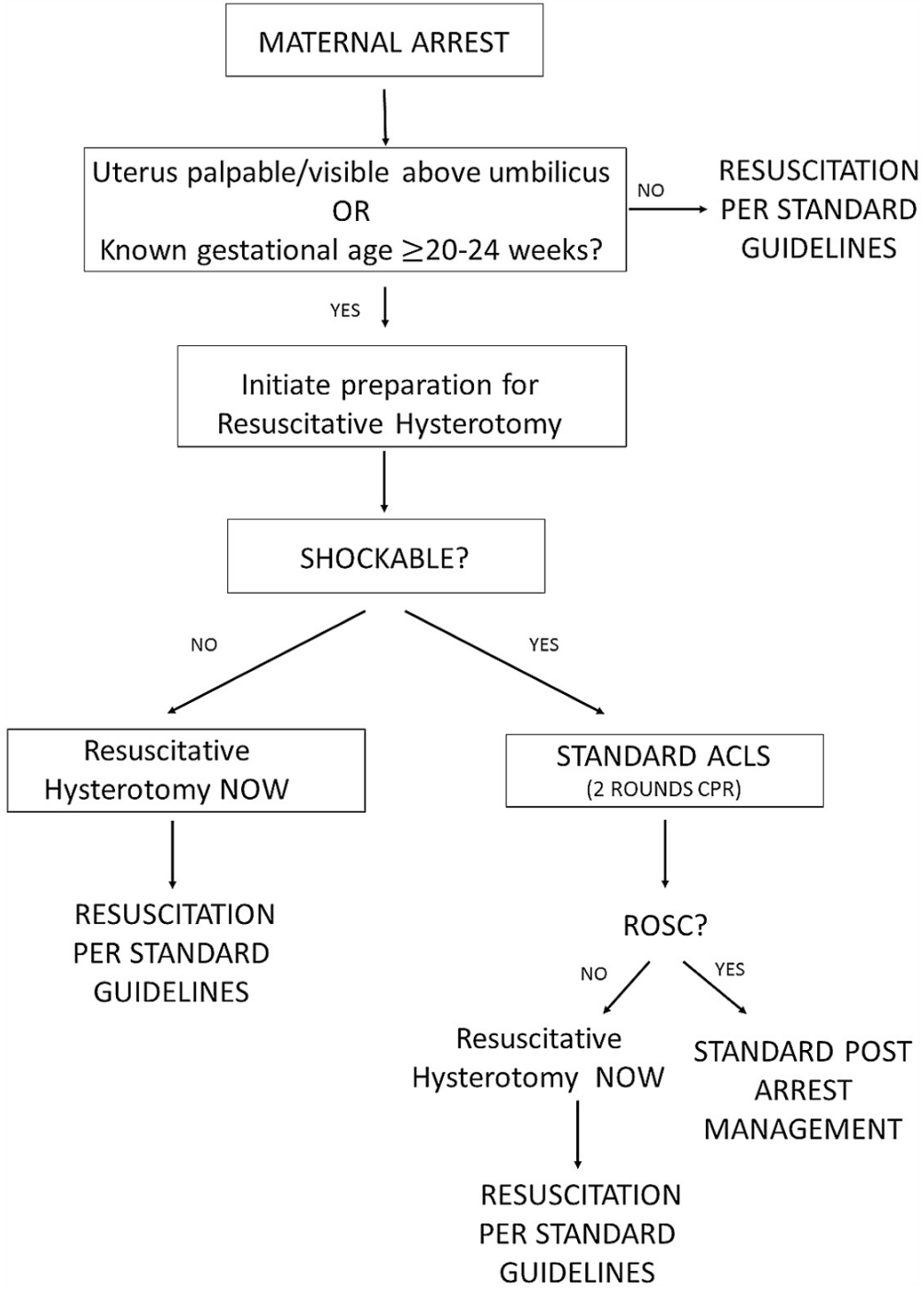
Challenging the 4- to 5-minute rule: from perimortem cesarean to resuscitative hysterotomy

PERIMORTEM CESAREAN

↓

RESUSCITATIVE HYSTEROTOMY

Transition from a fetocentric to a maternofetal resuscitative protocol where both outcomes are considered in parallel



