EVIDENCE WORKSHEET	
Guideline 6: Compressions	
ARC Subcommittee: BLS	**Guideline author:** Julie Considine

1. Clinical (PICO) question(s):

P: in pregnant women requiring cardiopulmonary resuscitation, does

I: positioning with lateral tilt or manual repositioning of the uterus

C: compared with supine position

O: improve survival outcomes?

Search Strategies:

PubMed (October 2013)

(pregnancy[MH] OR "pregnan*"[TI] OR matern*[TI] OR "obstetric*"[TI]) AND ("cardiopulmonary resuscitation/methods"[MH] OR "heart arrest/therapy"[MH] OR "cardiac arrest"[TI] OR "CPR" OR "resuscitation"[TI]) AND ("position*"[TIAB] OR "tilt"[TIAB] OR "wedg*"[TIAB] OR "displacing"[TI] OR "displacement"[TI] OR "decompression"[TI] OR "aorto-caval"[TI] OR "aortocaval"[TI] OR "caval compression"[TI] OR "left lateral"[TI] OR "aortic compression"[TI] OR "supine"[TI]) NOT (comment[PT] OR editorial[PT] OR "letter"[PT]) NOT (animals[MH] NOT humans[MH])

n=18

Databases / other sources searched:

Grey literature, reference lists

Inclusion criteria:

Any studies reporting outcomes for positioning/manual uterine displacement for pregnant human patients undergoing cardiopulmonary resuscitation.

Exclusion criteria

Non-systematic reviews / opinion papers/educational papers, abstract-only studies, animal studies, manikin studies, single case reports

Search results:

This search yielded 18 papers, none of which met the study inclusion criteria:

- 1 paper related to the effect of positioning on inferior vena cava diameter in non-arrested pregnant women [1]
- 1 case report of cardiac arrest in a pregnant patient undergoing spinal anaesthesia [2]
- 1 systematic review that failed to identify any studies of cardiac arrest in human pregnant patients [3]
- 2 discussion papers [4 5]
- 3 manikin studies simulating CPR in pregnancy [6-8]
- 3 papers irrelevant to PICO question (one related to post partum haemorrhage [9], one examining a device to assist airway management trialled in manikins [10], and one manikin study related to the effect of transport on resuscitation quality [11]
- 7 studies related to fetal or newborn resuscitation [12-18]

As a result of the low search yield, the three manikin studies [6-8]were reviewed from the perspective of CPR quality.

Number of papers / studies meeting criteria for further review: three manikin studies [6-8]

Methodological quality, levels of evidence & outcomes of studies examining positioning in pregnant women

Good	Fair	Poor
The methodological quality of the study is high with the likelihood of any significant bias being minimal	The methodological quality of the study is reasonable with the potential for significant bias being likely.	The methodological quality of the study is weak possessing considerable and significant biases

1. Studies *supportive* of left tilt or manual uterine displacement:

	I	II	III-1	III-2	III-3	IV	Extrapolated evidence
Good							
Fair							
Poor							Goodwin et al. 1992 (A,B,C)
	I	II	III-1	III-2	III-3	IV	Extrapolated evidence
				NH&MRC levels of evidence			

2. Studies *neutral* for left tilt or manual uterine displacement:

	I	II	III-1	III-2	III-3	IV	Extrapolated evidence
Good							
Fair							
Poor							Kim 2013 (A, B)
	I	II	III-1	III-2	III-3	IV	Extrapolated evidence
				NH&MRC levels of evidence			

3. Studies *opposing l*eft tilt or manual uterine displacement:

	I	II	III-1	III-2	III-3	IV	Extrapolated evidence
Good							
Fair							
Poor							Ress & Wills 1998 (C)
	I	II	III-1	III-2	III-3	IV	Extrapolated evidence
				NH&MRC levels of evidence			

Endpoints:
A = chest compression rate
B = chest compression depth
C = chest compression force

Treatment recommendation:
Class B (Acceptable)
Summary of science
There are no published studies of lateral positioning or manual displacement of the uterus vs supine positioning in human pregnant patients undergoing cardiopulmonary resuscitation: the studies reviewed provided extrapolated data from manikin studies with CPR being performed by trained (albeit, probably inexperienced) rescuers: midwives or medical students. Although chest compressions were feasible in a manikin tilted to a left lateral position, the maximum possible resuscitative force with chest compressions declines as the angle of inclination increases. There was only one manikin study with data specific to various elements of chest compression quality that showed no difference in compression rates, depth, recoil rates or hand position between supine and lateral positioning however were

significantly higher subjective ratings of difficulty when perfuming chest compressions in a lateral position.

Reviewer's final comments and assessment of benefit / risk:
There are no published studies of lateral positioning or manual displacement of the uterus vs supine positioning in human pregnant patients undergoing cardiopulmonary resuscitation. Based on current available evidence from studies of simulated cardiac arrest in pregnancy with trained providers of varying levels of experience, there is a risk that performing chest compressions with the "patient" in a lateral position may compromise compression force with no evidence of advantage in terms of rate, depth, recoil rates or hand position.

Evidence gaps and research priorities:
There are no published studies of lateral positioning or manual displacement of the uterus vs supine positioning in human pregnant patients undergoing cardiopulmonary resuscitation.

Citation list

Rees GA, Willis BA. Resuscitation in late pregnancy. Anaesthesia 1988;43(5):347-9.
This paper considers cardiopulmonary resuscitation in obstetric patients at term and the influence of aortocaval compression on the outcome. The maximum chest compression force produced by eight physicians was measured as a function of angle of inclination using an inclined plane. The compression force at an angle of 27 degrees is 80% of that in the supine position and the Cardiff resuscitation wedge, designed to prevent aortocaval compression, is described with this inclination. Midwives' expertise in basic life support 6 months after instruction was assessed using a manikin simulator. The majority had acquired errors in external chest compression and mouth to mouth ventilation. These were corrected by additional tuition. Resuscitation of the manikin on the Cardiff wedge was found to be as efficient as in the supine position.

NHMRC: prospective observational study of CPR by midwives in manikin tilted to 27 degrees
QUALITY: Poor
OUTCOME: C = chest compression force
INTERVENTION: Comparison of supine with 27 degree lateral tilt

Assessed the efficacy of chest compressions with the manikin at various angles of inclination of left lateral tilt from the horizontal. Study was set up by fitting a calibrated force transducer onto a plane ranging in inclinations from 0∘ (supine) to 90∘ (full left lateral tilt from the horizontal). The maximum possible resuscitative force of eight physicians studied was expressed as a function of the angle of inclination. The measured resuscitative force for each angle of inclination was expressed as a percentage of the rescuers' body weight. This study found that the maximum possible resuscitative force in terms of percent body weight decreased as the angle of inclination of the plane increased. In the supine position the maximal resuscitative force was 67% of the body weight compared to 36% in the 90∘ left lateral tilt from the horizontal. At angles of >30∘ left lateral tilt from the horizontal the manikin tended to slide or roll off the plane. The study concluded that at a maximum left lateral tilt of 27∘ from the horizontal, as provided by the Cardiff wedge, the "patient" would not slid or roll off the wedge, and this resulted in a maximum resuscitative force of 55% of the body weight, which is 80% of the force applied in the supine position. Forcefulness of chest compressions will decrease as the degree of left tilt from the horizontal increases. Therefore, chest compressions performed in left lateral tilt from the horizontal may result in reduced force of chest compressions.

