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PREVENTING SPINAL HYPOTENSION DURING CS

SHOULD NORADRENALINE BE THE 1ST LINE VASOPRESSOR?

SAOA SPRING MEETING BASEL 16.3.2024

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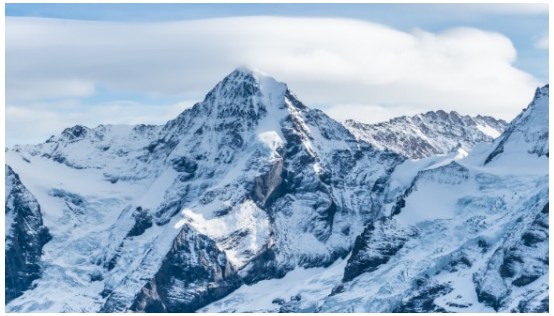
PREVENTING SPINAL HYPOTENSION DURING CS

Maternal & Fetal outcome

«EIGER»: Noradrenaline

Potent ICU-Drug
Standard of care in septic shock
Ratio of 1β : 7α receptor stimulation

«MÖNCH»: Phenylephrine



Standard drug in Anesthesia
Readily available α receptor agonist

«JUNGFRAU»: Ephedrine

Very standard drug in Anesthesia
«Low threshold & ready to go» in every induction room
Direct β and indirect α receptor stimulation

«Where it all starts»: Fluids

Cristalloids
Colloids
Plasma
(Albumin)

AGENDA

What are we talking about?
Maternal cardiac output and receptors – fetal well being

Ephedrine

Phenylephrine vs. Ephedrine

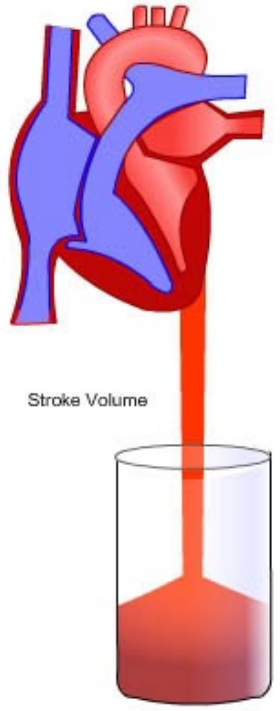
Phenylephrine vs. Noradrenaline

Take home message

WHAT ARE WE TALKING ABOUT?

MATERNAL CARDIAC OUTPUT AND RECEPTORS

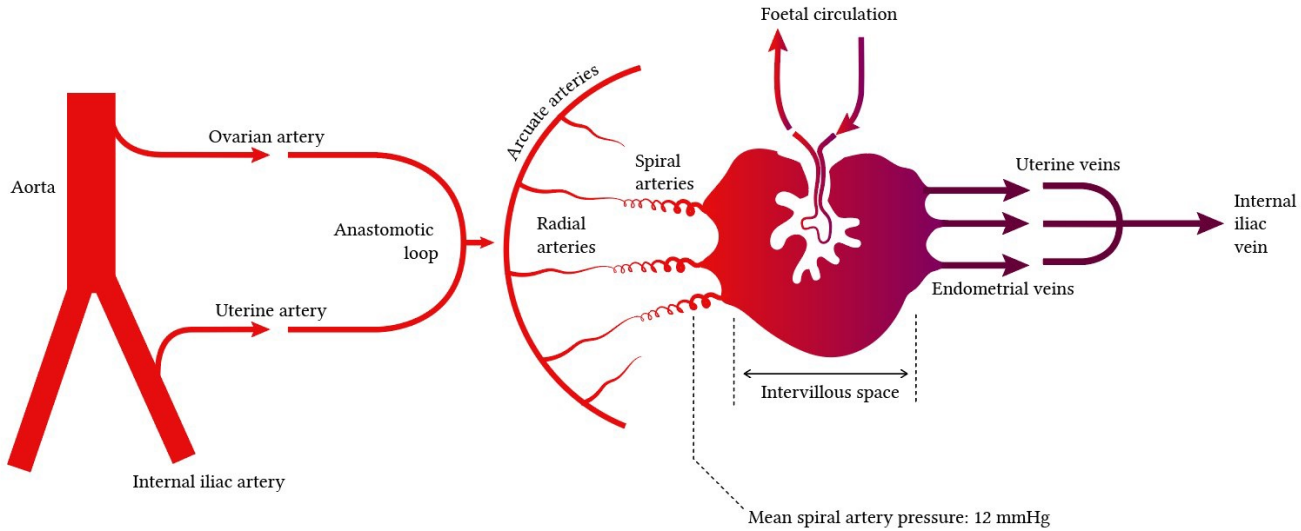
FETAL WELL BEING



To increase cardiac output

Increase stroke volume
or

Increase heart rate
or
increase both



MATERNAL CARDIAC OUTPUT AND FETAL WELL BEING

- Maternal Cardiac output: Heart rate x stroke volume
- Determinant factors: preload, afterload, contractility
- Modulation: Fluid status, $\alpha/\beta/Ca^{++}$
- Uterine perfusion: No autoregulation, determined by CO