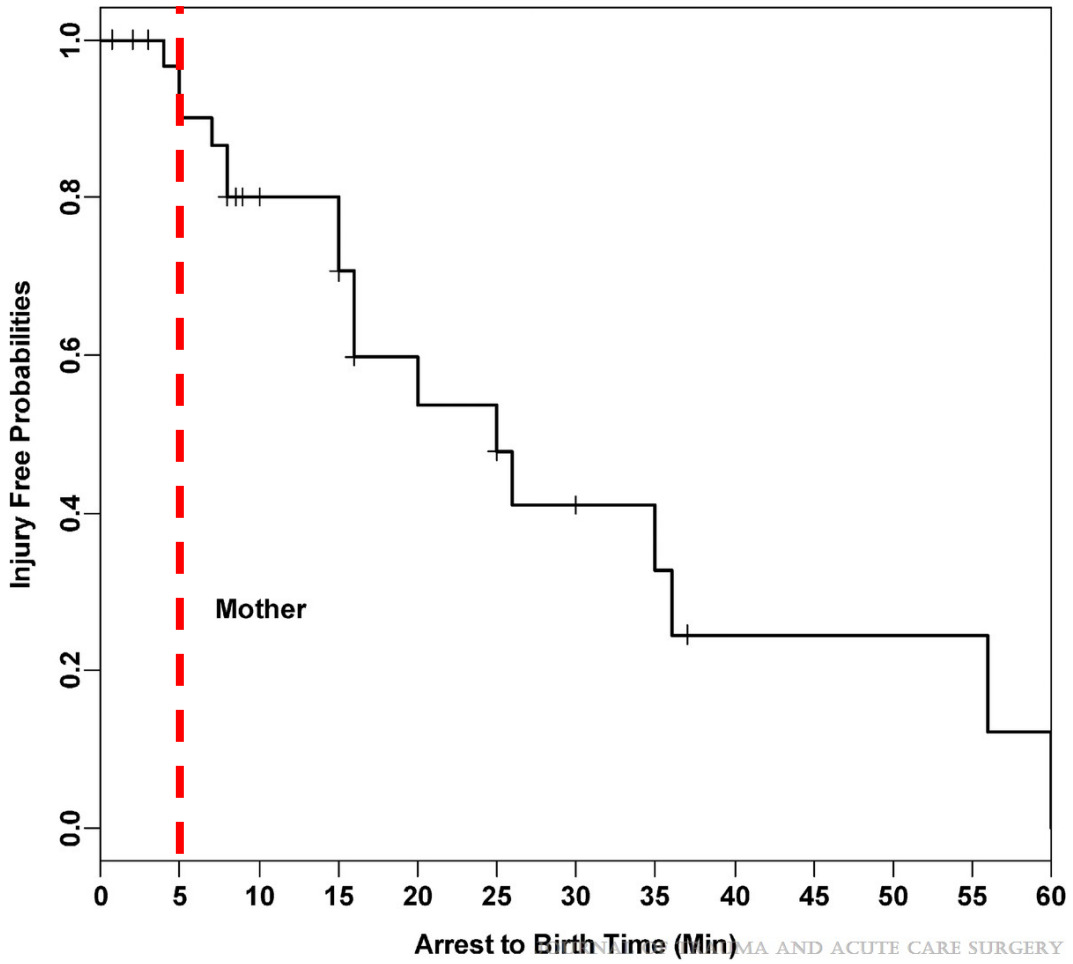
Rose CH et al. Am J Obstet Gynecol. 2015 Nov;213(5):653-6, 653.e1.