Goodwin AP, Pearce AJ. The human wedge. A manoeuvre to relieve aortocaval compression during resuscitation in late pregnancy. Anaesthesia 1992;47(5):433-4.

The important part of resuscitation in late pregnancy is the relief of aortocaval compression. A manoeuvre to relieve aortocaval compression (the human wedge) is described and evaluated. Eighteen qualified midwives performed basic life support in the supine and wedged position employing the human wedge. Performance was assessed using the Laerdal Resusci Anne Skillmeter. There was no difference (p = 0.4761) in performance of mouth-to-mouth expired air ventilation between the two positions. External cardiac compressions were performed significantly better (p = 0.0005) in the wedged position than in the supine position. The human wedge may provide an alternative to other methods of relieving aortocaval compression.

NHMRC: prospective observational study of CPR in manikin by 18 midwives
QUALITY: Poor
OUTCOME: A = chest compression rate, B = chest compression depth, C = 'correct' chest compressions
INTERVENTION: Comparison of supine vs human wedge

Qualified midwives knelt on the floor then sat on their heels. The manikin was positioned so that the back is positioned on the thighs of the human wedge/rescuer however, the degree of tilt was not formally measured in this study. When using the human wedge technique to provide a left lateral tilt from the horizontal, the rescuer could provide effective chest compressions on a manikin. 'Correct' techniques were judged by the manikin skill meter however specific elements of chest compression technique (rate, depth, force) were not reported. Chest compressions were performed significantly better in the wedged than in the supine position (p = 0.0005): mean % 'correct' external cardiac compressions was 32.5% in supine position and 66.6% in wedged position. 'Some' participants (not quantified), complained of painful knees. There was no difference in performance of mouth-to-mouth (p=0.476): mean % 'correct' expired air ventilations was 62.25% in supine position and 56.7% in wedged position.

Kim S, You JS, Lee HS, et al. Quality of chest compressions performed by inexperienced rescuers in simulated cardiac arrest associated with pregnancy. Resuscitation 2013;84(1):98-102

OBJECTIVE: We aimed to compare the quality of chest compressions performed by inexperienced rescuers in different positions, notably supine and at a 30 degrees inclined lateral position, to ascertain whether high-quality chest compression is feasible on a pregnant subject in cardiac arrest. SUBJECTS AND METHODS: We performed a prospective, randomised crossover design study. Each participant performed 2-min chest compressions in two different positions on a mannequin: a supine position and a 30 degrees left inclined lateral position. After 2 min of chest compression in one position, the participant took a rest for 10 min to minimise rescuer fatigue and then performed chest compression in the second position. Data on chest compression rate, mean chest compression depth, correct compression depth rate, correct recoil rate, and correct hand position rate were collected. To measure the angle between the rescuer's arm and the victim's chest surface, chest compressions were recorded with a video recorder. After each practice session, participants were asked to report the subjective difficulty of performing chest compressions using a visual analogue scale. RESULTS: All 32 participants successfully completed the study. The mean compression rate and depth were 121.0 per minute and 53.3 mm in the supine position and 118.8 per minute and 52.0 mm in the inclined lateral position, respectively (p=0.978 and p=0.260, respectively). Also, there were no differences in the correct compression depth rate, the correct hand position rate, or the correct recoil rate (p=0.426, p=0.467, and p=0.260, respectively). However, the lowest and highest angles and the subjective difficulty of chest compression differed significantly (p<0.001, p<0.001, and p=0.007, respectively). CONCLUSIONS: Inexperienced rescuers appear to be capable of performing high-quality chest compressions in a 30 degrees inclined lateral position on pregnant women in a simulated cardiac arrest state.

NHMRC: prospective, randomised crossover trial with 32 medical students performing CPR on a manikin
QUALITY: Poor
OUTCOME: A = chest compression rate, B = chest compression depth
INTERVENTION: Comparison of supine and 30 degrees left lateral tilt

Each participant performed 2-min chest compressions in two different positions (supine and 30 degrees left lateral) on a non-pregnant manikin (SkillReporter Resusci Anne. After 2 min of chest compressions in one position, the participant rested for 10 min to minimise rescuer fatigue, and chest compressions were then performed in the other° position. Participants were assigned at random to start at either the supine position or the 30° left inclined lateral position by a sequence generator computer program. There were *no significant differences* between supine and left lateral tilt positions in terms of:
-   mean compression rates (121/min vs 118.8/min (p=0.978)
-   mean compression depth (53.3 mm vs 52.0 mm (p = 0.260)
-   correct compression 'depth rate' (70.2% vs 64.5% (p=0.426) defined as the ratio of number of compressions to a depth of 50–60 mm to the total number of compressons
-   correct recoil rate 99.4% vs 99.8% (p=0.260)
-   correct rate of hand position 78.1% vs 72% (p=0.467)

however, the optimal compression depth was not reported and the rates in both positions are higher than current ARC / ILCOR recommendations of a compression rate of approximately 100 / minutes. There were significant differences in between supine and left lateral tilt positions in terms of:
-   highest compression angle between participant's arm and chest surface of the manikin 87.8 vs 82.5 degrees (p<0.001)
-   lowest compression angle between participant's arm and chest surface of the manikin 83.8 vs 77.9 degrees (p<0.001)
-   subjective rating of difficulty using visual analogue scale 58.3% vs 68.8% (p=0.007)

however the clinical significance of these outcomes remains unclear. This study suggests that inexperienced rescuers can perform high-quality chest compression in a 30 inclined lateral position in simulated cardiac arrest associated with pregnancy but perceive it to be more difficult than chest compression in a supine position with no difference in elements of compression technique known to impact on ROSC (compression rate, depth).