Source: deranged physiology, www.derangedphysiology.com

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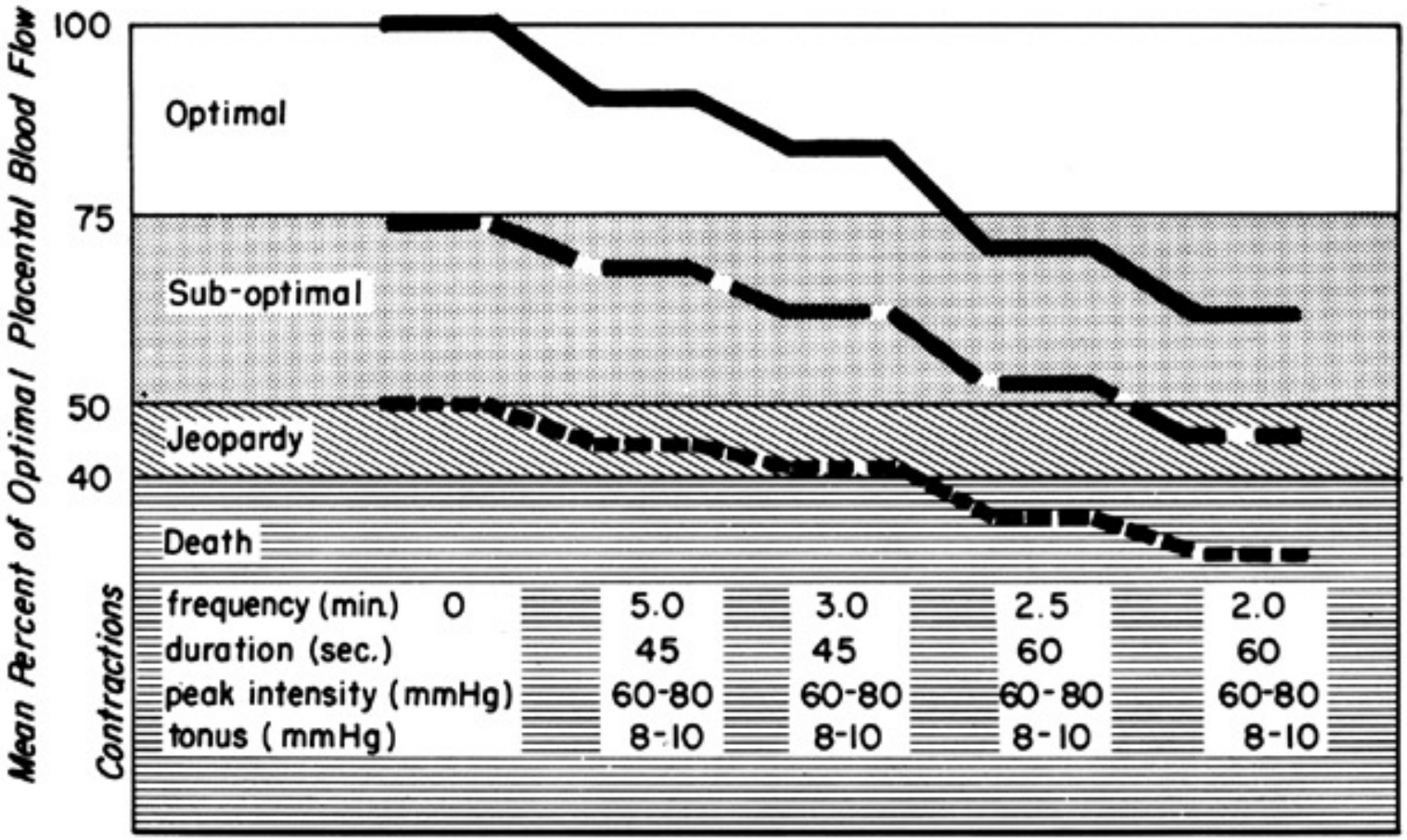
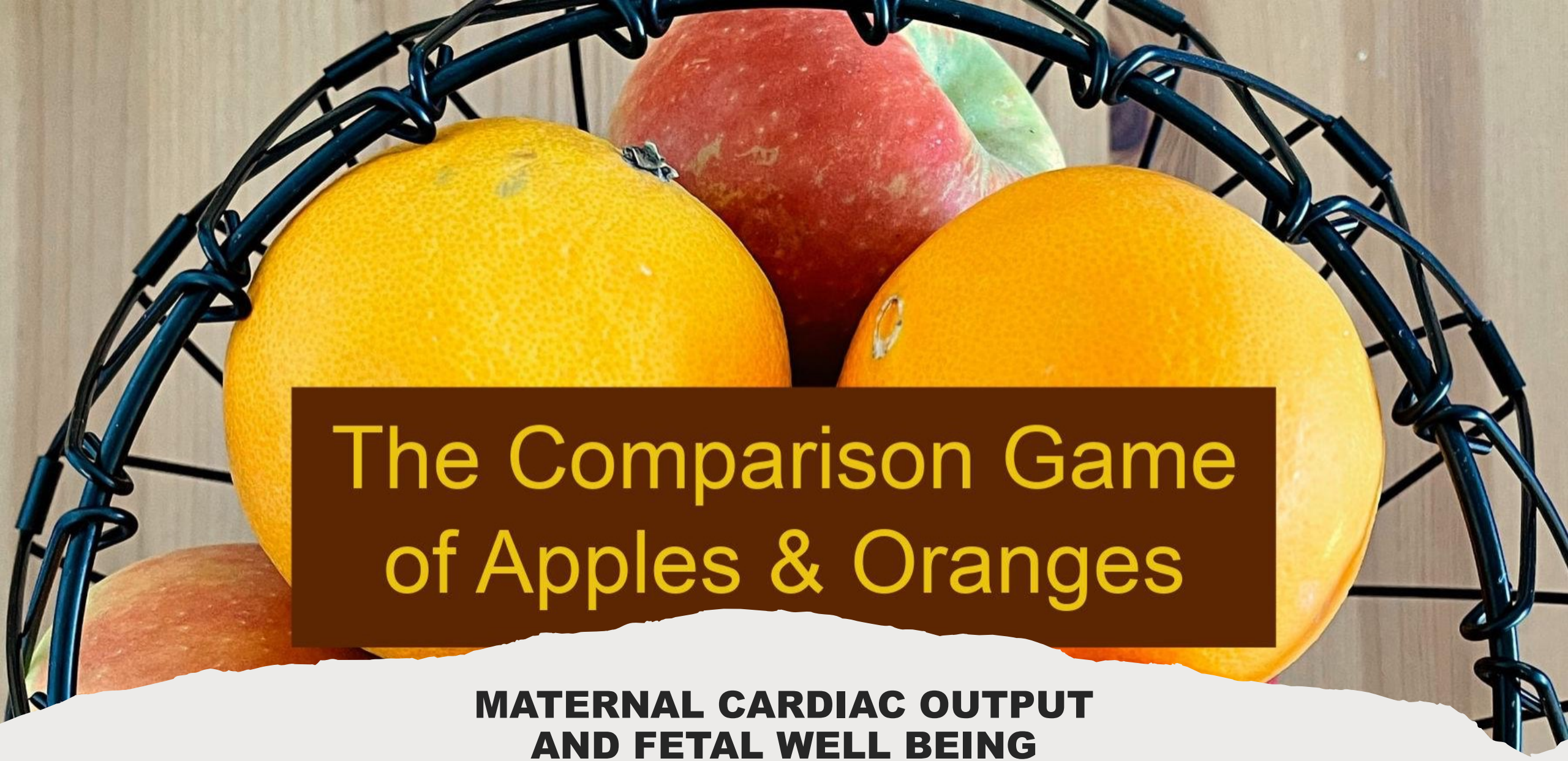
Vasoactive Influences Affecting Uteroplacental Vessels

Vasoconstriction	Vasodilation
• α-1 receptor stimulants	• β-2 receptor stimulants
• Hypoxia (severe)	• Hypoxia (mild)
• Nicotine	• Adenosine
• Vasopressin	• Bradykinin
• Angiotensin	• Oestrogens
• Thromboxane A_2	• Ischaemia
	• Nitrates
	• Prostaglandins E_1, E_2, and I
	• Vasoactive intestinal polypeptide

Greiss, F, *Glob. libr. women's med.*, 2008; DOI 10.3843/GLOWM.10197



Greiss, F, *Glob. libr. women's med.*, 2008; DOI 10.3843/GLOWM.10197



MATERNAL CARDIAC OUTPUT AND FETAL WELL BEING

PITFALLS IN CS STUDIES

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Elective, no labour

Most studies, RCT's
Good baseline CO
No fetal compromise

Emergency, no labour, fetal compromise

Literature less expansive – confounding bias
Baseline maternal CO very variable
β-2 agonists and volume administration
Preexisting fetal acidosis &
In utero rescucitation

Emergency, labour & fetal compromise

Largely retrospective cohorts
Baseline maternal CO very variable
β-2 agonists and volume administration
Preexisting fetal acidosis &
In utero rescucitation
Labour analgesia to a variable degree

Intravascular status, cava compression, fluid boluses vs. fluid maintenance
Pressor boluses vs pressor perfusion
Preexisting pathology
Receptor modulation: α/β/Ca^{++}/μ
Sympaticolysis with neuraxial blockade/analgesia

EPHEDRINE

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A Dose-Response Study of Prophylactic Intravenous Ephedrine for the Prevention of Hypotension During Spinal Anesthesia for Cesarean Delivery