Research Paper

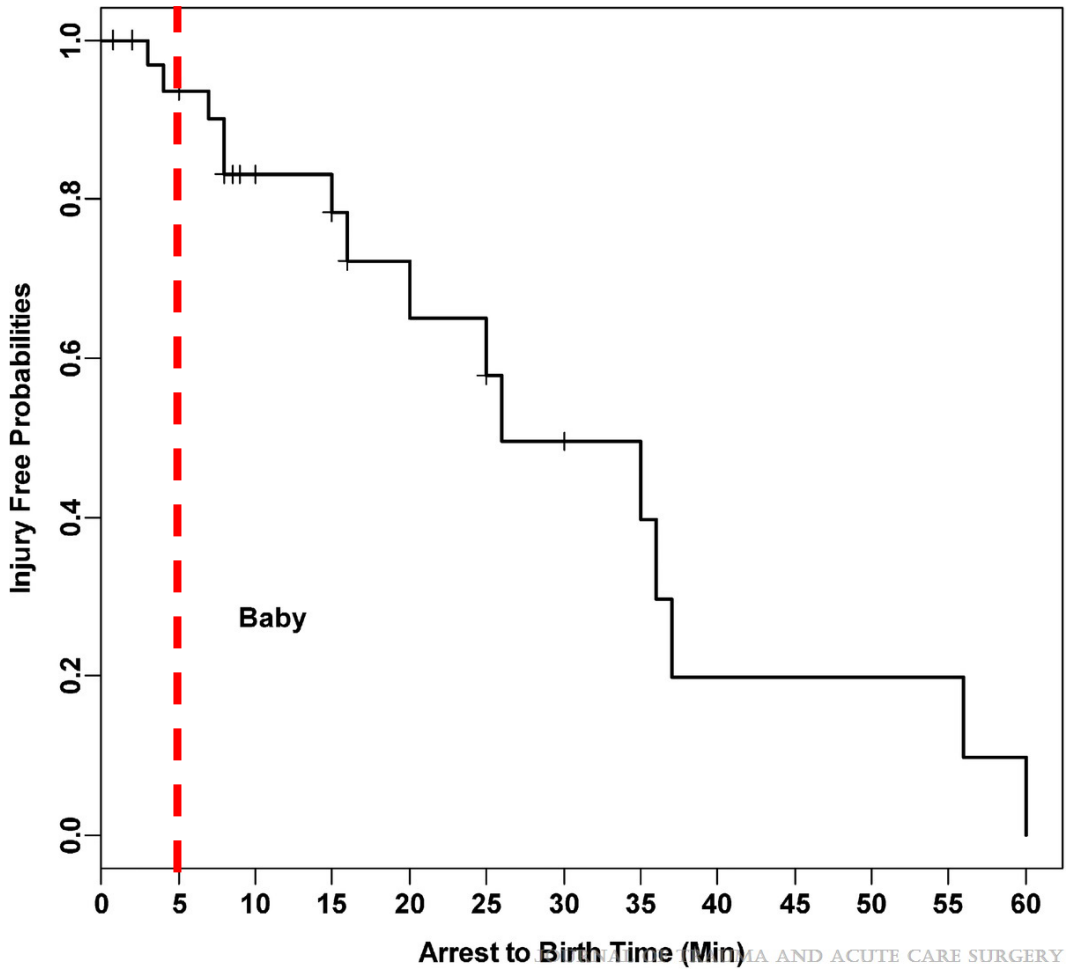
Maternal collapse: Challenging the four-minute rule

Benson M.D. [a,*], Padovano A. [b], Bourjeily G. [c], Zhou Y. [d]

Injury-free survival rate for pregnant women as a function of time.



Injury free survival curve for newborn as a function of time.



Benson MD et al. EBioMedicine. 2016 Apr;6:253-257.

The CAPS Study: incidence, management and outcomes of cardiac arrest in pregnancy in the UK: a prospective, descriptive study

VA Beckett,[a] M Knight,[b] P Sharpe[c]

66 maternal cardiac arrests
49 women underwent PMCS.

Table 2. Time to emergency procedures in minutes, median (range), following maternal collapse

	Women who survived (n = 38)	Women who died (n = 28)	P-value
Collapse to BLS	0 (0–17)	0 (0–23)	0.28
Collapse to ALS	1 (0–36)	0 (0–24)	0.08
Collapse to PMCS	3 (0–39)	12 (0–67)	0.01

Mann–Whitney *U* tests for nonparametric data were applied.