EVIDENCE WORKSHEET
Guideline 6: Compressions

ARC Subcommittee: BLS	Guideline author: Julie Considine

2. Clinical (PICO) question(s):

P: in pregnant women, does

I: positioning with lateral tilt or manual repositioning of the uterus

C: compared with supine position

O: cause aorto-caval compression (proxy outcomes = blood pressure, CVP, IVC diameter, cardiac output)

Search Strategies:

PubMed (October 2013)

((pregnancy[MH] OR "pregnan*"[TI] OR matern*[TI] OR "obstetric*"[TI]) AND ("tilt"[TI] OR "wedg*"[TIAB] OR "left lateral"[TI] OR "uterine displacement"[TI] OR "manual displacement"[TI] OR "aorto-caval"[TI] OR "aortocaval"[TI] OR "caval compression"[TI] OR "aortic compression"[TI] OR "supine"[TI] OR "recumbent"[TI])) NOT (comment[PT] OR editorial[PT] OR "letter"[PT]) NOT (animals[MH] NOT humans[MH])

n= 220 but after removal of duplicates from cardiac arrest studies, n = 209

Databases / other sources searched:

Grey literature, reference lists

Inclusion criteria:

Any studies reporting haemodynamic outcomes (BP, CVP, IVC diameter, cardiac output) for positioning/manual uterine displacement for pregnant human patients.

Exclusion criteria

Non-systematic reviews / opinion papers/educational papers, abstract-only studies, animal studies, manikin studies, single case reports

Search results:

CARDIAC ARREST SEARCH STRATEGY

This search yielded 209 papers:

- 8 were excluded as they related to newborn / neonatal depression and / or resuscitation [19-26]
- 10 were excluded as they were published in languages other than English [27-36]
- 15 were excluded as they were single case reports, review papers or opinion pieces [37-51]
- 23 were excluded as they related to positioning during induction or maintenance of anaesthesia, particularly spinal and epidural anaesthesia [52-73]
- 46 were excluded as they related to haemodynamic changes during labour and / or birth including Caesarean section [74-119]
- 92 were excluded for lack of relevance to the PICO question [120-211]
-

Number of papers / studies meeting criteria for further review: There were no randomised controlled trials so 15 observation studies were included for further review [1 212-225]

Methodological quality, levels of evidence & outcomes of studies examining haemodynamic effects of positioning in pregnant women, not requiring CPR		
Good The methodological quality of the study is high with the likelihood of any significant bias being minimal	**Fair** The methodological quality of the study is reasonable with the potential for significant bias being likely.	**Poor** The methodological quality of the study is weak possessing considerable and significant biases

4. Studies *supportive* of left lateral tilt or manual uterine displacement:

	A = Blood pressure increases with lateral tilt			**B** = CVP increases with lateral tilt		**C** = IVC diameter increases with lateral tilt	**D** = cardiac output increases with lateral tilt
Good							
Fair						Lee et al. 2012 (D)	
Poor						Rossi et al. 2011 (D) Armstrong et al. 2011 (D) Almeida et al. 2009 (B) Milsom et al. 1984 (D) Goldkrand et al. 1997 (A)	

	I	II	III-1	III-2	III-3	IV	Extrapolated evidence
				NH&MRC levels of evidence			

5. Studies *neutral* for left lateral tilt manual uterine displacement:

Good							
Fair						Lee et al. 2012 (A) Kundra et al. 2012 (A) Almeida et al. 2009 (A) Fields et al. 2013 (A, C)	
Poor						Kinsella 2006 (A) Bamber 2003 (A, D) Ellington et al. 1991 (A) Kinsella et al. 1990 (A) Quilligan et al. 1959 (A, D) Calvin et al. 1988 (A) Newman et al. 1983 (D)	

	I	II	III-1	III-2	III-3	IV	Extrapolated evidence
				NH&MRC levels of evidence			

6. Studies *opposing* left lateral tilt or manual uterine displacement:

	A = Blood pressure increases with lateral tilt			**B** = CVP increases with lateral tilt		**C** = IVC diameter increases with lateral tilt	**D** = cardiac output increases with lateral tilt
Good							
Fair							
Poor						Armstrong et al. 2011 (A) Milsom et al. 1984 (A)	

	I	II	III-1	III-2	III-3	IV	Extrapolated evidence
				NH&MRC levels of evidence			

Endpoints:
A = blood pressure
B = CVP
C = IVC diameter
D = cardiac output

Treatment recommendation:

Class B (Acceptable)

Summary of science

There are no high level studies that indicate any haemodynamic advantage to lateral positioning compared to supine position in pregnant patients. There were five studies supporting lateral tile positioning over supine positioning. One fair quality and three poor quality studies in healthy pregnant patients supported positioning with lateral tilt to increase cardiac output (Level IV) and one poor quality study that showed an increase in central venous pressure in healthy pregnant patients positioned with a lateral tilt position. There were nine studies that were neutral in terms of lateral vs supine positioning in healthy pregnant patients. Three fair quality and five poor quality studies showed that position made difference to blood pressure related to positioning. One fail quality and one poor quality study showed no difference in cardiac output between supine and lateral tilt positions. There were two studies that opposed lateral tilt both showing decreases in blood pressure when placed in left lateral tilt. Many of the studies presented statistically significant results with questionable clinical significance.

Reviewer's final comments and assessment of benefit / risk:

There is no evidence re optimum position for chest compressions in pregnant women suffering cardiac arrest. In healthy pregnant women, there are conflicting results regarding effect of positioning on blood pressure, inferior vena cava diameter, cardiac output and central venous pressure. Although some studies presented in this review statistically significant differences, the clinical significance of many differences presented remains unclear. A review of evidence related to positioning in simulated cardiac arrest in pregnancy suggests a risk of decreased effectiveness of chest compressions when the 'patient' is placed in a lateral tilt position. In the absence of any strong evidence that lateral positioning improves haemodynamic parameters and the risk of lateral positioning resulting in reduced effectiveness of chest compressions, rescuers should continue to do what they know in terms of CPR (supine position, 30:2 compression:ventilation ratio) and not be distracted / impeded by the presence of pregnancy.

Evidence gaps and research priorities:

There are conflicting results from studies of lateral positioning vs supine positioning in healthy human pregnant patients. Gaps in the current research include lack of randomised, controlled research designs; recruitment of patients of varying gestations in the same study; lack of clear definition of haemodynamic outcomes (eg. blood pressure, arterial pressure); variation in measurement of haemodynamic outcomes; lack of clarity about clinically significant outcomes (vs statistically significant outcomes).

