General Anaesthesia for C-section: How do I do it in 2023?

Thierry Girard

```
┌─────────────────────────┐
│      Preoxygenation      │
│   at least 4 deep breaths,│
│   preferable: $ETO_2 > 0.8$│
└─────────────────────────┘
              │
              ▼
┌──────────────────────────────────┐
│ 1. Alfentanil 0.5mg iv           │
│ 2. Propofol 2 (-3) mg/kg         │         ┌──────────────────────────────┐
│ 3. Rocuronium 1 mg/kg            │────────▶│ Preeclampsia, cardiovasc. disease: │
│ 4. Cricoid pressure              │         │ **Remifentanil** 1 µg/kg (instead of │
│ 5. Apnea oder gentle mask ventilation│      │     alfftentanil) slow bolus,  │
│ (Pmax <20 $cmH_2O$)              │         │     followed by infusion       │
│   NMBA after propofol, do not wait for apnea.│   (TCI oder 10-36 ml/h)    │
│     Intubation 50 sec after rocuronium│     └──────────────────────────────┘
│     (dose to ideal weight, opt. +20%)│
└──────────────────────────────────┘
              │
              ▼
┌──────────────────────────┐
│       Intubation         │
│    Check tube (CO2 !)     │
└──────────────────────────┘
              │
              ▼
           ◇ start surgery ◇
              │
              ▼
┌──────────────────────────┐
│    Sevo max 1 MAC        │         ┌──────────────────────────────┐
│    100 % O2              │         │ Propofol as alternative to Sevo: │
└──────────────────────────┘         │      TIVA with BIS           │
              │                       └──────────────────────────────┘
              ▼
           ◇ cord clamping ◇
              │
              ▼
┌──────────────────────────────────────┐
│    Fentanyl 2-3 µg/kg                 │
│    Midazolam 3-5 mg, if ø BIS or BIS > 55│
│    Reduce Sevo < 1MAC (uterine tone !) │
└──────────────────────────────────────┘
              │
              ▼
┌──────────────────────────────────────┐
│ TOF: 4 Twitches: Robinul/Neostigmin   │
│ < 4 Twitches: Sugammadex 200 mg        │
│ TOF< 0.9 after 4-5min: repeat 200mg    │
└──────────────────────────────────────┘
              │
              ▼
┌──────────────────────────┐
│     Awake, reflexes      │
│    no residual paralysis  │
│       Extubation         │
└──────────────────────────┘
```

Postoperative Analgesia:
Working epidural: Morphine 2mg epidural
No epidural
- Paracetamol 1g iv
- Ibuprofen 400mg iv
- Morphine 0.1mg/kg iv (ideal weight)

Optional wound infiltration with bupivacaine
0.25% 20-30ml
TAP block, if consent available

M. Brunner, Th. Girard, March 2023

Preoxygenation
at least 4 deep breaths,
preferable: $ETO_2>0.8$

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followed by infusion
(TCI oder 10-36 ml/h)

Intubation
Check tube (CO2 !)

Preoxygenation

Perioxygenation

```
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                │
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Check tube (CO2 !)

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ORIGINAL ARTICLE

Induction opioids for caesarean section under general anaesthesia: a systematic review and meta-analysis of randomised controlled trials

L.D. White,[a,b] A. Hodsdon,[c,d] G.H. An,[b] C. Thang,[a,b] T.M. Melhuish,[e,f] R. Vlok[g,h]

[a]School of Medicine, University of Queensland, QLD, Australia
[b]Department of Anaesthesia, Sunshine Coast University Hospital, QLD, Australia
[c]School of Medicine, University of Wollongong, NSW, Australia
[d]Wollongong Hospital, NSW, Australia
[e]School of Medicine, University of New South Wales, NSW, Australia
[f]Intensive Care Service, Royal Prince Alfred Hospital, NSW, Australia
[g]School of Medicine Sydney, University of Notre Dame Australia, NSW, Australia
[h]Intensive Care Service, Royal North Shore Hospital, NSW, Australia

- BPsys, BPmean, HR 👍

- Remifentanil 0.5-1 µ/kg 👍

- Alfentanil 7.5-10 µg/kg 👍

- Fentanyl 0.5-1 µg/kg 👎