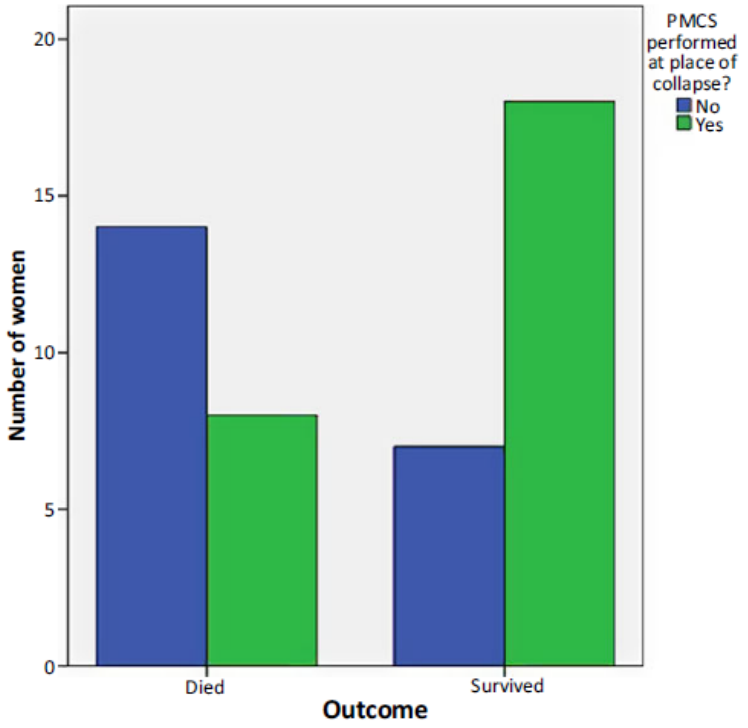


Table 1. Characteristics of women who survived or died following cardiac arrest

	All women	Women who survived (n = 38)	Women who died (n = 28)	P-value	Unadjusted		Adjusted	
					OR	P-value	OR	P-value
Age								
<35 years	40 (61)	22 (33)	18 (27)	0.59	1.00	0.600	**	**
>35 years	26 (39)	16 (24)	10 (16)		1.31 (0.48–3.58)			
Ethnicity								
White British	35 (53)	17 (26)	18 (27)	0.12	1.00	0.118	1.00	0.117
Other	31 (47)	21 (32)	10 (15)		2.22 (0.82–6.06)		2.74 (0.78–9.67)	
BMI (kg/m^2)								
<30	38 (60)	18 (29)	20 (31)	0.02	1.00	0.027	1.00	0.017
≥30	25 (40)	19 (30)	6 (10)		3.52 (1.15–10.75)		5.86 (1.38–24.97)	
Paid employment								
No	31 (49)	16 (25)	15 (24)	0.38	1.00	0.384	**	**
Yes	32 (51)	20 (32)	12 (19)		1.56 (0.57–4.27)			
Smoked in pregnancy								
No	51 (80)	29 (45)	22 (34)	0.43	1.00	0.968	**	**
Yes	13 (20)	8 (13)	5 (8)		1.03 (0.29–3.67)			
Gestation at arrest (completed weeks)	37 (20–42)	38 (20–42)	35 (20–41)	0.03	1.09 (0.99–1.19)	0.084	1.09 (0.98–1.20)	0.117

PMCS factor	Number of women (n = 49)
Decision made by	
Obstetrician	43
Anaesthetist	1
Other clinician	2
Missing	3
Operation performed by	
Obstetrician	46 (26 by Consultant grade)
Other clinician	1
Missing	2
Aseptic precautions	
None	12
Skin preparation	11
Sterile drapes	6
Sterile gloves	11
Full scrub	8
Sterile gown	4
Antibiotics	5
Time from arrest to PMCS	
Less than 5 minutes	30/49 (61%)
5 minutes or more	17/49 (35%)
Not known	2/49 (4%)

Beckett VA et al. BJOG. 2017 Aug;124(9):1374-1381.

Contents lists available at SciVerse ScienceDirect

Resuscitation

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

Review article

Maternal cardiac arrest and perimortem caesarean delivery: Evidence or expert-based?☆,☆☆

Sharon Einav[a,*], Nechama Kaufman[a,b], Hen Y. Sela[c]

Table 2
Logistic regression analysis of variables potentially predictive of maternal survival.

Variable	*n*	Univariable		Multivariable	
		OR (95%CI)	*p*-Value	OR (95%CI)	*p*-Value
Witnessed arrest	84/87	2.80 (0.24–32.10)	0.408	Not in model	
In-hospital arrest location	63/90	6.14 (2.23–16.88)	<0.001	7.42 (1.32–41.60)	0.023
Presenting rhythm (alternative models)					
VT/VF	23/83	1.25 (0.46–3.40)	0.662	Not in model	
PEA	72/83	7.56 (0.92–62.23)	0.060	13.1 (0.95–178)	0.54
Not asystole	59/83	1.95 (0.74–5.12)	0.175	Not in model	
Time from arrest to PMCD (alternative models)					
Yes, at any time	57/57	1.146 (1.06–1.24)	0.001	Not in model	
Within <5 min	4/57	3.625 (0.35–37.14)	0.278	Not in model	
Within <10 min	18/57	11.25 (2.74–46.26)	0.001	5.17 (1.06–25.15)	0.042
Within <15 min	32/57	8.80 (5.57–30.18)	0.001	Not in model	
Gestational age <28 weeks	16/85	1.28 (0.42–3.92)	0.663	Not in model	
Gestational age <30 weeks	20/85	1.135 (0.41–3.15)	0.808	Not in model	

Table 3
Logistic regression analysis of variables potentially predictive of firstborn neonatal survival in viable pregnancies. Among the 86 viable pregnancies there were two cases in which neonatal survival was not described. Overall, 57 of the 84 firstborn neonates whose outcome was described also survived.