Citation List:

Fields JM, Catallo K, Au AK, et al. Resuscitation of the pregnant patient: What is the effect of patient positioning on inferior vena cava diameter? Resuscitation 2013;84(3):304-8
STUDY OBJECTIVE: Patients in the third trimester of pregnancy presenting to the emergency department (ED) with hypotension are routinely placed in the left lateral tilt (LLT) position to relieve inferior vena cava (IVC) compression from the gravid uterus thereby increasing venous return. However, the relationship between patient position and proximal intrahepatic IVC filling has never assessed directly. This study set out to determine the effect of LLT position on intrahepatic IVC diameter in third trimester patients under real-time visualization with ultrasound. METHODS: This prospective observational study on the labor and delivery floor of a large urban academic teaching hospital enrolled patients between 30 and 42 weeks estimated gestational age from August 2011 to March 2012. Patients were placed in three different positions: supine, LLT, and right lateral tilt (RLT). After the patient was in

each position for at least 3 min, IVC ultrasound using the intercostal window was performed by one of three study sonologists. Maternal and fetal hemodynamics were also monitored and recorded in each position. RESULTS: A total of 26 patients were enrolled with one excluded from data analysis due to inability to obtain IVC measurements. The median IVC maximum diameter was 1.26 cm (95% confidence interval [CI] 1.13-1.55) in LLT compared to 1.13 cm (95% CI 0.89-1.41) in supine, p=0.01. When comparing each individual patient's LLT to supine measurement, LLT lead to an increase in maximum IVC diameter in 76% (19/25) of patients with the average LLT measurement 29% (95% confidence interval 10-48%) larger. Six patients had the largest maximum IVC measurement in the supine position. No patients experienced any hemodynamic instability or distress during the study. CONCLUSION: IVC ultrasound is feasible in late pregnancy and demonstrates an increase in diameter with LLT positioning. However, a quarter of patients had a decrease in IVC diameter with tilting and, instead, had the largest IVC diameter in the supine position suggesting that uterine compression of the IVC may not occur universally. IVC assessment at the bedside may be a useful adjunct in determining optimal positioning for resuscitation of third trimester patients.

NHMRC: prospective observational study of 26 patients between 30 and 42 weeks gestation, 1 patient from data analysis excluded due to imaging difficulties
QUALITY: Fair
OUTCOME: A = blood pressure; C = proximal intrahepatic IVC filling
INTERVENTION: Comparison of three positions: supine, left lateral tile, right lateral tilt

Patients had IVC ultrasound in three different positions in the following order: supine, left lateral tilt, right lateral tilt in that order and remained in different positions for 3 minutes: no cross over. Left lateral tilt vs supine maximum IVC diameter was 1.26 cm vs 1.13cm (p=0.01): clinical significance of 0.13cm increase in maximum IVC diameter unclear. There were no significant difference between supine and left lateral positions in IVC minimum diameter 0.76cm vs 0.81cm (p=0.19) nor material systolic BP (115mmHg vs 115mmhg, p=0.10). In 76% (19/25) of patients, left lateral tilt increased IVC diameter compared to supine: remainder had largest IVC diameter in supine position. There were no significant differences in maximum or IVC diameters when right lateral tilt was compared to supine (max: 1.23 cm vs 1.13cm, p=0.11; min: 0.69 vs 0.81, p=0.50) There were no significant differences between supine and right lateral positions in material systolic BP (117mmHg vs 115mmhg, p=0.50). In 56% (14/25) of patients, right lateral tilt increased IVC diameter compared to supine: remainder had largest IVC diameter in supine position. Overall 48% (12/25) patients had largest maximum IVC diameter in left lateral position, 28% (7/25) in right lateral position and 24% (6/25) in supine position – statistical significance not tested.

Lee SW, Khaw KS, Ngan Kee WD, Leung TY, Critchley LA. Haemodynamic effects from aortocaval compression at different angles of lateral tilt in non-labouring term pregnant women. Br J Anaesth 2012;109(6):950-6.
BACKGROUND: Aortocaval compression (ACC) can result in haemodynamic disturbances and uteroplacental hypoperfusion in parturients. Its detection is difficult because in most patients, sympathetic compensation results in no signs or symptoms. However, profound hypotension may develop after sympathectomy during regional anaesthesia. In this prospective observational study, we aimed to detect ACC by analysing haemodynamic changes in term parturients who were positioned sequentially at different angles of lateral tilt. METHODS: We studied haemodynamic changes in 157 non-labouring term parturients who were positioned in random order at 0 degrees , 7.5 degrees , 15 degrees , and full left lateral tilt. Cardiac output (CO), stroke volume, and systemic vascular resistance were derived using suprasternal Doppler. Non-invasive arterial pressure (AP) measured in the upper and lower limbs was analysed to detect aortic compression. RESULTS: CO was on average 5% higher when patients were tilted at >/=15 degrees compared with <15 degrees. In a subgroup of patients (n=11), CO decreased by more than 20%, without changes in systolic AP, when they were tilted to <15 degrees which was considered attributable to severe inferior vena caval compression. Only one patient in the supine position had aortic compression with the systolic AP in the upper limb 25 mm Hg higher than the lower limb. CONCLUSIONS: Patients with ACC can be identified by the CO changes from serial measurements between supine, 15 degrees, or full lateral tilt. Our findings

suggest that in non-labouring parturients, ACC is asymptomatic and can be effectively minimized by the use of a left lateral tilt of 15 degrees or greater.

NHMRC: prospective observational study of157 non-labouring women at term
QUALITY: Fair
OUTCOME: A = blood pressure in the upper and lower limbs, D = cardiac output,
INTERVENTION: Comparison of four positions in random order: 0 degrees (supine), 7.5 degrees, 15 degrees, and full left lateral tilt.
Premedication of famotidine 20 mg orally was given the night before and on the morning of surgery. 170 patients enrolled, 13 excluded due to technical equipment malfunctions, two patients withdrew with back pain. 'Arterial pressure' was actually non-invasive blood pressure. There were no significant differences in upper or lower limb systolic BP. Upper limb mean blood pressure lowest at 15 degrees tilt (78/78/75/76, p<0.001) as was lower limb mean blood pressure (90/90/89/91, p=0.015). Cardiac output was significantly higher when patients were positioned in the 15 degrees and 90 degrees compared with the 0 degrees and 7.5 degrees tilted positions, indicating that aortocaval compression is best relieved when the degree of tilt is ≥15 degrees.

Kundra P, Velraj J, Amirthalingam U, et al. Effect of positioning from supine and left lateral positions to left lateral tilt on maternal blood flow velocities and waveforms in full-term parturients. Anaesthesia 2012;67(8):889-93.
Positioning the parturient from supine to the left lateral tilt position (supine-to-tilt) may not effectively displace the gravid uterus, but turning from the left lateral position to the left lateral tilt position (left lateral-to-tilt) may keep the gravid uterus displaced and prevent aortocaval compression. Fifty-one full-term parturients were randomly placed in the left lateral position, supine-to-tilt and left lateral-to-tilt positions using a Crawford wedge. Femoral vein area, femoral vein velocity, femoral artery area, pulsatility index, resistance index and right arm mean arterial blood pressure and heart rate were recorded. Our results showed a lower mean (SD) femoral vein area (82.2 (14.9) vs 96.2 (16.4) mm(2)), a lower pulsatility index (3.83 (1.3) vs 5.8 (2.2)), a lower resistance index (0.93 (0.06) vs 0.98 (0.57)), a higher femoral artery area (33.3 (3.8) vs 30.9 (4.4) mm(2)) and a higher femoral vein velocity (7.9 (1.2) vs 6.1 (1.6) cm.s(-1)) with left lateral-to-tilt when compared with supine-to-tilt (all p < 0.001). Our results suggest that moving a full-term parturient from the full left lateral to the lateral tilt position may prevent aortocaval compression in full-term parturients more efficiently than when positioning the parturient from a supine to left lateral tilt position.

