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Editorial

CPR-related organ injuries in pregnant and non-pregnant subjects: Liver. An overview of evidence

Cardiac arrest in pregnancy is a rare event. However, its incidence is on the rise from 1:30,000 to 1:20,000 according to the seventh confidential inquiry into maternal deaths in the UK (CEMACH) [1]. This rise has been attributed to the increasing age, morbidity and medical complexity of the antenatal population [2]. Routine resuscitation practices must be modified to appreciate the physiological changes of pregnancy and the unique challenges it presents during CPR. Poor resuscitation skills and areas of substandard care continue to be highlighted in practice, reflecting the need for further training, development, and research in this field [3–5].

In this edition of Resuscitation, Cox et al hypothesise that rate of liver lacerations following CPR is higher amongst pregnant and 'early post partum' patients compared to the general population, alluding this to increased intravascular volume, hepatic congestion, and physiologic compression of liver capsule in pregnancy [6]. The authors are amongst the first to study CPR related liver complications in pregnancy, as published literature in this topic to date has been limited to a handful of individual case reports. Cox et al conducted a single centre, retrospective case review to determine liver injury rates following peripartum (20 weeks gestation to one year postpartum) CPR performed at the University of Maryland Medical Centre (UMMC) between 2011 and 2016. Women with previously known liver injury or disease were excluded from the study. Eleven cases of peripartum CPR were identified out of 9408 deliveries, with return of spontaneous circulation rate of 64%, and an overall mortality rate of 82%. Interestingly, this mortality rate is much higher than rates reported by Mogos et al (49.4%), and Lavecchia et al (63.1%) [7,8]. Moreover, liver lacerations were noted in three out of eleven patients (27%) by Cox et al, which is also much higher than the published rates of Meron et al (0.6%) – Krischer et al (2.1%) in the general population [9,10]. Data of CPR outcomes from non-pregnant patients, matched for important variables, during the same period would have been useful in identifying how mortality rates and liver laceration rates compare.

The first case presented by Cox et al features a 34 year old, woman with eclampsia and several risk factors for HELLP syndrome, and pre-arrest abdominal pain. The episode of unresponsiveness, and the large right lobe subcapsular haematoma discovered would also be consistent with a differential of hepatic rupture secondary to complications of eclampsia before CPR [11].

The second case presents a 38 weeks pregnant, multiparous woman with confusion, agitation, tachypnea, and cyanosis. The patient was treated with tPA (50 mg) for suspected pulmonary embolus (PE), following which maternal shock and abnormal fetal heart trace suggestive of hypoxia and acidemia was reported. The patient delivered abdominally, and was transferred for veno-arterial ECMO, a procedure requiring further anti-coagulation. The patient would have been susceptible to developing haemorrhagic complications, including following CPR [12–15]. Whilst thrombosis and thromboembolism remain the leading cause of direct maternal death, haemorrhage remains the most common cause of maternal collapse [1,16]. Both can present with similar features of shock, and causes of haemorrhage may not always be obvious. Concealed haemorrhage from rarer causes such as splenic artery and hepatic rupture is possible [2]. This is particularly relevant in pregnancy when dealing with fit healthy women, who have physiologically increased plasma volume, and can tolerate significant blood loss prior to showing signs of decompensation [2]. The latest MBRACE-UK 'Saving lives, Improving mother's care report recommends that women with suspected PE should have a Focused Assessment with Sonography in Trauma (FAST) scan to exclude intra-abdominal bleeding prior to thrombolysis being given [2].

The final case of this series involves a multiparous woman with known uterine fibroids and pre-arrest coagulopathy, again making complications such as liver haematoma following CPR more likely. The presence of coagulopathy and/or treatment with thrombolytic seem to be reported commonly in literature amongst both pregnant and general populations receiving CPR [9,12–14].