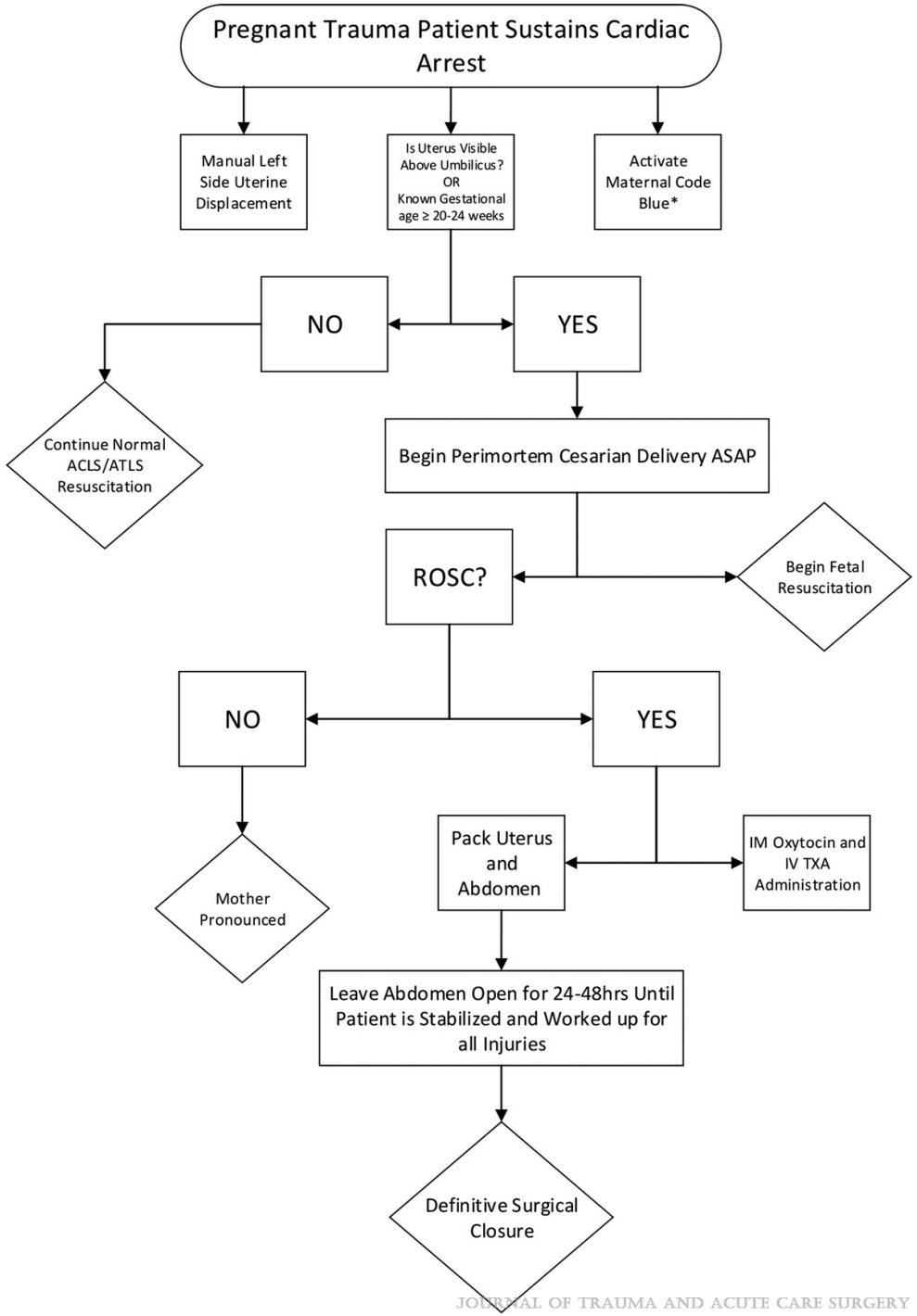
Variable	*n*	Univariable		Multivariable	
		OR (95%CI)	*p*-Value	OR (95%CI)	*p*-Value
Witnessed arrest	75/77	1	<0.000	Not in model[a]	
In-hospital arrest location	57/80	17.35 (5.26–57.25)	<0.001	13.02 (2.85–59.54)	0.001
Presenting rhythm (alternative models)					
VT/VF	17/73	3.27 (0.67–15.9)	0.142	Not in model	
Not PEA	64/73	1.5 (0.34–6.7)	0.596	Not in model	
Not asystole	50/73	1.89 (0.64–5.61)	0.251	Not in model	
Time from arrest to PMCD (alternative models)					
<5 min	4/57	1.68 (0.16–17.26)	0.664	Not in model	
<10 min	18/57	6.86 (1.39–33.93)	0.018	2.62 (0.41–16.69)	0.307
<15 min	32/57	3.87 (1.23–12.2)	0.021	Not in model	
FHR detected	73/81	3.86 (0.85–17.6)	0.081	2.14 (0.22–20.93)	0.513
Gestational age >28 weeks	67/75	3.19 (0.71–14.22)	0.129	Not in model	
Gestational age >30 weeks	63/75	2.27 (0.63–8.27)	0.208	Not in model	

[a] Unwitnessed arrest synonymous with death.