```
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at least 4 deep breaths,
preferable: ETO$_2$>0.8
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```
Intubation
Check tube (CO2 !)
```

CrossMark

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ORIGINAL ARTICLE

A dose–response study of remifentanil for attenuation of the hypertensive response to laryngoscopy and tracheal intubation in severely preeclamptic women undergoing caesarean delivery under general anaesthesia

K.Y. Yoo,[a] D.H. Kang,[a] H. Jeong,[a] C.W. Jeong,[a] Y.Y. Choi,[b] J. Lee[c]

[a] Department of Anaesthesiology and Pain Medicine, [b] Department of Pediatrics, [c] Department of Physiology, Chonnam National University Medical School, Gwangju, South Korea
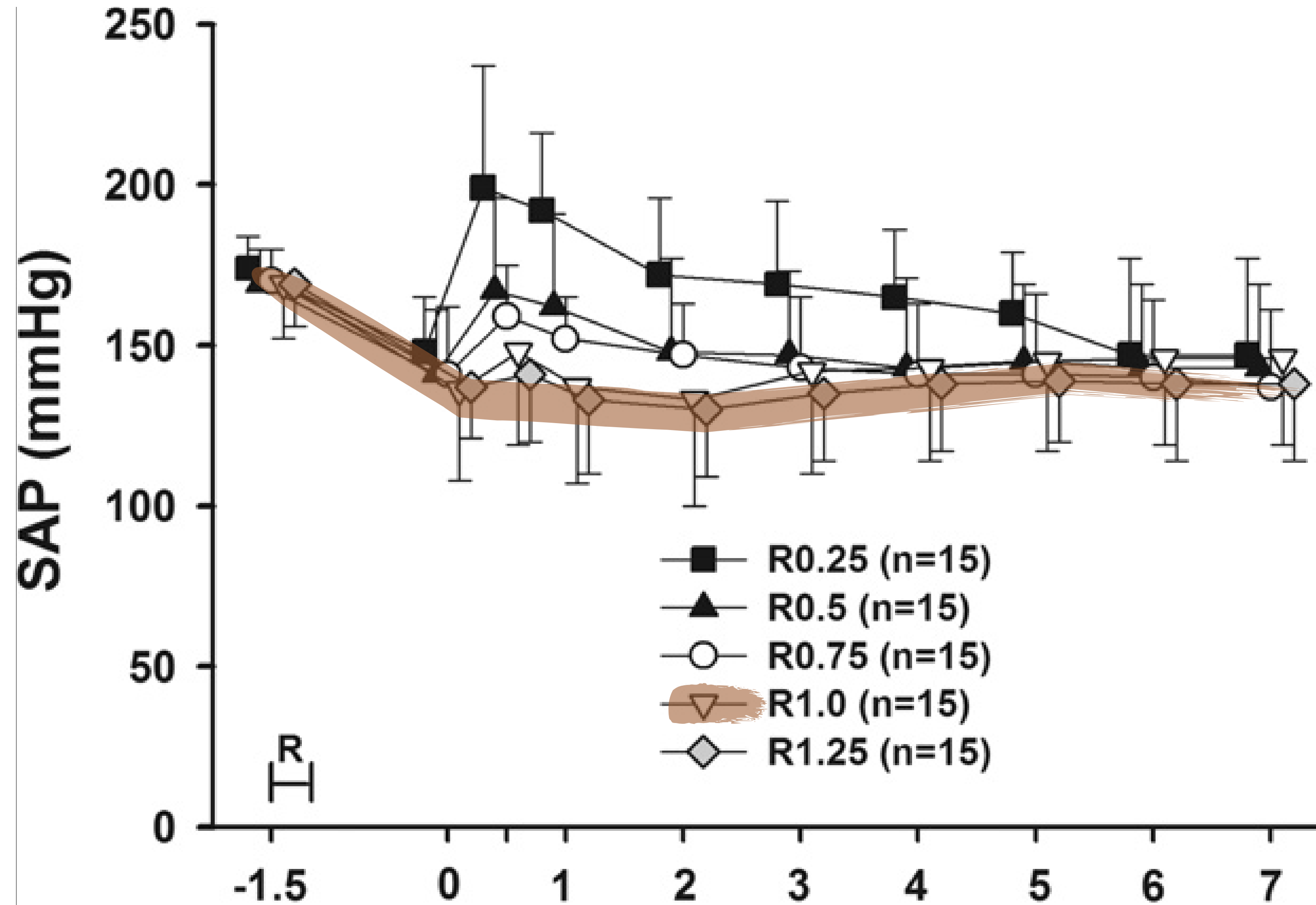
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(TCI oder 10-36 ml/h)

Intubation
Check tube (CO2 !)

Original Article

1:670

The 5th National Audit Project (NAP5) on accidental awareness during general anaesthesia: summary of main findings and risk factors