As the authors in this study were not able to account for confounding variables, we cannot make any causative assumptions between CPR and increased liver injury rates in pregnancy at present. Further research with data from several hospitals over a prolonged study period is recommended to determine more accurately rates of peripartum CPR and associated liver lacerations. It will be interesting to see what the UK Obstetric Surveillance System (UKOSS) surveillance of cardiac arrest in pregnancy might show.

Moreover, in all three cases reviewed in Cox et al, liver lacerations were identified during surgical abdominal exploration. In comparison, a retrospective analysis of non-pregnant cardiac arrests, conducted by Meron et al highlighted that only one out of fifteen patients with liver injury were identified via surgical exploration [9]. Clinical suspicion and a drop in haematocrit levels were key in triggering further investigation. Eight patients (53%) had a bedside abdominal ultrasound scan which showed free intraperitoneal fluid. Six patients (40%) with liver lacerations or rupture were not detected intra vitam, and only found during autopsy [9].

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Table 1
Overview of methods and imaging modalities used to detect liver lacerations/complications following CPR in pregnant and non-pregnant subjects.

Author	Study design	Total no. of CPR patients reviewed	No. of patients with liver complications following CPR	Detection method
Non-pregnant subjects				
Meron et al [9]	Retrospective analysis of patient chart, lab data, imaging and autopsy	2558	15	Abdominal US (8), explorative surgery (1), autopsy (6)
Krischer et al [10]	Prospective study – autopsy of cases post CPR	705	15	Autopsy
Pinto et al [17]	Retrospective, autopsy series	175	2	Autopsy
Clark [18]	Retrospective, autopsy series	19	4	Autopsy
Beydilli et al [19]	Case series	2	2	Autopsy
Zahn et al [12]	Case series	2	2	Abdominal US, followed by CT Abdomen
Kouzu et al [13]	Case series	2	2	Echocardiography, followed by CT Abdomen
Adler et al [20]	Case series	2	2	CT Abdomen (1), Abdominal surgery (1)
Juan et al [14]	Case report	1	1	CT Angiography
Kapłon-Ciesílicka et al [21]	Case report	1	1	Abdominal US, followed by CT Abdomen
Lundqvist et al [22]	Case report	1	1	Abdominal US & diagnostic laparotomy
Naess et al [23]	Case report	1	1	Abdominal US, followed by CT Abdomen
Camden et al [24]	Case report	1	1	Multiple detector CT (MDCT)
Von Bary et al [25]	Case report	1	1	CT Pulmonary Angiogram
Nashiki et al [26]	Case report	1	1	Abdominal US (FAST) scan
Druwe et al [15]	Case report	1	1	Abdominal US, followed by CT Abdomen
Monsuez et al [27]	Case report	1	1	CT Abdomen
Yamasaki et al [28]	Case report	1	1	CT Chest and Abdomen
Pregnant Subjects				
Cox et al [6]	Case series	11	3	Surgical abdominal exploration
Nagar et al [29]	Case report	1	1	Inconclusive exploratory laparotomy performed (liver not visualised), liver haematoma identified in consequent US Abdomen.
Ilsaas et al [30]	Case report	1	1	Surgical abdominal exploration
Lau [31]	Case report	1	1	Detected during pulmonary embolectomy surgery

As peri-mortem caesarean section is a vital and well-established part of resuscitation in pregnancy, one could argue that high rates of liver lacerations in pregnancy may be a consequence of better detection with surgery. Indeed, most liver laceration cases in pregnancy in the literature were identified during surgery, whereas most cases in non-pregnant subjects were identified via abdominal ultrasound, CT imaging, or autopsy (Table 1).

In summary, the study by Cox et al has been valuable in starting the conversation about resuscitation complications in pregnancy. Currently, there is insufficient causal evidence to suggest higher rates of liver lacerations from CPR in pregnancy. Presence of coagulopathy and/or treatment with thrombolytic medication are probably associated with bleeding from liver lacerations following CPR. Future multi-centre, studies would be helpful in more accurately determining rates and significance of liver lacerations following CPR in pregnancy.

Conflicts of interests

None.

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