- 80 relevant papers (a total of 94 patients);
- in 32% PMCD was considered beneficial to maternal survival;
- ***in no instances proved detrimental***;
- ***54.3% of mothers survived*** to hospital discharge;
- 78.4% good to moderately impaired neurological outcome;
- ***maternal outcomes*** more favourable when PMCD was performed ***within 10 minutes*** of cardiac arrest, (OR 7.42, $P < 0.05$);
- ***neonatal survivors*** had a shorter ***mean cardiac arrest-to delivery time of 14 + 11 minutes*** compared to non-survivors (22 ± 13 minutes);
- neonatal survival only occurred in cases of maternal cardiac arrest in hospital;
- PMCS is not usually started within the ideal 4- and 5- minute timeframes; even when these timeframes are breached, maternal or fetal benefits are still possible (reports of healthy infants being delivered 30 minutes after maternal cardiac arrest).

Einav S et al. Resuscitation. 2012 Oct;83(10):1191-200.

Perimortem cesarean section after severe injury: What you need to know



Larson NJ et al. J Trauma Acute Care Surg. 2024 Nov 1;97(5):670-677.

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Best Practice & Research Clinical Obstetrics and Gynaecology

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

11

Management of cardiac arrest in pregnancy

Farida Jeejeebhoy, MD, FRCPC, FACC, Lecturer [a,*],
Rory Windrim, MB, MSc, FRCS, Professor [b,1]