J. J. Pandit,[1] J. Andrade,[2] D. G. Bogod,[3] J. M. Hitchman,[4] W. R. Jonker,[5] N. Lucas,[6] J. H. Mackay,[7] A. F. Nimmo,[8] K. O'Connor,[9] E. P. O'Sullivan,[10] R. G. Paul,[11] J. H. MacG. Palmer,[12] F. Plaat,[13] J. J. Radcliffe,[14] M. R. J. Sury,[15] H. E. Torevell,[16] M. Wang,[17] J. Hainsworth[18] and T. M. Cook[19]
On behalf of the Royal College of Anaesthetists and the Association of Anaesthetists of Great Britain and Ireland

SCIENTIFIC REPORTS

natureresearch
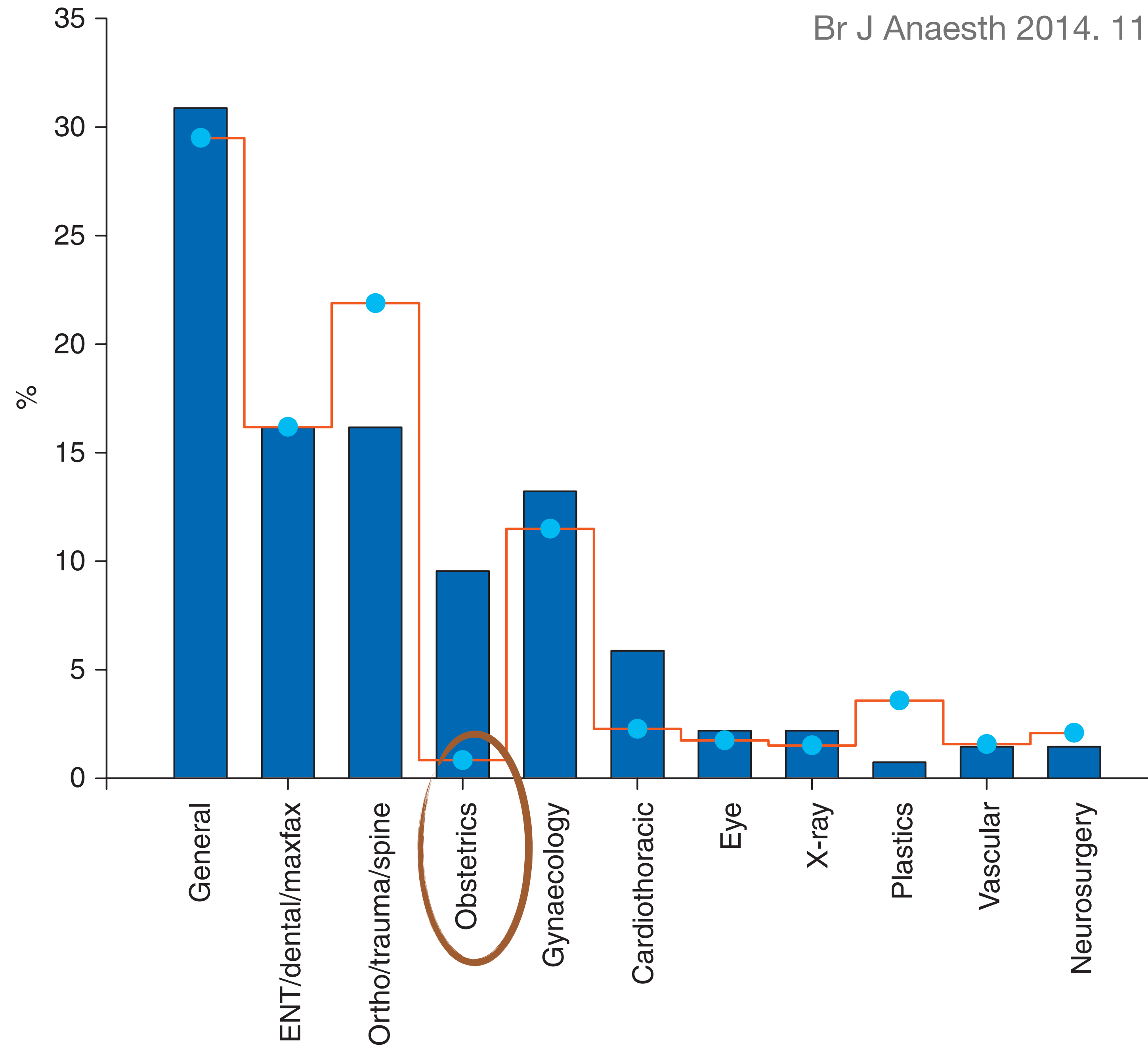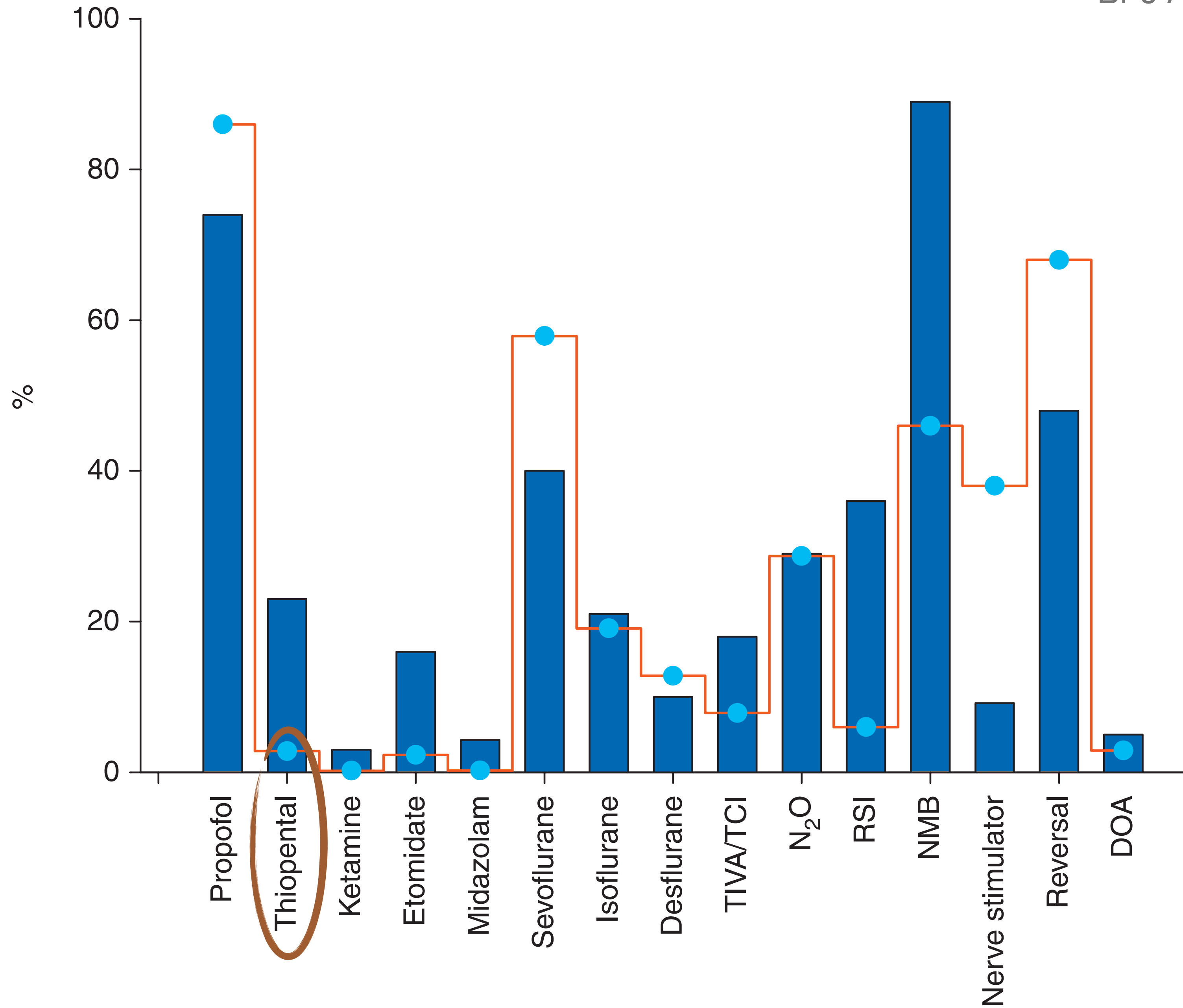
OPEN

Comparison of electroencephalogram between propofol- and thiopental-induced anesthesia for awareness risk in pregnant women

Hee-Sun Park[1,3], Yeon-Su Kim[2,3], Sung-Hoon Kim[1], A-Rom Jeon[1], Seong-Eun Kim[2]* & Woo-Jong Choi[1]*
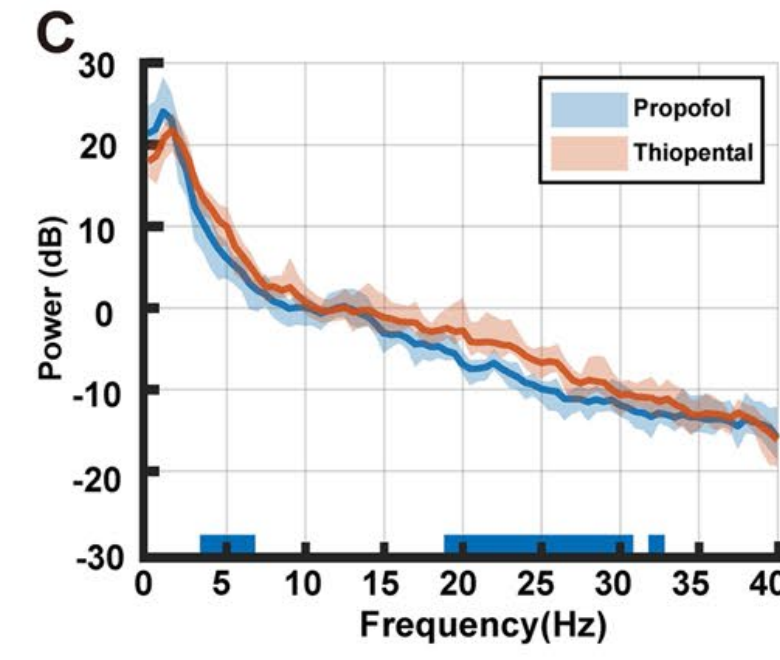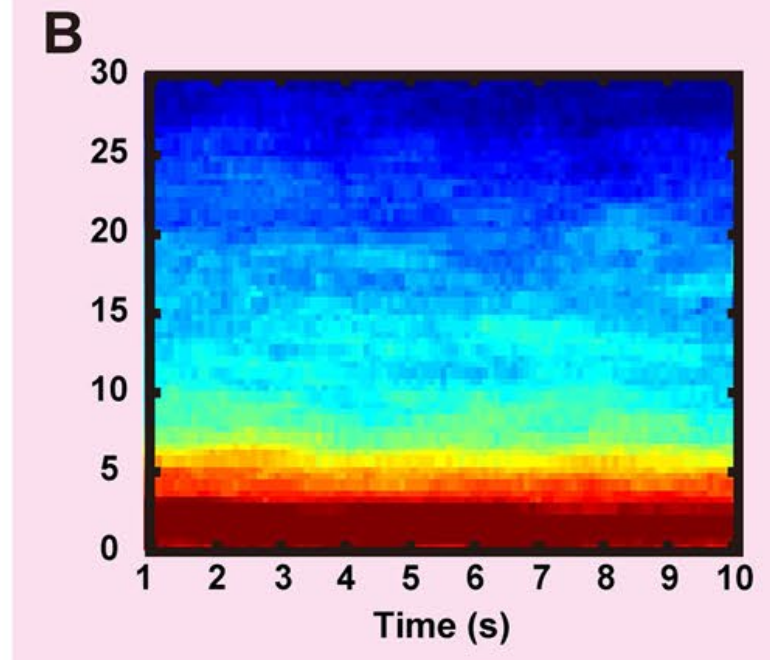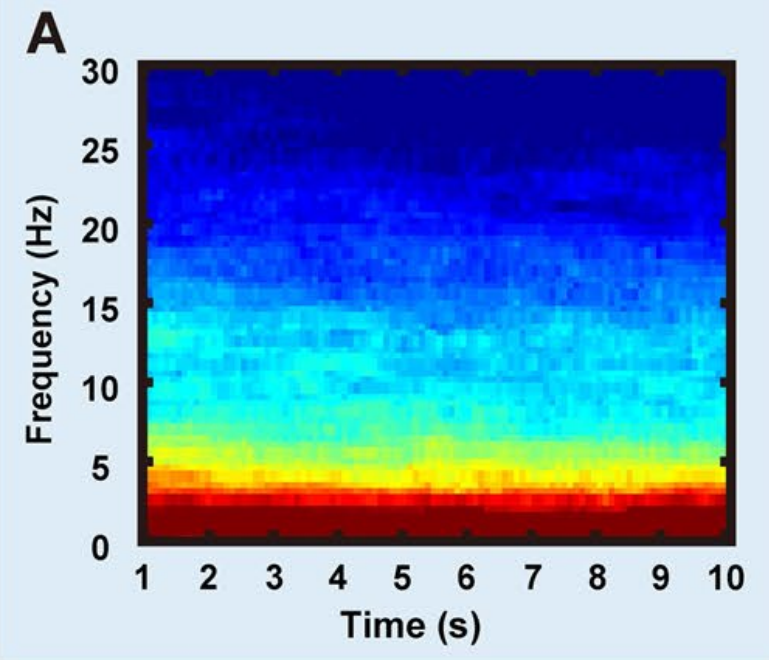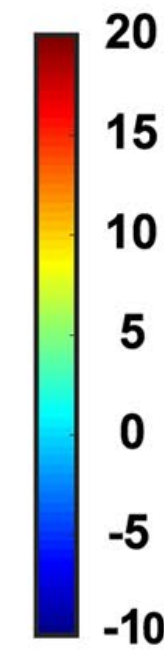
Park et al. Sci Rep. 2020;10:6192.
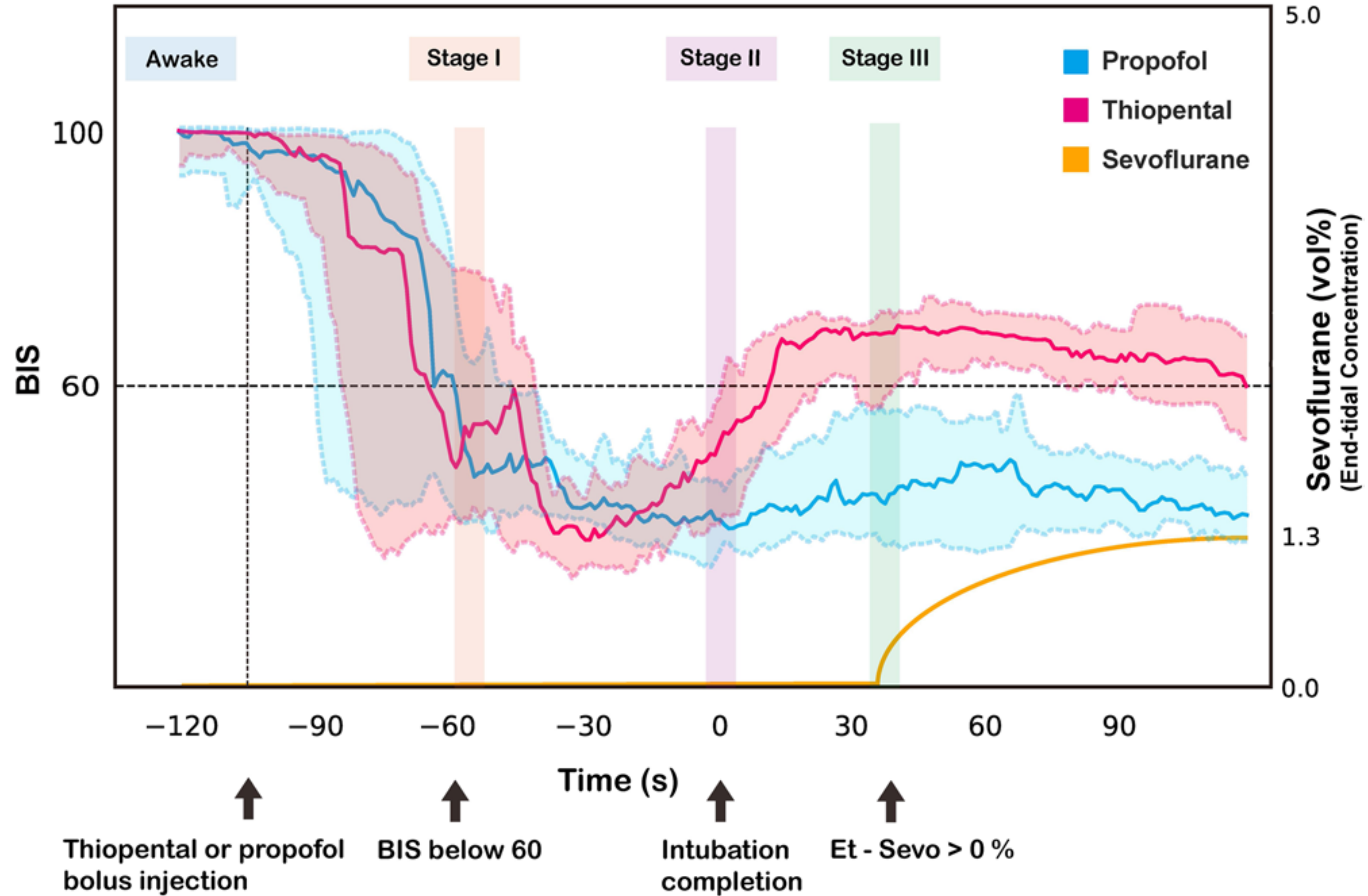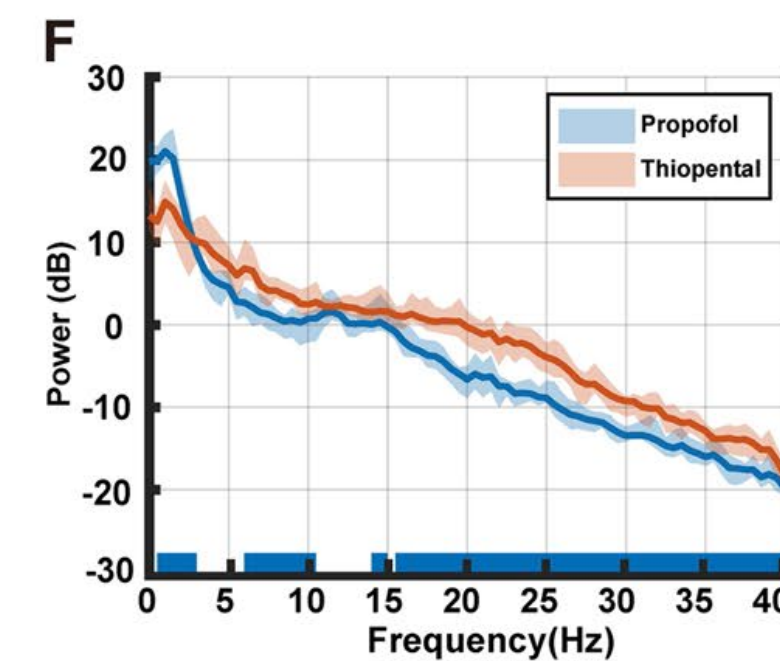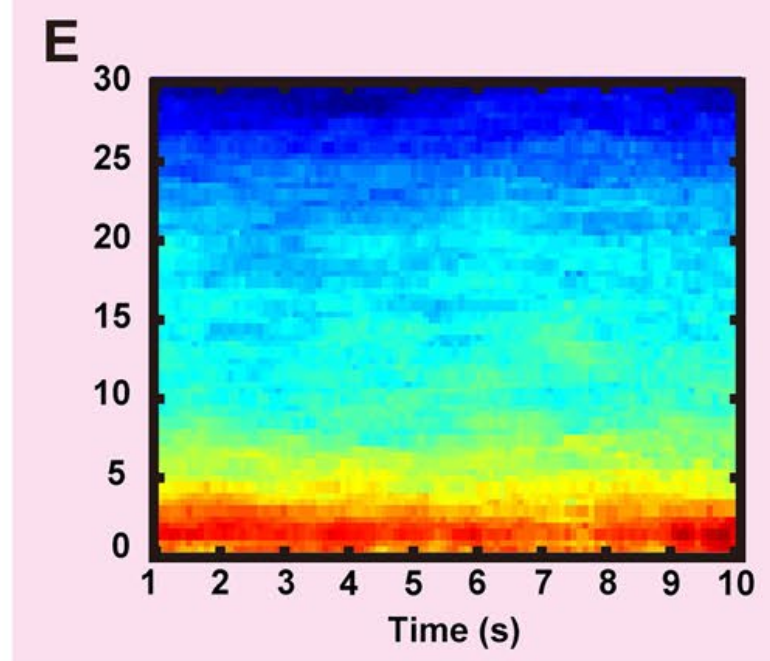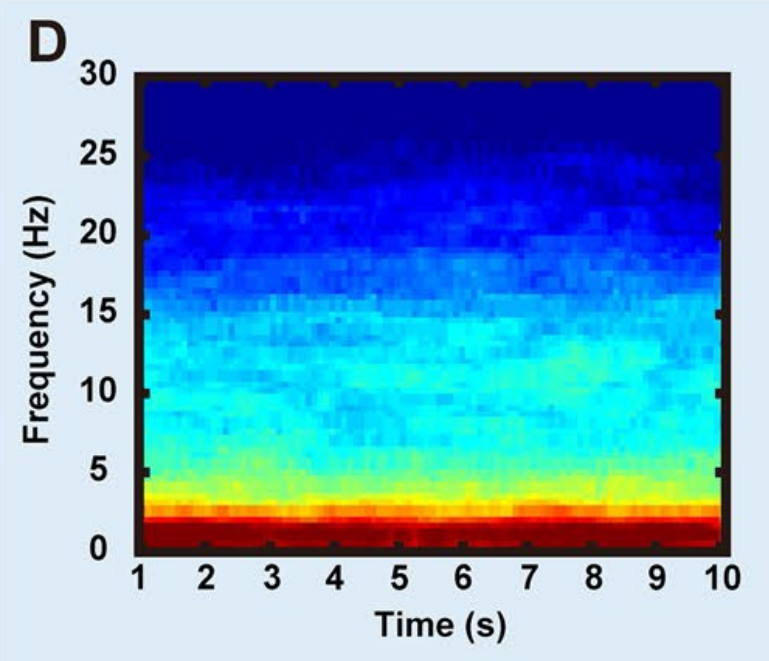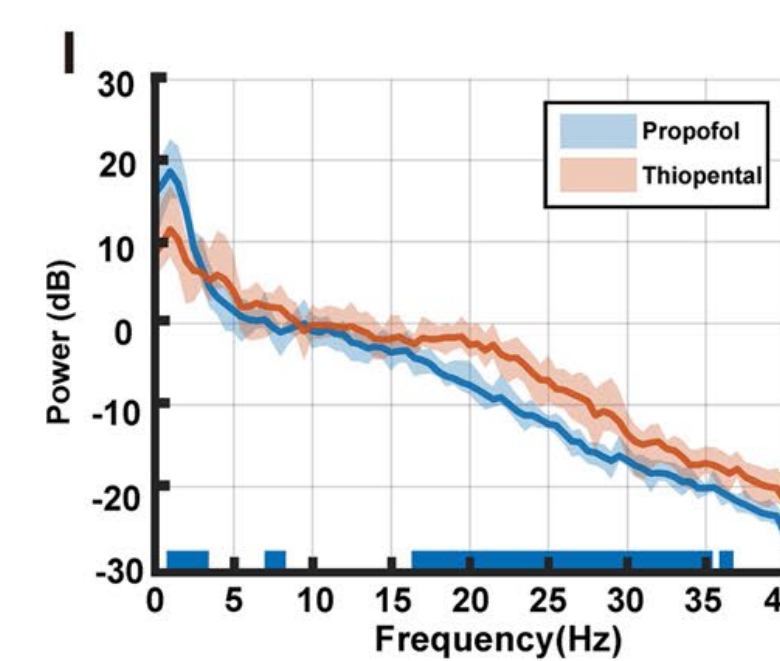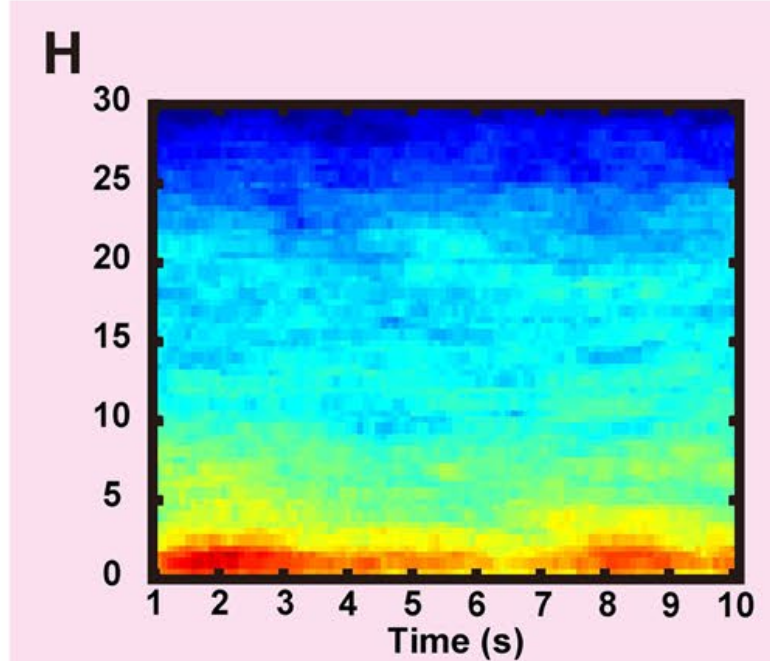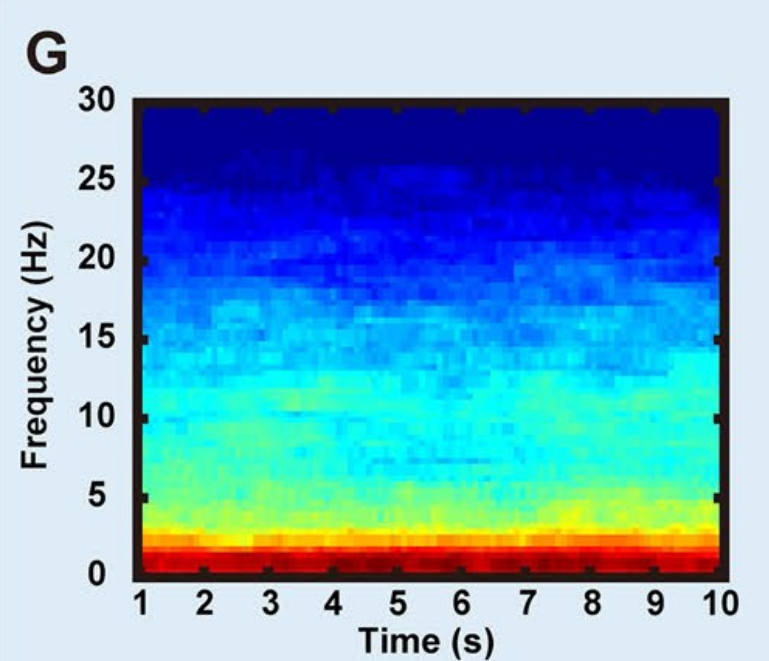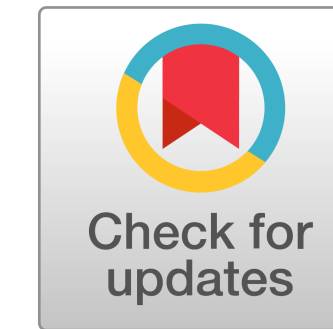