Warwick D. Ngan Kee, MBChB, MD, FANZCA*, Kim S. Khaw, MBBS, FRCA*, Bee B. Lee, MBBS, FANZCA*, Tze K. Lau, MBBS, MRCOG†, and Tony Gin, MBChB, MD, FANZCA, FRCA*

Departments of *Anaesthesia and Intensive Care and †Obstetrics and Gynaecology, The Chinese University of Hong Kong, Prince of Wales Hospital, Shatin, Hong Kong, China

Anesth Analg 2000

CONCLUSIONS

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- All patients received a crystalloid preload of 20 ml/kg – hereby efficacy questioned
- Ephedrine 30 mg to avoid hypotension
- Hypotension, nausea, vomiting and fetal acidosis still present in a part of the cohort
- Hence: “ Further investigation of methods reducing the incidence of maternal hypotension is indicated”

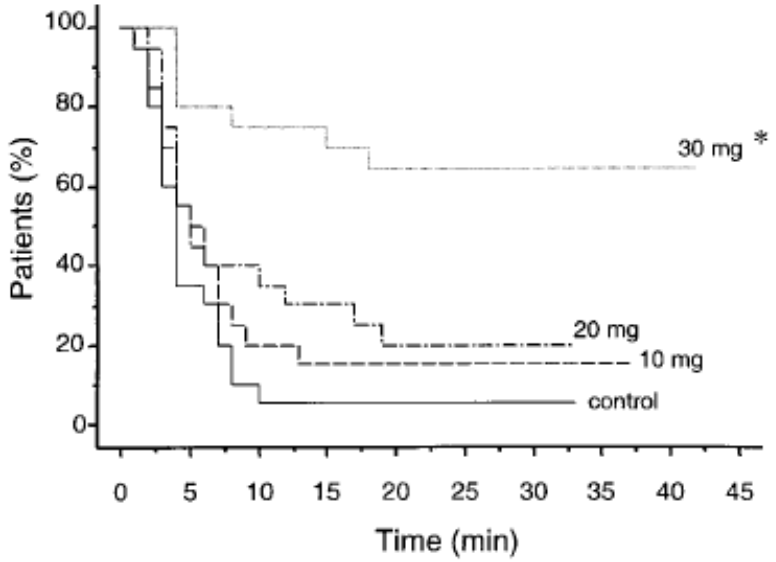

Figure 3. Cumulative survival curves showing percentage of patients remaining not hypotensive until delivery. *$P = 0.0001$ versus control.

PARADIGM CHANGE

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Anesthesiology 2009; 111:506–12

Placental Transfer and Fetal Metabolic Effects of Phenylephrine and Ephedrine during Spinal Anesthesia for Cesarean Delivery

Warwick D. Ngan Kee, M.B.Ch.B., M.D., F.A.N.Z.C.A., F.H.K.A.M., Kim S. Khaw, M.B.B.S., F.R.C.A., F.H.K.A.M.,† Perpetua E. Tan, B.Sc., M.Phil.,‡ Floria F. Ng, R.N., B.A.Sc.,§ Manoj K. Karmakar, M.B.B.S., F.R.C.A., F.H.K.A.M.†*

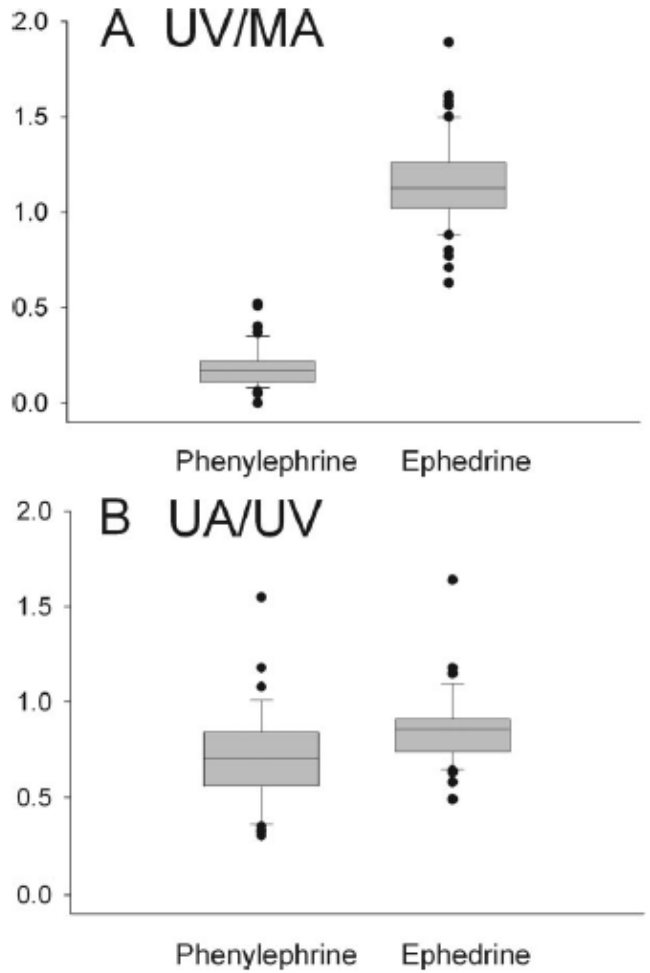

Fig. 1. Plasma concentration ratios for phenylephrine and ephedrine. Data are shown for (*A*) umbilical venous to maternal arterial (UV/MA) and (*B*) umbilical arterial to umbilical venous (UA/UV) ratios. *Box plots* display the 25th, 50th, and 75th percentiles as *horizontal lines* on a bar, *whiskers* above and below the box indicate the 90th and 10th percentiles, and data beyond the 10th and 90th percentiles are displayed as individual *points*. Data were significantly different between groups ($P \leq 0.001$) for both concentration ratios.

BULLETPOINTS

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- Ephedrine crosses the placenta to a geater extent and undergoes less early metabolism in the fetus, compared to phenylephrine
- Increased fetal concentrations of lactate, glucose and catecholamines support the hypothesis related to metabolic effects secondary to stimulation of fetal β-receptor stimulation
- Despite the evidence suggesting a better maintained uterine blood flow with ephedrine, the overall effect of vasopressors on fetal oxygen supply and demand balance in favor of phenylephrine

Table 3. Plasma Concentrations of Lactate, Glucose, Epinephrine, Norepinephrine, Phenylephrine, and Ephedrine

	Phenylephrine Group	Ephedrine Group	*P* Value
Maternal arterial			
Lactate, mmol/l	2.3 [2.0–2.7] (44)	2.4 [2.0–2.7] (45)	0.56
Glucose, mg/dl	80 [76–85] (44)	86 [80–94] (45)	0.003
Epinephrine, pg/ml	33.5 [19–54] (46)	47 [22–73] (50)	0.046
Norepinephrine, pg/ml	115 [92–178] (45)	297 [223–390] (50)	<0.001
Phenylephrine, ng/ml	8.2 [5.7–10.7] (47)		
Umbilical arterial			
Lactate, mmol/l	2.2 [1.9–2.6] (52)	4.2 [3.0–6.7] (49)	<0.001
Glucose, mg/dl	55 [49–60] (52)	63 [59–71] (49)	<0.001
Epinephrine, pg/ml	525 [289–852] (45)	696 [507–1,291] (49)	0.019
Lactate, mmol/l	2.2 [1.9–2.4] (51)	3.4 [2.7–5.1] (50)	<0.001
Glucose, mg/dl	66 [61–70] (51)	73 [68–79] (50)	<0.001
Epinephrine, pg/ml	97 [50–214] (50)	132 [84–226] (52)	0.039
Norepinephrine, pg/ml	446 [293–683] (50)	1,568 [812–2,940] (52)	<0.001
Phenylephrine, ng/ml	1.4 [0.8–1.9] (47)		
Ephedrine, ng/ml		434.5 [334.0–594.3] (52)	

Values are number or median [interquartile range] (number of samples).