NHMRC: prospective observational study of 51 patients at full term
QUALITY: Fair
OUTCOME: A = mean arterial blood pressure (right arm)
INTERVENTION: Comparison of three positions: left lateral position, supine-to-tilt and left lateral-to-tilt positions

Mean arterial pressure was measured using non-invasive blood pressure and was lowest with supine-to-tilt (73.1mmHg) compared with left lateral-to-tilt (74.8mmHg) and left lateral (75.2mmHg) (p<0.001) however the clinical significance of these differences is unclear.

Rossi A, Cornette J, Johnson MR, et al. Quantitative cardiovascular magnetic resonance in pregnant women: cross-sectional analysis of physiological parameters throughout pregnancy and the impact of the supine position. J Cardiovasc Magn Reson 2011;13:31
BACKGROUND: There are physiological reasons for the effects of positioning on hemodynamic variables and cardiac dimensions related to altered intra-abdominal and intra-thoracic pressures. This problem is especially evident in pregnant women due to the additional aorto-caval compression by the enlarged uterus. The purpose of this study was to investigate the effect of postural changes on cardiac dimensions and function during mid and late pregnancy using cardiovascular magnetic resonance (CMR). METHODS: Healthy non-pregnant women,

pregnant women at 20th week of gestation and at 32nd week of gestation without history of cardiac disease were recruited to the study and underwent CMR in supine and left lateral positions. Cardiac hemodynamic parameters and dimensions were measured and compared between both positions. RESULTS: Five non-pregnant women, 6 healthy pregnant women at mid pregnancy and 8 healthy pregnant women at late pregnancy were enrolled in the study. In the group of non-pregnant women left ventricular (LV) cardiac output (CO) significantly decreased by 9% (p=0.043) and right ventricular (RV) end-diastolic volume (EDV) significantly increased by 5% (p=0.043) from the supine to the left lateral position. During mid pregnancy LV ejection fraction (EF), stroke volume (SV), left atrium lateral diameter and left atrial supero-inferior diameter increased significantly from the supine position to the left lateral position: 8%, 27%, 5% and 11%, respectively (p<0.05). RV EDV, SV and right atrium supero-inferior diameter significantly increased from the supine to the left lateral position: 25%, 31% and 13% (p<0.05), respectively. During late pregnancy a significant increment of LV EF, EDV, SV and CO was observed in the left lateral position: 11%, 21%, 35% and 24% (p<0.05), respectively. Left atrial diameters were significantly larger in the left lateral position compared to the supine position (p<0.05). RV CO was significantly increased in the left lateral position compared to the supine position (p<0.05). CONCLUSIONS: During pregnancy positional changes affect significantly cardiac hemodynamic parameters and dimensions. Pregnant women who need serial studies by CMR should be imaged in a consistent position. From as early as 20 weeks the left lateral position should be preferred on the supine position because it positively affects venous return, SV and CO.

NHMRC: prospective observational study, 5 non-pregnant women , 6 healthy pregnant women in mid pregnancy (20 weeks), 8 healthy pregnant women in late pregnancy (32 weeks)
QUALITY: Poor
OUTCOME: D =left ventricular cardiac output
INTERVENTION: Comparison of supine and left lateral positions

At 20 weeks, there was no difference in left ventricular cardiac output between supine and left lateral position (6.5 L/min for both, p=0.917), at 32 weeks cardiac output was significantly lower in supine position (5.6 vs 6.9, p=0.012).

Armstrong S, Fernando R, Columb M, Jones T. Cardiac index in term pregnant women in the sitting, lateral, and supine positions: an observational, crossover study. Anesth Analg 2011;113(2):318-22
BACKGROUND: Aortocaval compression may affect maternal hemodynamic indices and fetal well-being in various maternal positions. There has been much debate regarding the optimal position for performing neuraxial blockade for labor analgesia and cesarean delivery. We hypothesized that in pregnant women at term, cardiac index (CI) may be improved in the lateral positions as compared with the flexed sitting position. Our primary outcome was to measure CI as assessed by suprasternal Doppler. METHODS: A prospective, observational, crossover study was conducted in 25 ASA physical status I/II women with uncomplicated pregnancies presenting for elective cesarean delivery at term. Hemodynamic indices were measured in 4 positions in random order: supine with a 15-degree left tilt, sitting with neck and hips flexed, and flexed left lateral and flexed right lateral positions. Maternal CIs were measured using a noninvasive suprasternal Doppler device and upper arm noninvasive arterial blood pressure. Umbilical Dopplers were performed simultaneously to measure the fetal heart rate and umbilical artery pulsatility and resistivity indices. RESULTS: CI differed by position (P = 0.01); it was higher in the right lateral position compared with the sitting and supine positions (by 8.8% and 8.1%, respectively) and in the left lateral compared with sitting position (by 7.8%) (P < 0.05). Maternal stroke volume index, heart rate, and systolic blood pressure were higher in the lateral positions compared with the sitting and supine-tilt positions. We found no significant differences in fetal heart rate, pulsatility index, or resistivity index among positions. CONCLUSION: Positioning for neuraxial anesthesia may influence maternal hemodynamic variables. We found no difference in healthy fetal blood flow indices among positions, suggesting that these changes are not clinically significant. This study provides new physiological information on the changes that occur in a group in whom it has not been practical to study

previously. Further study is necessary to determine whether these changes are significant in the presence of neuraxial anesthesia or in the high-risk parturient.

NHMRC: prospective, observational, crossover study was conducted in 25 pregnant women at term. Patients were healthy (ASA physical status I/II) women with uncomplicated pregnancies having elective caesarean delivery at term.
QUALITY: Poor
OUTCOME: A = systolic blood pressure, D = cardiac index (as proxy for cardiac output)
INTERVENTION: Comparison of supine with a 15-degree left tilt, sitting with neck and hips flexed, and flexed left lateral and flexed right lateral positions.

Only results related to supine and lateral positions were considered for this worksheet. In this study supine position actually supine with 15 degree tilt to the left. Cardiac index was significantly lower in supine position when compared to right and left lateral positions (2.96 / 3.20 / 3.17 L/min/m^2, p = 0.005), maternal systolic blood pressure was highest in supine position when compared to right and left lateral positions (115 / 97 / 101 mmHg, p<0.001). The clinical significance of these differences is questionable.