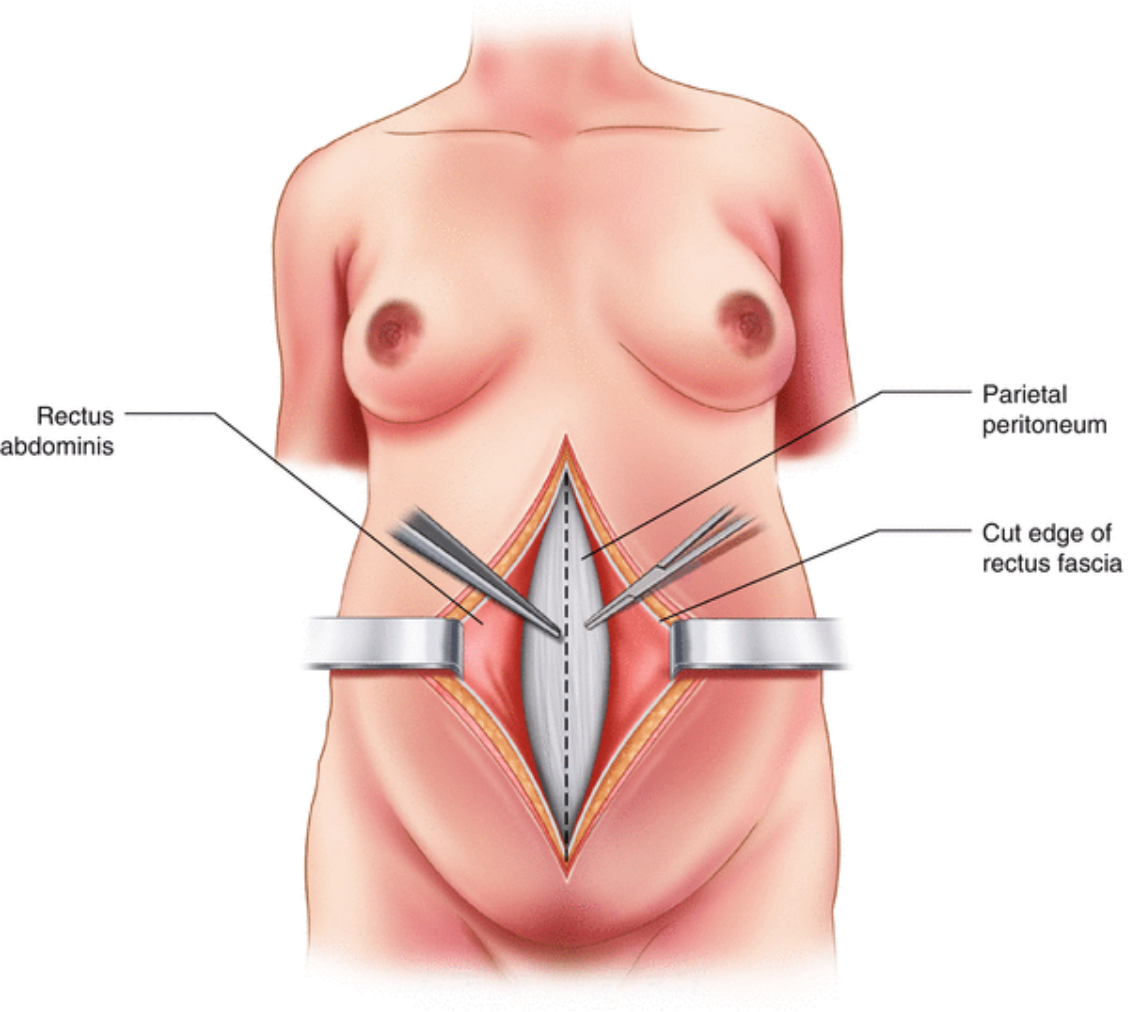


Table 1
Recommended equipment in high risk areas.

Equipment contents of the emergency caesarean section tray	Equipment for neonatal resuscitation and stabilisation
Scalpel with number 10 blade	Over-bed warmer
Lower end of Balfour retractor	Neonatal airway supplies
Pack of sponges	Umbilical access
Two Kelly clamps	Medications (e.g. epinephrine 1: 10,000 (0.1 mg/ml))
Needle driver	
Russian forceps	
Sutures and suture scissors	

The ideal resuscitation team and equipment

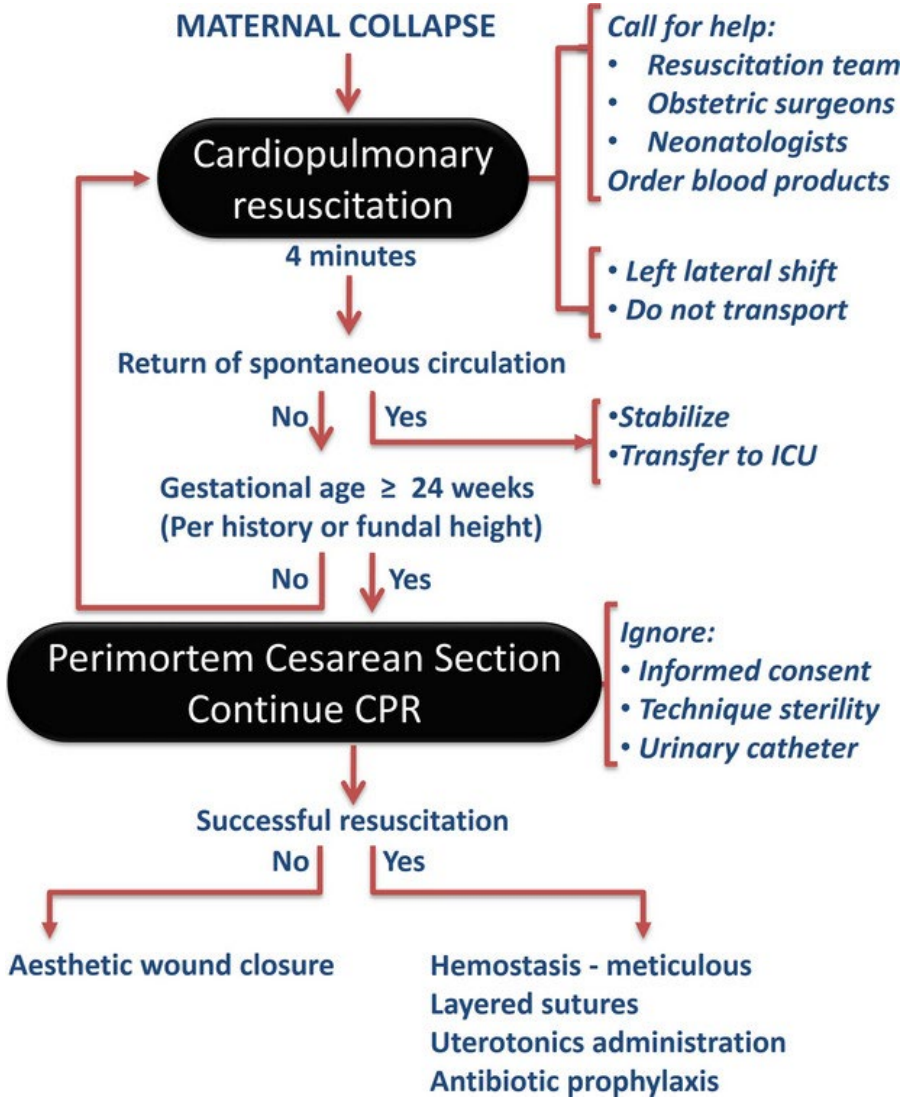
(1) the adult resuscitation team;
(2) the obstetrical team, including one doctor and one nurse or midwife;
(3) the anaesthesia team, including one doctor and one adult respiratory therapist;
(4) the neonatal team, including one neonatologist, one nurse, and one neonatal respiratory therapist.