THE BASEL TRAM

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THE BASEL TRAM

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Published in final edited form as:
Anesthesiology. 2009 September ; 111(3): 470–472. doi:10.1097/ALN.0b013e3181b16466.

BURDEN OF PROOF

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In early 2009, a two-day symposium on Obstetric Anesthesia had just ended, and my colleague and I stepped onto the tram in Basel, Switzerland, to begin our respective journeys home. One of the final discussions at the conference had concerned treatment/prevention of hypotension during spinal anesthesia for cesarean delivery, and I had spoken about the evidence in favor of phenylephrine infusions, and my personal practices in utilizing the drug. On the tram, I asked my colleague what he generally used to treat hypotension during cesareans and he responded "Boluses of ephedrine or phenylephrine, as does most of the rest of my group." The following

IT HAPPENED IN SEPT 2009 IN ANESTHESIOLOGY

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- The “weight of the evidence” has now equaled the “burden of proof,” and our clinical burden should be to incorporate the evidence into our routine practice.
- As the famous Alka-Seltzer ad from the 1970s said, “Try it, you’ll like it (and so will your patients)”

BURDEN OF PROOF

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2000, 2009, 2015:
WARWICK D. NGAN KEE DID IT AGAIN

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Randomized Double-blinded Comparison of Norepinephrine and Phenylephrine for Maintenance of Blood Pressure during Spinal Anesthesia for Cesarean Delivery

Warwick D. Ngan Kee, M.B.Ch.B., M.D., F.A.N.Z.C.A., F.H.K.A.M.,
Shara W. Y. Lee, B.Sc.(Hons.), M.Sc., Ph.D., Floria F. Ng, R.N., B.A.Sc.,
Perpetua E. Tan, B.Sc., M.Phil., Kim S. Khaw, M.B.B.S., M.D., F.R.C.A., F.H.K.A.M.

Anesthesiology 2015

WHY DID HE DO IT ?

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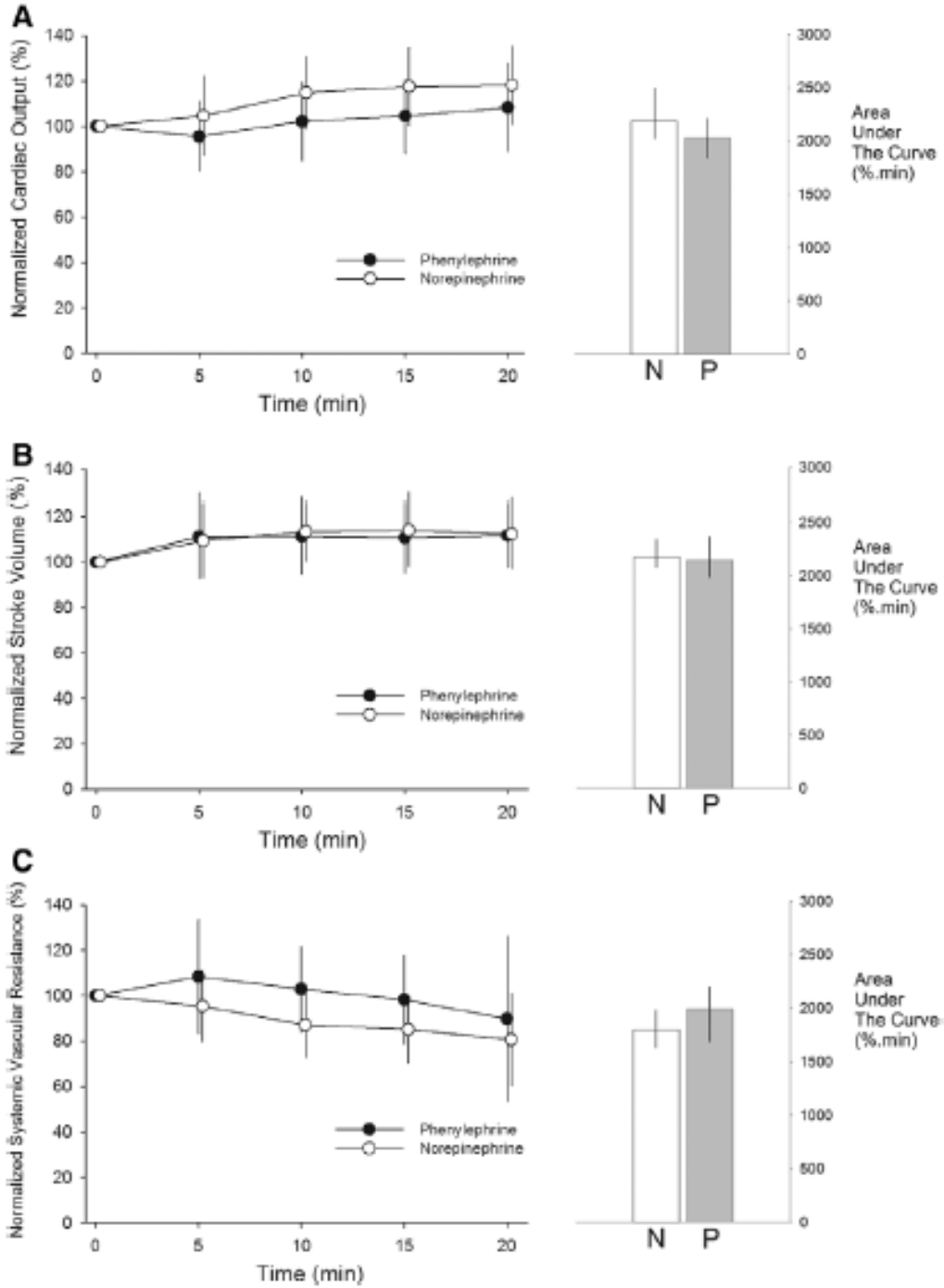
Concern in Phenylephrine's pure α effect on cardiac output

Dose-related reflex bradycardia and concurrent decrease in maternal cardiac output

Potential harm in the presence of a compromised fetus

- RCT, N=104,
- double blind,
- computer programmed automated adminsitration of NE or Phenylephrine
- CO, SV and SVR measurement by suprasternal doppler



- HR greater in NE group
- CO greater in NE group approx. 10%
- SVR lower in NE group
- SV unchanged

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Norepinephrine for Spinal Hypotension during Cesarean Delivery

Another Paradigm Shift?

Brendan Carvalho, M.B.B.Ch., F.R.C.A., Robert A. Dyer, F.C.A.(SA), Ph.D.