Original Article

Incidence of accidental awareness during general anaesthesia in obstetrics: a multicentre, prospective cohort study

P. M. Odor,[1] iD **S. Bampoe,**[1] **D. N. Lucas,**[2] **S. R. Moonesinghe,**[3] **J. Andrade,**[4] **J. J. Pandit,**[5,6] and **Pan-London Peri-operative Audit and Research Network (PLAN), for the DREAMY Investigators Group***

1 Consultant, Centre for Anaesthesia and Peri-operative Medicine, University College London Hospital, London, UK
2 Consultant, Department of Anaesthesia, Northwick Park Hospital, London, UK
3 Professor, Centre for Peri-operative Medicine, Research Department for Targeted Intervention, University College London, London, UK
4 Professor, School of Psychology, University of Plymouth, Plymouth, UK
5 Consultant, Nuffield Department of Anaesthetics, Oxford University Hospitals NHS Trust, Oxford, UK
6 Professor, University of Oxford, Oxford, UK

1 in 256 (95%CI 149-500)

1 in 212 (95%CI 122-417)

75% induction/emergence
83% evening or night

ID	Adjudication outcome	Michigan Awareness Classification instrument	Phase of anaesthesia	Surgery	Induction drug; dose (mg.kg^{-1}) Opioid for induction NMB drug for tracheal intubation	Maintenance drug Nitrous oxide for maintenance MAC; median [range] Additional NMB drug	NPSA	Summary of experience by the patient	κ
1	Certain/ probable	5D	Induction and maintenance	CS category 2	Thiopental (3.9) No opioid Suxamethonium	Sevoflurane No nitrous oxide MAC 0.9 [0.7–1.0] No further NMB drug	3	Detailed recollection of the process of tracheal intubation and felt a painful initial surgical incision	1.00
2	Certain/ probable	4D	Emergence	CS category 1	Thiopental (6.7) No opioid Suxamethonium	Sevoflurane + nitrous oxide MAC 0.9 [0.8–1.2] No further NMB drug	3	Residual paralysis during emergence. Confirmed suxamethonium apnoea	1.00
3	Certain/ probable	5D	Maintenance	CS category 2	Thiopental (4.7) Alfentanil Suxamethonium	Sevoflurane + nitrous oxide MAC 1.4 [1.3–1.6] No further NMB drug	2	Felt surgical pain and hearing voices asking for surgical instruments	1.00