Jeejeebhoy Fet al. Best Pract Res Clin Obstet Gynaecol. 2014 May;28(4):607-18.

DOI: 10.1111/tog.12493
The Obstetrician & Gynaecologist
http://onlinetog.org
2018;20:151–158
Review

Perimortem caesarean section – why, when and how

Justin J Chu MBChB MRCOG PhD,[a,*] Kim Hinshaw MBBS FRCOG,[b] Sara Paterson-Brown MBBCh FRCS FRCOG,[c] Tracey Johnston MBChB MD FRCOG,[d] Margaret Matthews MBBS FRCOG MA,[e] Julian Webb MBBS FRCS (Ed) FRCEM,[f] Paul Sharpe MBBS FRCA[g]



AOGS
ACTA Obstetricia et Gynecologica Scandinavica

AOGS REVIEW ARTICLE

Perimortem cesarean section for maternal and fetal salvage: concise review and protocol

LIOR DRUKKER[1], YAEL HANTS[2], EINAV SHARON[3], HEN Y. SELA[1] & SORINA GRISARU-GRANOVSKY[1]

Where should perimortem caesarean section be performed?

- ***hospital setting***: PCMS in the delivery room or in the emergency department.
- ***pre-hospital care***: in rare circumstances, PMCS may be considered setting but only when appropriately trained members of medical staff are available (PMCS out of hospital/rapidly transport the patient to hospital, case-by-case basis).
- PMCS following cardiorespiratory arrest requires no general anaesthesia and bleeding is initially minimal. However, with successful ROSC, ***anaesthesia*** must be available to allow surgery to be completed.

Management when resuscitation is unsuccessful

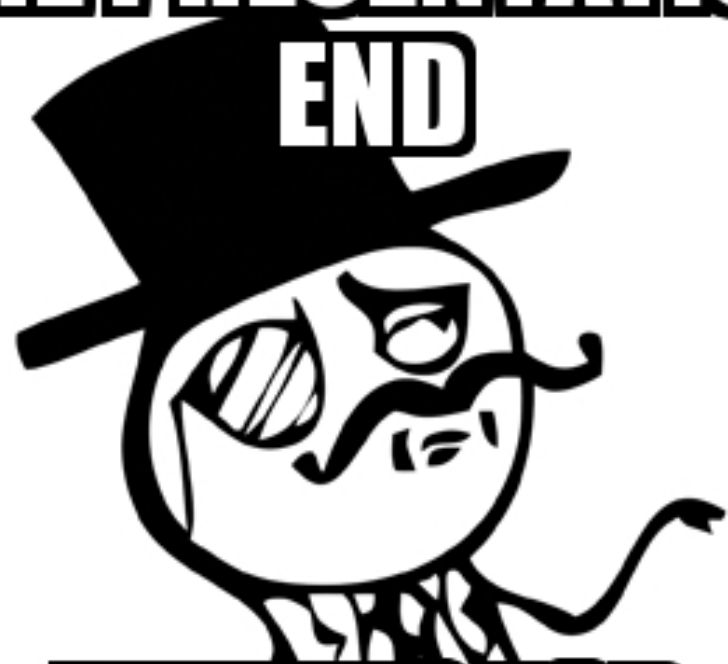
- ***Resuscitation efforts should continue*** until the clinical situation dictates a decision to stop (by the attending senior consultant team together with the cardiac arrest team);
- ***medical devices*** (vascular catheters, tracheal tubes) should be left in situ until the time of declaration of death;
- the ***placenta should not be removed*** if it was in place at the time of death, and if the uterus was open it should be left unsutured (covered with a dressing);
- however, out of ***consideration for the feelings of family members***, it might be appropriate to close the skin edges of a large incision with a minimal number of simple sutures before covering the wound with a dressing.

Aftercare

- Appropriate ***neonatal care*** and ***family support*** whatever the outcome;
- keeping contemporaneous ***medical notes*** can be difficult (accurate documentation, a completed critical incident);
- the ***distress*** caused by a maternal cardiac arrest must not be underestimated;
- for both the ***family and the members of staff*** involved in the patient's care, the ***emotional trauma*** from such a dramatic event can have significant emotional consequences;
- both relatives and staff members should be offered a thorough ***debrief*** with detailed exploration and ***discussion*** of the events.

Drukker L et al. Acta Obstet Gynecol Scand. 2014 Oct;93(10):965-72.
Chu J et al. BJOG. 2020 Apr;127(5):e14-e52.

THE PRESENTATION
END



THANKS FOR
YOUR ATTENTION