Anesthesiology 2015

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- Spinal hypotension is primarily driven by a decrease in symathetic tone in the arterial system, and not by a reduction in the central venous capacitance
- This physiological observation is consistent with the findings, that α-agonist vasopressors are the most reliable method for preventing and treating spinal hypotension during a cesarean delivey
- Physiologic studies have shown a modest increase in heart rate and stroke volume after an induction of spinal anesthesia, so a β effect may not be necessary
- The relave importance of cardiac output and blood pressure maintenance to optimize uteroplacental perfusion is uncertain as of now
- However, there is a close correlation of heart rate to cardiac output in the setting of phenylephrine administration for hypotension

IS IT A NEW CHAPTER ?

PHENYLEPHRINE VS. NOREPINEPRINE

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International Journal of Obstetric Anesthesia (2017) **29**, 1–4

http://dx.doi.org/10.1016/j.ijoa.2017.01.002

EDITORIAL

More perfect?

R. SMILEY IN 2017

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- Burden of proof not reached, we certainly are NOT at the point of replacing phenylephrine with norepinephrine
- It may well be that norepinephrine facilitates a higher maternal cardiac output than phenylephrine, but the clinical implications are questionable
- The current practice is quite effective and safe; ie there is no desperate need for improvement

Anaesthesia 2021, 76, 743–747 doi:10.1111/anae.15363

Editorial

Noradrenaline – at best it is not worse. A comparison with phenylephrine in women undergoing spinal anaesthesia for caesarean section

M. Heesen,[1] **T. Girard**[2] and **M. Klimek**[3]

1 Professor, Department of Anaesthesia, Kantonsspital Baden, Baden, Switzerland
2 Professor, Department of Anaesthesia, University Hospital Basel, Basel, Switzerland
3 Consultant, Department of Anaesthesiology, Erasmus University Medical Centre, Rotterdam, The Netherlands

Table 1 Comparison of ephedrine, phenylephrine and noradrenaline. Based on [3], modified by the authors [35–37].

	Ephedrine	Phenylephrine	Noradrenaline
Mode of action	Indirect >> direct	Direct	Direct
Activity on α-adrenoceptor	+/++	+++	+++
Activity on β-1-adrenoceptor	+++	0	+/++
Activity on β-2-adrenoceptor	++	0	?
Onset	Slow	Immediate	Immediate
Duration	Prolonged	Intermediate	Short
ED_{95} in adults	5–30 mg	40–150 µg	3–11 µg
Relative potency	0.0123	1	10–12.5
Other concerns	Tachyphylaxis with repeated doses	Reflex bradycardia possible	Reflex bradycardia possible

ED_{95} = recommended effective dose for an effect in 95% of the cases.

2024: WHERE ARE WE TODAY ?

Celebrating the 33rd anniversary of the SAOA
“Where we come from, where we are, where we go”

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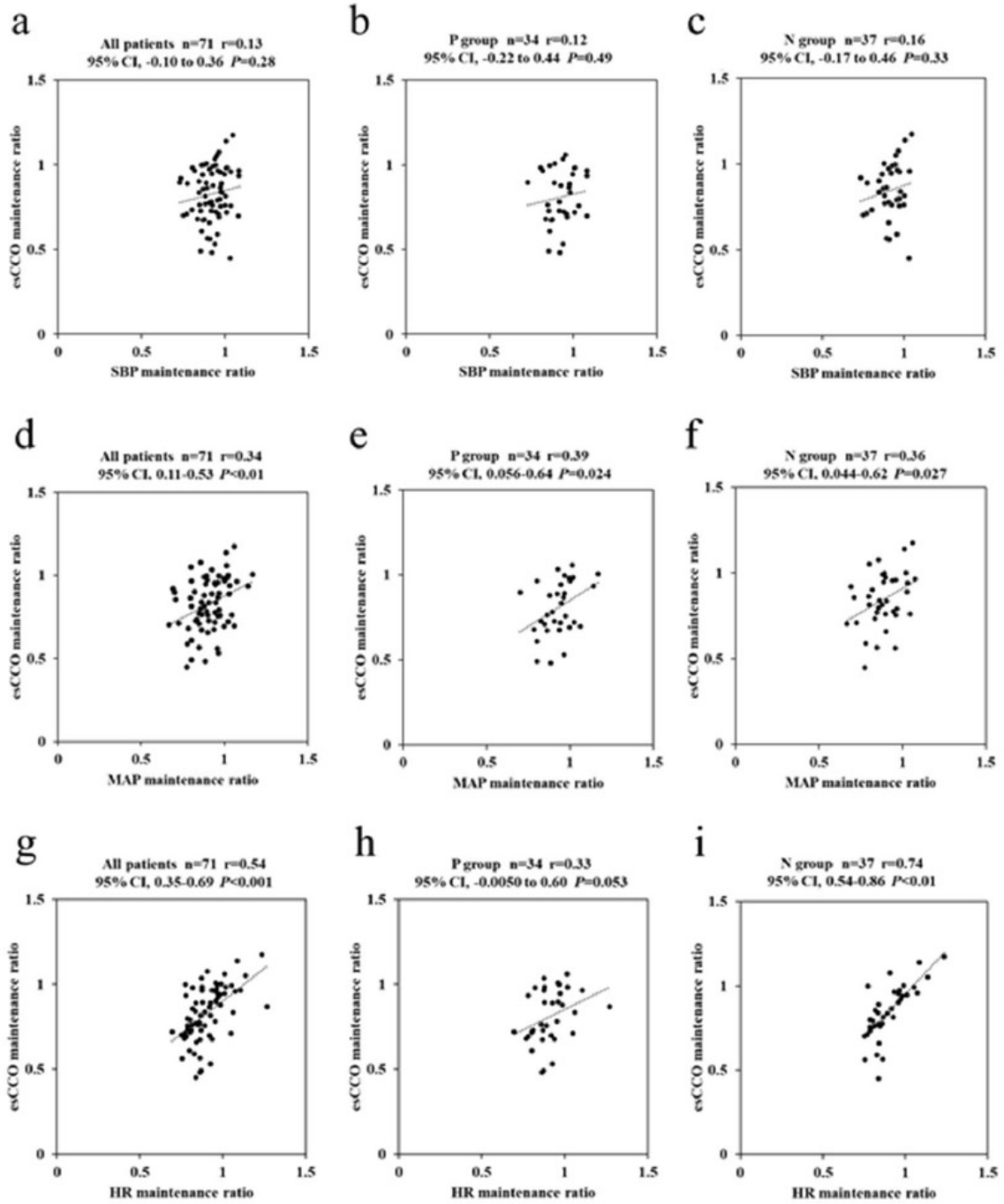
APPLES & ORANGES & PEAS

Major monitoring and cardiac output during cesarean delivery

Yuki Nakano[1] · Jun Takeshita[1] · Kazuya Tachibana[1]

Received: 24 September 2021 / Accepted: 5 January 2022 / Published online: 15 January 2022

- N/Norepinephrine 34 patients, P/Phenylephrine 37 patients
- Estimated CO (esCCO), MAP, SBP, HR


a
All patients n=71 r=0.13
95% CI, -0.10 to 0.36 P=0.28
b
P group n=34 r=0.12
95% CI, -0.22 to 0.44 P=0.49
c
N group n=37 r=0.16
95% CI, -0.17 to 0.46 P=0.33
d
All patients n=71 r=0.34
95% CI, 0.11-0.53 P<0.01
e
P group n=34 r=0.39
95% CI, 0.056-0.64 P=0.024
f
N group n=37 r=0.36
95% CI, 0.044-0.62 P=0.027
g
All patients n=71 r=0.54
95% CI, 0.35-0.69 P<0.001
h
P group n=34 r=0.33
95% CI, -0.0050 to 0.60 P=0.053
i
N group n=37 r=0.74
95% CI, 0.54-0.86 P<0.01
esCCO maintenance ratio
SBP maintenance ratio
MAP maintenance ratio
HR maintenance ratio
0
0.5
1
1.5