4	Certain/ probable	4D	Emergence	CS category 2	Thiopental (10.6) Fentanyl	Sevoflurane + nitrous oxide	2	Residual paralysis during	1.00

ID	Adjudication outcome	Michigan Awareness Classification instrument	Phase of anaesthesia	Surgery	Induction drug; dose (mg.kg^{-1}) Opioid for induction NMB drug for tracheal intubation	Maintenance drug Nitrous oxide for maintenance MAC; median [range] Additional NMB drug	NPSA	Summary of experience by the patient	κ
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2	Certain/ probable	4D	Emergence	CS category 1	Thiopental (6.7) No opioid Suxamethonium	Sevoflurane + nitrous oxide MAC 0.9 [0.8–1.2] No further NMB drug	3	Residual paralysis during emergence. Confirmed suxamethonium apnoea	1.00
3	Certain/ probable	5D	Maintenance	CS category 2	Thiopental (4.7) Alfentanil Suxamethonium	Sevoflurane + nitrous oxide MAC 1.4 [1.3–1.6] No further NMB drug	2	Felt surgical pain and hearing voices asking for surgical instruments	1.00
4	Certain/ probable	4D	Emergence	CS category 2	Thiopental (10.6) Fentanyl	Sevoflurane + nitrous oxide	2	Residual paralysis during	1.00