Almeida FA, Pavan MV, Rodrigues CI. The haemodynamic, renal excretory and hormonal changes induced by resting in the left lateral position in normal pregnant women during late gestation. BJOG 2009;116(13):1749-54.
OBJECTIVE: To characterise the haemodynamic, renal-electrolyte and hormonal parameters in normal near-term pregnancy. DESIGN: Observational prospective case-series study. SETTING AND POPULATION: Eleven women with normal pregnancies at 35-39 weeks gestation. METHODS: Following baseline laboratory assessments and placement of a right-atrial catheter, serial measurements were obtained for 2 hours in the supine position (SP) followed by a change to the (LLP) and subsequent observations for 2 hours. MAIN OUTCOME MEASURES: Blood pressure (BP), central venous pressure (CVP), atrial natriuretic peptide (ANP), plasma renin activity (PRA), plasma aldosterone (ALDO), diuresis, creatinine clearance, sodium and potassium excretion. RESULTS: In the SP, the subjects' BP remained stable while their CVP decreased. In the LLP, the subjects' systolic and diastolic BP consistently decreased by about 15 mmHg and their CVP increased within the first 60 minutes. ANP levels doubled in the subjects while they rested in the LLP, whereas the subjects' PRA and ALDO levels decreased by half compared with when they rested in the SP. In the LLP, the subjects' creatinine clearance significantly increased by 12% and their sodium excretion and diuresis increased by 38% and 59% respectively. CONCLUSION: Rest in the LLP induces systemic and intra-renal haemodynamic and hormonal changes that may play a central physiological role in the renal excretory response to restore excessive sodium/water retention in late pregnancy.

NHMRC: prospective, observational study of 11 women with normal pregnancies at 35-39 weeks gestation
QUALITY: Poor
OUTCOME: A = systolic blood pressure, B = CVP measured every 30 minutes for 2 hours
INTERVENTION: Comparison of supine and left lateral positions

In the first 2 hours, the pregnant women laid horizontally in supine position followed by a second 2-hour period in which they laid in a left lateral position: no crossover. In supine position, systolic BP measurements were ~120 mmHg compared with ~110mmHg in left lateral position (ns). CVP ranged from 0 to -1.5 cmH$_2$O in supine position and +0.5 to -1 mmH$_2$O in left lateral position (p<0.05) however the clinical significance of these differences is unclear.

Kinsella SM. Effect of blood pressure instrument and cuff side on blood pressure reading in pregnant women in the lateral recumbent position. Int J Obstet Anesth 2006;15(4):290-3.

BACKGROUND: Hydrostatic forces affect non-invasive blood pressure measurement in the lateral position. This study assessed the extent of this effect with the mercury column sphygmomanometer and Dinamap oscillometric instrument as well as different recommendations for comparing supine and lateral blood pressure measurements. METHOD: Thirty-two term pregnant women were studied in the antenatal clinic. Blood pressure was recorded from both arms in the right lateral and supine recumbent positions, using the sphygmomanometer and Dinamap. RESULTS: Blood pressure in the uppermost arm while lateral was lower than supine by a mean 10 mmHg or more. Systolic, mean and diastolic pressures in the dependent arm while lateral were higher than supine by a mean (SD) 3.1 (6.8)mmHg, 5.6 (6.8)mmHg, and 6.9 (8.7)mmHg using the sphygmomanometer and 3.8 (8.1)mmHg, 3.2 (7.1)mmHg, and 1.9 (5.3)mmHg using the Dinamap. Systolic, mean and diastolic pressure values calculated as the average taken from both arms in the lateral position were lower than supine by a mean (SD) 3.5 (7.5)mmHg, 3.9 (4.7) mmHg, and 4.1 (5.8)mmHg using the sphygmomanometer and 4.6 (6.0)mmHg, 4.9 (4.4)mmHg, and 4.8 (4.4)mmHg using the Dinamap. Corresponding blood pressure readings were always higher using the Dinamap than the sphygmomanometer. CONCLUSIONS: In normotensive non-labouring term pregnant women, the use of the dependent arm or an average blood pressure from both arms while in the lateral position will give a closer reading to supine blood pressure than the use of the uppermost arm. However, use of the dependent arm is simpler.

NHMRC: prospective, observational study of 34 women from antenatal clinic, gestation unclear
QUALITY: Poor
OUTCOME: A = systolic blood pressure
INTERVENTION: Comparison of two recumbent positions: full right lateral or supine with 15 degree pelvic tilt to the left

Difference in systolic blood pressure between supine and right lateral positions (average of both left and right arms) was 3.5mmHg (ns), difference in mean blood pressure between supine and right lateral positions (average of both left and right arms) was 3.9mmHg (p<0.028) using a sphygmomanometer. Using automated NIBP device (Dinamp), difference in systolic blood pressure between supine and right lateral positions (average of both left and right arms) was 4.6mmHg (p<0.028), difference in mean blood pressure between supine and right lateral positions (average of both left and right arms) was 4.9mmHg (p<0.028) using a sphygmomanometer. Clinical signficance of these differences is unclear.

Bamber JH, Dresner M. Aortocaval compression in pregnancy: the effect of changing the degree and direction of lateral tilt on maternal cardiac output. Anesth Analg 2003;97(1):256-8.
No abstract

NHMRC: prospective, randomised study of 32 women in third trimester of pregnancy
QUALITY: Poor
OUTCOME: A = blood pressure, D = cardiac output
INTERVENTION: Comparison of 7 positions: horizontal left lateral and right lateral, horizontal supine, lying supine with left lateral or right tilts @ 12.5° and 5°.

The order in which the positions were adopted was randomized – no mention of randomisation technique. Each position was adopted for a total of 5min: 2min were allowed to let the volunteer settle and then 3-min measurement time. Cardiac output, stroke volume, and heart rate were measured continuously using bioimpedance cardiography with the BoMed® NCCOM3-R7 monitor. Blood pressure was measured automatically over the left brachial artery. 37 women approached: 34 volunteered and one did not complete the study because of feeling faint even in the lateral tilt position. Cardiac output was greatest in left lateral position (M=7.7 L/min,

95% CI: 70-8.5) and lowest in supine position right tilt 12.5^0 with the table tilted laterally to the right (M=6.3 L/min, 95%CI: 5.8-6.8). Systolic blood pressure was highest when in left lateral position (M=113 mmHg, 95%CI: 109-117) and lowest in supine position right tilt 12.5^0 with the table tilted laterally to the right (M=110mmHg, 95%CI: 105-115).

Goldkrand JW, Jackson MJ. Blood pressure measurement in pregnant women in the left lateral recumbent position. Am J Obstet Gynecol 1997;176(3):642-3.
To evaluate blood pressure in pregnant women in the left lateral position, we studied indirect blood pressure in 169 patients with normal blood pressure, chronic hypertension, and preeclampsia in the supine and then the lateral recumbent positions. Two additional patients had aortic arch blood pressure compared with indirect measures. For all groups, mean arterial pressure in the lateral position was lower than in the supine position. Regarding direct aortic arch blood pressure, (1) supine blood pressure equalled that in the lateral position and (2) direct blood pressure in the lateral position equalled the mean indirect mean arterial pressure of both arms. Therefore the actual blood pressure in the lateral recumbent position is the combined mean arterial pressure of both arms.