4 Tram Zürich-West


3
Birsfelden Hard
680

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Prophylactic norepinephrine infusion for postspinal anesthesia hypotension in patients undergoing cesarean section: A randomized, controlled, dose-finding trial

Yi Chen[1] | Lili Zou[1] | Zhenzhou Li[1] | Lei Guo[1] | Wei Xue[2] | Ling He[2] | Shuqin Ma[2] | Xinli Ni[1]

TABLE 1 Demographic and baseline characteristics

	NS group (n = 19)	NE 25 group (n = 20)	NE 50 group (n = 20)	NE 75 group (n = 20)	NE 100 group (n = 20)	p Value
Age (years)	31.79 ± 4.52	32.65 ± 4.12	32.80 ± 5.23	32.55 ± 4.68	29.95 ± 4.84	0.287
BMI (kg/m^2)	28.52 ± 3.38	27.34 ± 3.67	29.21 ± 2.23	28.82 ± 3.28	29.01 ± 4.44	0.469
Baseline						
SBP (mm Hg)	119.21 ± 12.40	116.40 ± 11.15	120.60 ± 11.43	116.00 ± 7.38	119.05 ± 11.83	0.631
HR (beats/min)	95.95 ± 14.24	91.75 ± 15.35	90.90 ± 15.66	98.25 ± 14.51	90.35 ± 14.62	0.370
Block height[a]	6 [4,6]	6 [6,6]	6 [6,6]	6 [6,6]	6 [6,6]	0.061
Time from anesthesia to fetal delivery (min)	14.74 ± 4.40	13.10 ± 4.19	13.35 ± 2.60	14.25 ± 3.73	15.30 ± 3.39	0.300
Time from skin incision to fetal delivery (min)	3.37 ± 1.57	3.90 ± 1.71	3.35 ± 2.06	4.35 ± 2.11	4.15 ± 1.98	0.351
Length of postoperative stay (day)	3.47 ± 0.70	3.40 ± 0.60	3.65 ± 0.93	3.45 ± 0.51	3.55 ± 1.32	0.906

Note: Data are presented as mean ± SD (standard deviation) and median [quartiles].

Abbreviations: BMI, body mass index; HR, heart rate; NE, norepinephrine; NS, normal saline; SBP, systolic blood pressure.

[a]Sensory blockade was assessed using a sterile needle.

TABLE 2 Adverse effects

	NS group (n = 19)	NE 25 group (n = 20)	NE 50 group (n = 20)	NE 75 group (n = 20)	NE 100 group (n = 20)	p Value
Postspinal anesthesia hypotension, *N* (%)	13 (68.42)*	8 (40.00)	4 (20.00)	3 (15.00)	2 (10.00)	<0.001
Severe postspinal anesthesia hypotension, *N* (%)	4 (21.05)	2 (10.00)	2 (10.00)	1 (5.00)	0 (0.00)	0.220
Total additional bolus of norepinephrine	1 [0,2]†	0 [0,1]	0 [0,0]	0 [0,0]	0 [0,0]	<0.001
Bradycardia, *N* (%)	1 (5.26)	1 (5.00)	1 (5.00)	2 (10.00)	2 (10.00)	0.928
Total additional bolus of atropine	0 [0,0]	0 [0,0]	0 [0,0]	0 [0,0]	0 [0,0]	0.943
Nausea, *N* (%)	5 (26.32)	2 (10.00)	1 (5.00)	1 (5.00)	1 (5.00)	0.125
Vomiting, *N* (%)	2 (10.53)	0 (0.00)	0 (0.00)	0 (0.00)	1 (5.00)	0.217
Hypertension, *N* (%)	1 (5.26)	1 (5.00)	1 (5.00)	2 (10.00)	3 (15.00)	0.717

Notes: Data are presented as number (%) and median [quartiles]. Kruskal-Wallis test with a Dunn post hoc test was used to compare groups pairwise for the outcomes of total additional bolus of norepinephrine and atropine. ANOVA test with a Bonferroni post hoc test was used to compare groups pairwise for other outcomes.

Abbreviations: NE, norepinephrine; NS, normal saline.

*p = 0.003 vs. NE 50 group, p = 0.001 vs. NE 75 group, p < 0.001 vs. NE 100 group.

†p = 0.004 vs. NE 50 group, p = 0.001 vs. NE 75 group, p < 0.001 vs. NE 100 group.

TABLE 4 Neonatal outcomes

	NS group (n = 19)	NE 25 group (n = 20)	NE 50 group (n = 20)	NE 75 group (n = 20)	NE 100 group (n = 20)	p Value
pH	7.38 ± 0.04	7.37 ± 0.04	7.37 ± 0.04	7.37 ± 0.04	7.36 ± 0.05	0.588
PCO_2 (mm Hg)	38.45 ± 4.82	38.04 ± 5.85	37.36 ± 4.99	37.25 ± 3.38	40.25 ± 5.62	0.332
BE (mmol/L)	−2.83 ± 1.26	−2.98 ± 1.29	−3.22 ± 1.38	−3.53 ± 1.01	−2.87 ± 2.11	0.536
PO_2 (mm Hg)	25.69 ± 4.44	25.83 ± 6.20	26.79 ± 5.21	27.87 ± 4.41	25.42 ± 6.45	0.600
Apgar score, 1 min	9 [9,9]	9 [9,9]	9 [9,9]	9 [9,9]	9 [9,9]	0.912
<7 at 1 min, N (%)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1.000
Apgar score, 5 min	10 [10,10]	10 [10,10]	10 [10,10]	10 [10,10]	10 [10,10]	0.666
<7 at 5 min, N (%)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1.000

Notes: Data are presented as mean ± SD (standard deviation), median [quartiles], and number (%). Kruskal-Wallis test with a Dunn post hoc test was used to compare groups pairwise for the outcomes of Apgar score at 1 and 5 min. ANOVA test with a Bonferroni post hoc test was used to compare groups pairwise for other outcomes.

Abbreviations: BE, base excess; NE, norepinephrine; NS, normal saline; PCO_2, partial pressure of carbon dioxide; PO_2, partial pressure of oxygen.

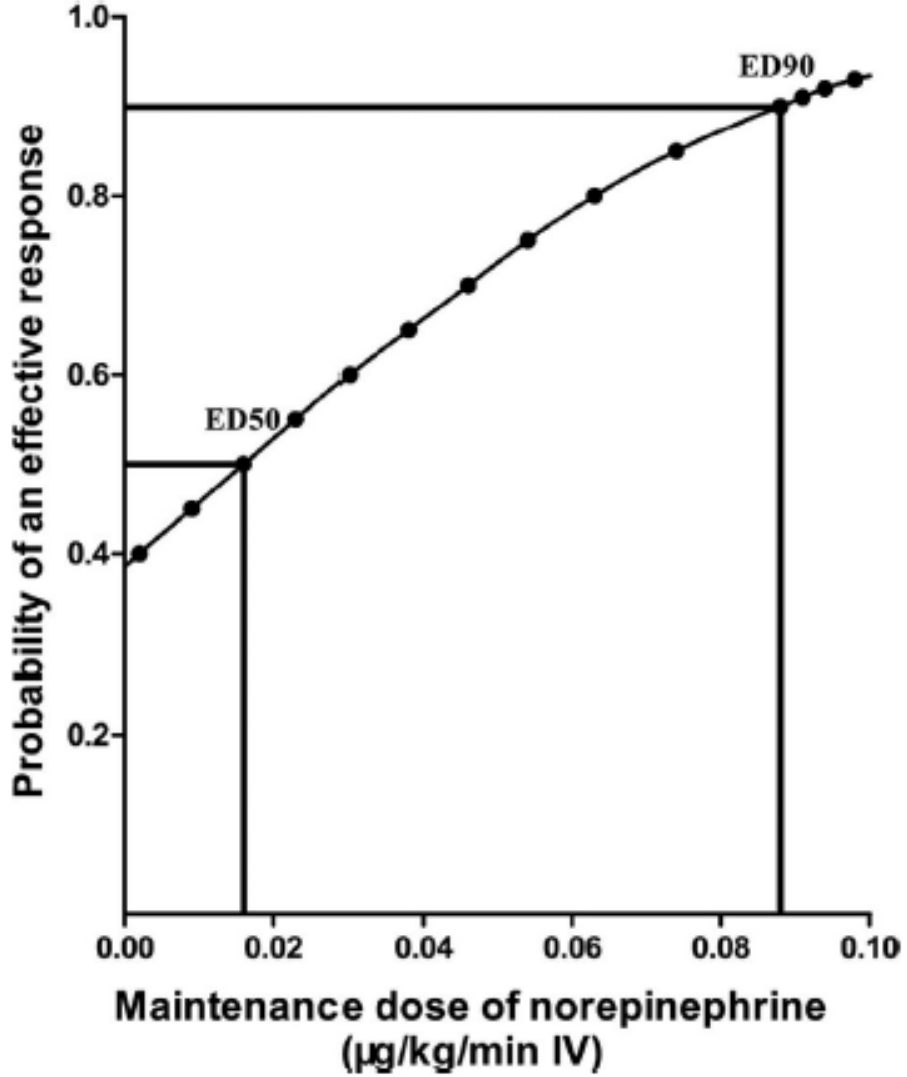

FIGURE 3 Dose-response curve of norepinephrine infusion for preventing post-spinal anesthesia hypotension

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Prophylactic Fixed-Rate Phenylephrine Versus Norepinephrine Infusion in the Prevention of Post-spinal Anesthesia Hypotension During Cesarean Delivery

Anisha Pauline [1], K Arthi [1], Aruna Parameswari [1], Mahesh Vakamudi [1], Akilandeswari Manickam [1]

1. Anesthesiology, Sri Ramachandra Institute of Higher Education and Research, Chennai, IND

N=208, Phenylephrine vs. Norepinephrine infusions

DOI: 10.7759/cureus.41251

Parameters	Phenylephrine group (n = 104)	Norepinephrine group (n = 104)	P-value
Venous pH	7.32 (0.03)	7.33 (0.03)	0.062
Venous pCO_2	45.91 (5.84)	45.12 (5.10)	0.29
Venous pO_2	23.95 (5.63)	25.28 (6.28)	0.10
Venous HCO_3	24.29 (2.35)	24.30 (2.44)	0.98

TABLE 3: Comparison of umbilical cord blood gases and neonatal outcomes.

The data are represented as mean (SD).

P-values less than 0.05 were considered significant.

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EJA

Eur J Anaesthesiol 2021; **38**:1077–1084

ORIGINAL ARTICLE

A randomised double-blind comparison of phenylephrine and norepinephrine for the management of postspinal hypotension in pre-eclamptic patients undergoing caesarean section

Medha Mohta, Lakshmi R, Geetanjali T. Chilkoti, Rachna Agarwal and Rajeev Kumar Malhotra

N=220 patients
Phenylephrine boluses versus norepinephrine boluses

Table 2 Severity of pre-eclampsia

	Phenylephrine ($n=43$)	Norepinephrine ($n=43$)	*P* value
Patients with pre-eclampsia without severe features	26 (60.5)	22 (51.2)	0.385
Patients with severe pre-eclampsia	17 (39.5)	21 (48.8)	
Patients receiving magnesium sulphate prophylaxis	8 (18.6)	11 (25.6)	0.436

Data are *n* (%).

Table 3 Umbilical cord blood gas parameters and other neonatal parameters

	Phenylephrine ($n=39$)	Norepinephrine ($n=40$)	*P* value
A pH	7.26 ± 0.06	7.27 ± 0.06	0.903
A PO_2 (mmHg)	22.9 ± 7.2	28.1 ± 16.5	0.075
A PCO_2 (mmHg)	46.8 ± 9.4	46.1 ± 9.7	0.747
A O_2 saturation (%)	37.6 ± 16.9	40.9 ± 17.6	0.466
A HCO_3 (mEq/l)	21.0 ± 3.6	21.2 ± 3.4	0.817
A base excess (mEq/l)	4.1 ± 6.0	1.8 ± 6.6	0.111
Fetal acidosis (ApH <7.2)	5 (12.8)	4 (10.0)	0.693
V pH	7.31 ± 0.06	7.31 ± 0.07	0.855
V PO_2 (mmHg)	29.5 ± 9.8	39.0 ± 16.4	0.003
V PCO_2 (mmHg)	39.1 ± 7.9	36.5 ± 8.4	0.160
V O_2 saturation (%)	49.6 ± 21.0	64.4 ± 15.9	0.001
V HCO_3 (mEq/l)	19.8 ± 3.2	19.3 ± 2.9	0.461
V base excess (mEq/l)	−6.6 ± 3.2	−6.7 ± 4.0	0.979
(A−V) PCO_2 difference	7.7 ± 6.1	9.6 ± 6.4	0.181
Apgar 1 min[a]	9 [9 to 10]	9 [9 to 10]	0.770
Apgar 5 min[a]	10 [10 to 10]	10 [10 to 10]	1.000
Baby birth weight (kg)[a]	2.6 ± 0.5	2.7 ± 0.6	0.511

Data are mean ± SD, median [IQR] or *n* (%). A, arterial; V, venous. [a]$n=43$.