NHMRC: prospective, observational study of 169 women in 2nd and 3rd trimesters, with normal blood pressure (62.7%, n=106), chronic hypertension (16%, n=27) and pre-eclampsia (21.3, n=36).
QUALITY: Poor
OUTCOME: A = blood pressure
INTERVENTION: Comparison of supine and left lateral positions

Blood pressure was recorded by the investigators with a standard sphygmomanometer on the patient's right arm in the sitting and supine positions and on both arms in the lateral recumbent position, with ~5 minutes of rest between any position change. No description of position change protocol. Two patients (one pregnant: normal blood pressure with a perirenal mass, one non-pregnant hypertensive) underwent aortic catheterization; the blood pressure in the aortic arch was compared with the indirect blood pressure in the right and left arms in the supine and left lateral positions – not sure of the intent of this arm of the study. For all groups (normal, hypertensive, pre-eclamptic) there was a significant increase in blood pressure (p < 0.001) when the mean of both arms in the left lateral position was compared with the mean in the right arm in the supine position: actual values across all participants not reported so difficult to make meaningful conclusions from this study.

Ellington C, Katz VL, Watson WJ, Spielman FJ. The effect of lateral tilt on maternal and fetal hemodynamic variables. Obstet Gynecol 1991;77(2):201-3.
We measured maternal blood pressure and heart rate, fetal heart rate, and umbilical artery velocity waveforms in 25 healthy women placed in the supine and in both right and left 5 degrees and 10 degrees lateral tilt positions. Although we found no significant difference among these variables in the various maternal positions, two of 25 women became hypotensive and symptomatic in the supine and 5 degrees tilt positions. Because we could not predict which women would become symptomatic, we recommend lateral tilt of all pregnant women during operative procedures beyond 20 weeks' gestation, including those in the lithotomy position for vaginal delivery.

NHMRC: prospective, observational study of 25 women at 25-40 weeks gestation, non-labouring
QUALITY: Poor
OUTCOME: A = blood pressure
INTERVENTION: Comparison of six positions: supine, supine with left and right tilts of 5^0 and 10^0

All women were positoned in the following order: supine, 5^0 and 10^0 right lateral tilt then 5^0 and 10^0 left lateral tilt: no crossover. There were no signficant changes in mean systolic blood pressure which ranged from 117 to 121

mmHg and was highest in supine position and supine position with 10^0 left tilt (121 mmHg) and lowest in supine position with 5^0 right tilt (117 mmHg) (p = 0.22).

Kinsella SM, Lee A, Spencer JA. Maternal and fetal effects of the supine and pelvic tilt positions in late pregnancy. Eur J Obstet Gynecol Reprod Biol 1990;36(1-2):11-7.
Material and fetal cardiovascular effects of position change were assessed in 20 women in late pregnancy. On changing from the left lateral to the supine position, there was a 45% reduction in leg blood flow, measured by strain guage plethysmography. Arterial resistance, measured with Doppler ultrasound in the femoral, brachial and uterine arteries, remained unchanged, confirming the absence of compensatory vasoconstriction. There was no change in blood pressure (BP) in the leg, indicating no significant aortic compression, but a rise in maternal heart rate in the supine position suggested the presence of inferior vena cava (IVC) compression. Neither the left or the right pelvic-tilt position was associated with a significant change in leg blood flow or maternal heart rate compared to the supine position. A possible 'sluice' effect in the placental circulation was not confirmed, as fetal heart rate and umbilical Doppler resistance did not change in any position. In the absence of active vasoconstriction and significant aortic compression, IVC compression is the likely cause of the decrease in leg blood flow, and also of the previously demonstrated decrease in uterine blood flow. Leg BP and Doppler ultrasound measurements of uterine artery resistance may not be adequate measures of the effect of posture on uteroplacental perfusion.

NHMRC: prospective, observational study of 20 women at term
QUALITY: Poor
OUTCOME: A = blood pressure
INTERVENTION: Comparison of six positions: supine, supine with left and right tilts of 5^0 and 10^0

Women were inpatients with: elevated BP (12) suspected intra-uterine growth retardation (3), unstable lie (2), urinary tract infection (l), premature rupture of the membranes (l), or polyhydramnios (1). Leg mean arterial pressure (MAP) and heart rate (HR) were measured with an Accutorr 2 device (Datascope, Cambridge) with the cuff on the left ankle. Four standard positions were used: the left lateral, supine and pelvic tilt to the left or right, using a Crawford wedge under the opposite buttock. The women were placed initially in the left tilt (wedge under right buttock) while the instruments were connected and a full set of measurements was made. They were then placed in the other positions, always ending with the lateral position: no evidence of crossover. There were no changes in mean arterial pressure measured using the arm (range 89.4-91, ns) or the leg (range 98.7-100, ns).

Calvin S, Jones OW, 3rd, Knieriem K, Weinstein L. Oxygen saturation in the supine hypotensive syndrome. Obstet Gynecol 1988;71(6 Pt 1):872-7.
This study used recently available, continuous non-invasive monitoring techniques to evaluate positional variations in pulse, blood pressure, and maternal oxygen saturation in 42 women undergoing fetal stress testing in the third trimester. Ten non-pregnant women were similarly evaluated with the automatic sphymomanometer and pulse oximeter. Six of 42 pregnant women (14.3%) developed the supine hypotensive syndrome (defined as a mean blood pressure decrease of 15 mmHg and a sustained increase in pulse of 20 beats per minute) when in the supine position. Nine of them (21.4%) met at least one of the criteria, but the majority (27 of 42, 64.3%) met neither criterion. None of the ten non-pregnant subjects had hypotension or tachycardia, although nine demonstrated blood pressure elevation after assuming the supine position. Significant oxygen desaturation did not occur in any patient, although three of six hypotensive patients had a transient 3-5% desaturation after supine rest. This study confirms that a significant percentage of patients in the third trimester are affected to some degree by supine hypotension. However, significant oxygen desaturation does not appear to occur.

NHMRC: prospective, observational study 42 pregnant women in 3rd trimester and 10 non-pregnant controls
QUALITY: Poor
OUTCOME: A = blood pressure
INTERVENTION: Comparison of supine and left lateral decubitus positions

Patients were in left lateral position for 5 minutes or until mean blood pressure equilibrated, then supine position for a minimum of 10 minutes or subjective symptoms or fetal heart rate changes required position change, then left lateral position for 5 minutes: no crossover. BP measurements were made using an adult cuff placed over the brachial artery on the nondependent (right) arm: initial BP (less than two minutes) and delayed (longer than two minutes) to supine positioning. Supine positioning caused increased mean BP in 37/42 pregnant patients (mean difference +14.4 mmHg) and 9/10 controls (mean difference +14.7 mmHg). Signs of supine hypotension syndrome (sustained (>2 minute) decrease in BP greater than 15mmHg and increase in heart rate of ≥ 20 / minute) were absent in 64.3% of patients (27/42), 21.4% (9/42) had one sign and 14.3% (6/42) had both signs.