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Research Article

Effectiveness of Prophylactic Bolus Ephedrine Versus Norepinephrine for Management of Postspinal Hypotension during Elective Caesarean Section in Resource Limited Setting: A Prospective Cohort Study

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- N=84, prospective cohort
- APGAR: All scores > 7 at 1 and 5 minutes
- Blood pressure: NA>ephedrine
- Heart rate: Ephedrine>NA
- Nausea and vomitting: NS

NE can be used as a substitute to ephedrine to maintain blood pressure in pregnant women undergoing elective CS under spinal anesthesia without adverse effects the mother and babys

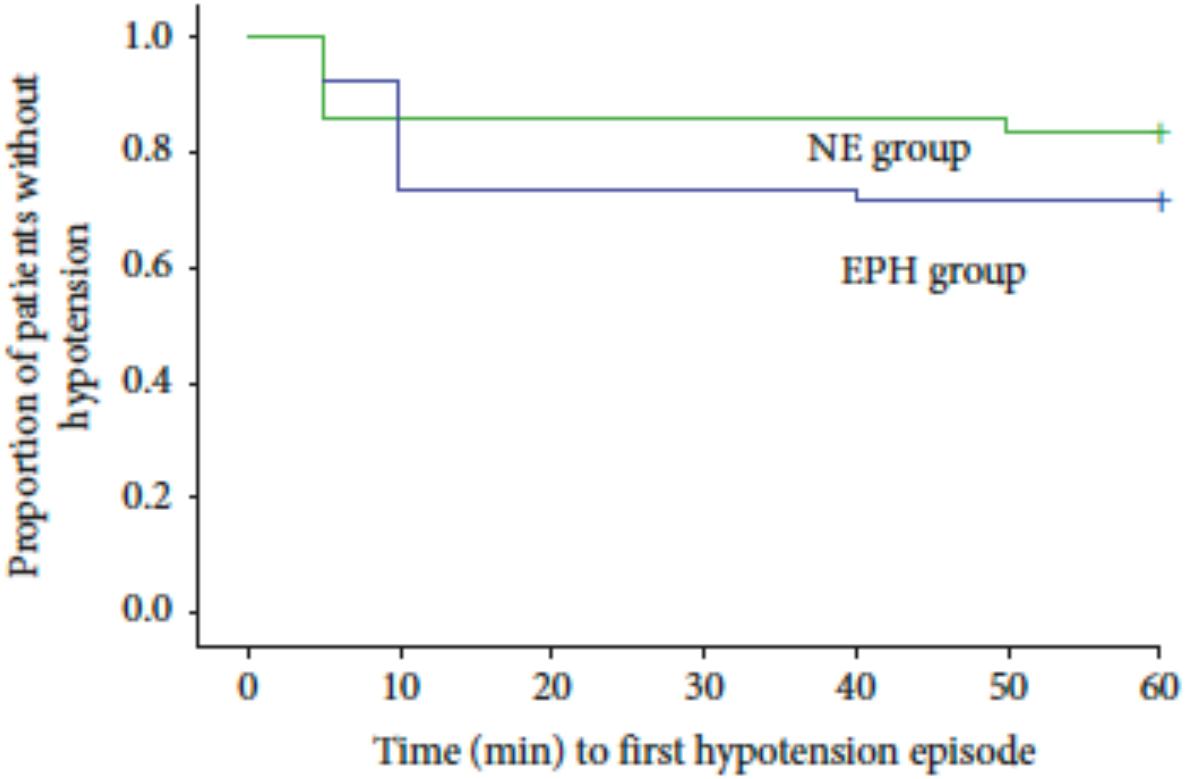

FIGURE 3: A Kaplan–Meier curve depicting the change in mean arterial blood pressure between the groups over time.

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THE BASEL TRAM IS “TOP OF EUROPE”

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PANIC BOLUS
USE WHAT YOU KNOW

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USE IT WISELY
CARDIAC OUTPUT ROUGHLY CORRELATES TO HEART RATE

QUESTIONS?

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THANK YOU

Prophylactic Norepinephrine and Phenylephrine Boluses to Prevent Postspinal Anesthesia Hypotension During Cesarean Section: A Randomized Sequential Allocation Dose-Finding Study

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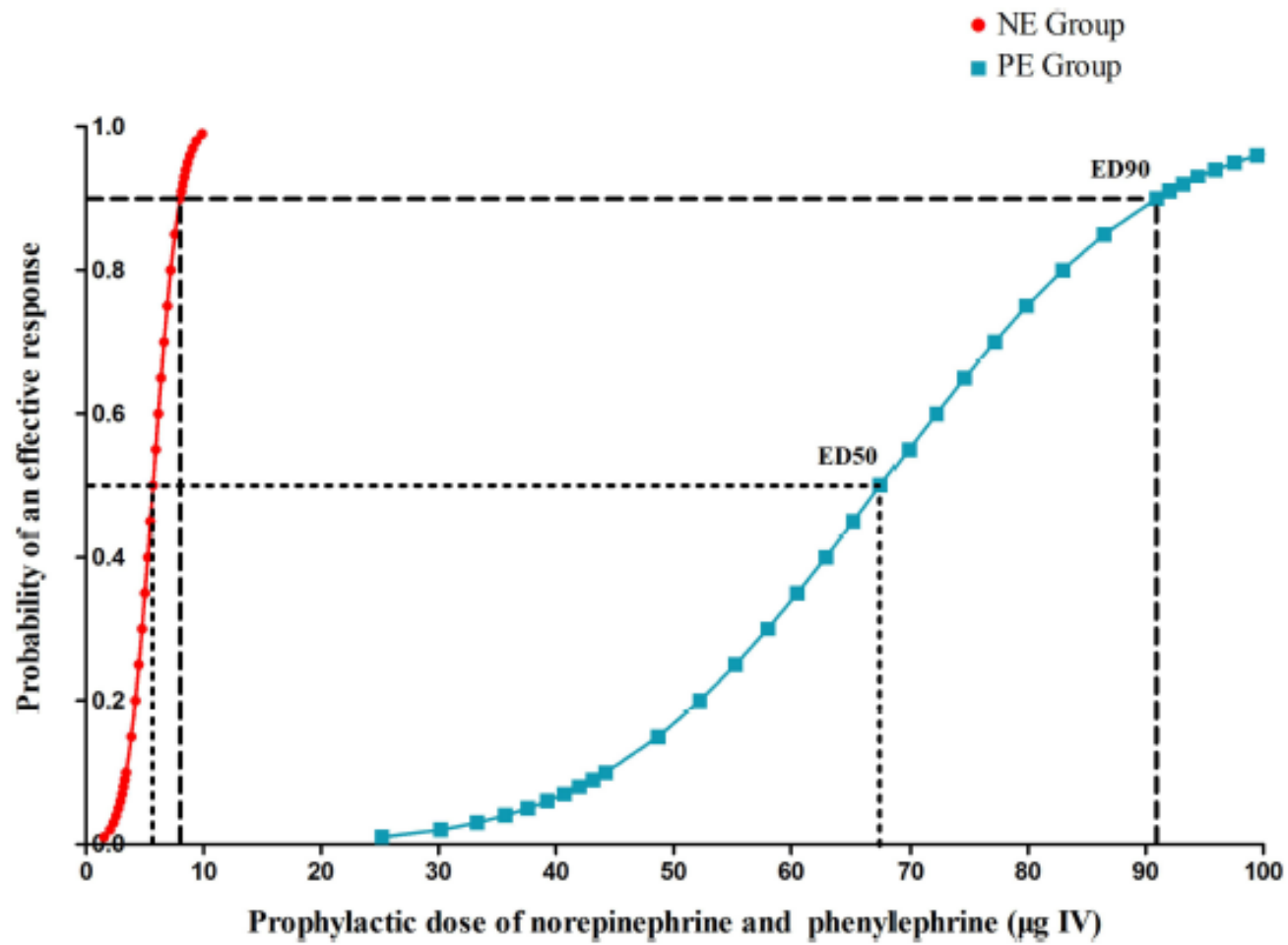

Figure 3 The dose–response curve of a prophylactic bolus dose of norepinephrine or phenylephrine for preventing postspinal anesthesia hypotension.
Abbreviation: ED, effective dose.