Milsom I, Forssman L. Factors influencing aortocaval compression in late pregnancy. Am J Obstet Gynecol 1984;148(6):764-71.
The circulatory effects of postural change in late pregnancy were investigated in 20 healthy pregnant women. Maximum stroke volume (93.2 +/- 11.9 ml) was recorded with the subject in the left lateral position and was significantly (p less than 0.001) reduced in the supine, right lateral, and lithotomy positions, but was largely unchanged in the standing motionless position (89.9 +/- 12.6 ml). Diastolic, systolic, and mean arterial blood pressures and total peripheral vascular resistance were significantly (p less than 0.001) increased in the supine, right lateral, lithotomy, and upright motionless positions when compared to the same variables in the left lateral position. The following factors were found to be significantly correlated to the hemodynamic response to the supine recumbent position: maternal age (p less than 0.05), the position of the fetus in the uterus (p less than 0.05), and systolic (p less than 0.001) and diastolic (p less than 0.001) blood pressures measured with the subject in the left lateral position. The implications of the present findings for modern obstetric delivery care and the etiology of the supine hypotensive syndrome are discussed.

NHMRC: prospective, observational study 20 pregnant women in 3rd trimester
QUALITY: Poor
OUTCOME: A = blood pressure, D = cardiac output
INTERVENTION: Comparison of left lateral, supine, right lateral, lithotomy and standing positions

Sequence of positions was 'varied according to predetermined patterns'. In 10 women position sequence was: left lateral, supine, right lateral, lithotomy and standing. In other 10 women, position sequence was: left lateral, standing, lithotomy, right lateral and supine. Measurements were performed at 1,2,3,5 and 10 minutes in each position. BP was measured using indirect syphgmomanometry. Stroke volume was measured using impedance cardiography and cardiac output was calculated by multiplying SV x heart rate obtained from ECG. Cardiac output was highest in left lateral position (M=6.6 L/min) when compared to supine (M=5.5 L/min), right lateral (M=5.9 L/min) and lithotomy positions (M=5.9 L/min) (p<0.001). There was a significant increase in blood pressure in supine (M=113.6 mmHg), right lateral (M=110.3 mmHg), lithotomy (M=109.4 mmHg)and standing positions (M=112.7 mmHg) when compared to left lateral position (100.7 mmHg) (p<0.001). The clinical significance of these differences is unclear. None of the women in this study had symptoms of supine hypotensive syndrome (bradycardia, hypotension, fainting).

Newman B, Derrington C, Dore C. Cardiac output and the recumbent position in late pregnancy. Anaesthesia 1983;38(4):332-5.
Changes in cardiac output were measured by transcutaneous aortovelography in 30 pregnant patients and in 30 control subjects with change of position from the supine. When compared to the supine position, the left and right lateral and left and right 15^0 tilt positions caused statistically significant increases in cardiac output, whereas the right 15^0 tilt position did not. Neither fetal head engagement nor the time spent in each position had significant effects on the changes in cardiac output. It was not possible to identify subgroup of pregnant patients who were particularly sensitive to changes in posture.

NHMRC: prospective, observational study of 30 pregnant women between 36 and 40 weeks gestation and 30 non-pregnant controls
QUALITY: Poor
OUTCOME: D = cardiac output
INTERVENTION: Comparison of supine, left and right lateral, and left and right 15^0 tilt positions

Changes in cardiac output measured by the noninvasive Doppler ultrasound technique: transcutaneous aortovelography. Recordings were made in the supine, left and right lateral, and left and right 15^0 tilt positions, latter being held with the aid of a Crawford wedge. The order of the positions assumed was randomised using a random number chart. Each patient rested in initial position for 5 minutes, subsequent positions were maintained for 1 or 5 minutes before cardiac output recordings were taken. When compared to supine position, the differences in cardiac output for pregnant participants in each position were as follows:
- left lateral: +0.18% (ns)
- left 15^0 tilt: +2.16 (ns)
- right lateral: -0.27% (ns)
- right 15^0 tilt: +0.39 (ns)

Authors concluded that "no group of patients were particularly sensitive to changes in position however the findings of this study suggest supine and right 15^0 tilt should be avoided in late pregnancy" despite no statistically significant changes in cardiac output. The clinical implications of such small changes in cardiac output are unclear.

Quilligan EJ, Tyler C. Postural effects on the cardiovascular status in pregnancy: a comparison of the lateral and supine postures. Am J Obstet Gynecol 1959;78:465-71.
No abstract
NHMRC: prospective, observational study 196 randomly selected near-term pregnant women
QUALITY: Poor
OUTCOME: A = blood pressure, D = cardiac output
INTERVENTION: Comparison of lateral and supine recumbent positions

Aims: (1) How are pulse rate, stroke volume, and cardiac output altered by a change from the lateral to the supine recumbent position in the near-term pregnant patient? (2) Is the increase in femoral venous pressure in the pregnant subject lying· supine associated with a decrease in cardiac output- and/or a decrease in cardiac stroke volume? (3) If there is a decrease in the renal plasma flow in the supine position, then is this a reflection of decreased cardiac output or stroke volume?
For the 196 patients, blood pressure was measured by sphygmomanometery. They were placed in lateral recumbent position and blood pressure measured then turned to supine position and consecutive blood pressure readings taken until stabilisation of blood pressure was reached. There were no episodes of supine hypotension. There were 62 changes in 15 mm Hg or more in 28% of patients (55/196): there were 39 BP decreases and 23 increases in the supine position compared to the lateral: no p values published.

Cardiac output was estimated by the pulse pressure method in 15 non-obese, normotensive patients aged under 35 years: because of technical difficulties, results available for 13/15 patients. Patients rested in bed in left lateral position for 30-120 minutes, after needle was inserted into brachial artery and constant records of pulse rate and blood pressure, the patient remained in this position for 18 minutes then turned to supine position for another 18 minutes. Short term measures = all of beats during 90 seconds before turning. Long term measures = first 18 minutes of supine laying and 18 minutes of lateral laying. 84% of patients (11/130 had no significant changes in arterial blood pressure with change of position: one patient had 12% increase (of 14 mmHg) and the other patient had 15% decrease (of 18mmHg). 69% of patients (9/13) had no significant change in estimated cardiac index: 2 had an increase in estimated cardiac index when supine and 2 had a decrease – no p values published.

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