								No further NMB drug		Confirmed suxamethonium apnoea
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4	Certain/ probable	4D		Emergence	CS category 2	Thiopental (10.6) Fentanyl Rocuronium	Sevoflurane + nitrous oxide MAC 1.1 [1–1.2] No further NMB drug	2	Residual paralysis during emergence, secondary to incomplete reversal of rocuronium	1.00
5	Certain/ probable	2		Induction	CS category 1	Thiopental (8.0) No opioid Suxamethonium	Sevoflurane + nitrous oxide MAC 1.1 [1–1.2] Atracurium	0	Painless sensation of the initial surgical incision	1.00
6	Certain/ probable	4		Induction	CS category 2	Propofol (1.7) No opioid Suxamethonium	Sevoflurane No nitrous oxide MAC 1.1 [1.2–1.5] No further NMB drug	2	Felt unable to move and heard multiple voices; likely occurred during management of difficult airway	1.00
7	Certain/ probable	4D		Induction	CS category 2	Thiopental (8.6) No opioid	Isoflurane + nitrous oxide	1	Immediately after induction she	0.33

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┌─────────────────────────────┐
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└─────────────────────────────┘
              │
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│  5. Apnea oder gentle mask ventilation   │          alftentanil) slow bolus,
│  (Pmax <20 cmH$_2$O)                     │          followed by infusion
│                                          │          (TCI oder 10-36 ml/h)
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└──────────────────────────────────────────┘
              │
              ▼
┌─────────────────────────────┐
│        Intubation           │
│    Check tube (CO2 !)       │
└─────────────────────────────┘
              │
              ▼
```

Lysthenon® 5% - 2 ml
i.v.
Zus. / Comp.:
50 mg Suxamethonii
Ampullen

ESMERON®
Rocuronii bromidum
50 mg = 5 ml
EXP.:
2018-07

Comparison

- Intubation conditions

👍 👍

- Onset of action

- Duration of action

ORIGINAL ARTICLE

Effect of suxamethonium vs rocuronium on onset of oxygen desaturation during apnoea following rapid sequence induction

S. K. Taha,[1] M. F. El-Khatib,[2] A. S. Baraka,[3] Y. A. Haidar,[4] F. W. Abdallah,[5] R. A. Zbeidy[4] and S. M. Siddik-Sayyid[1]
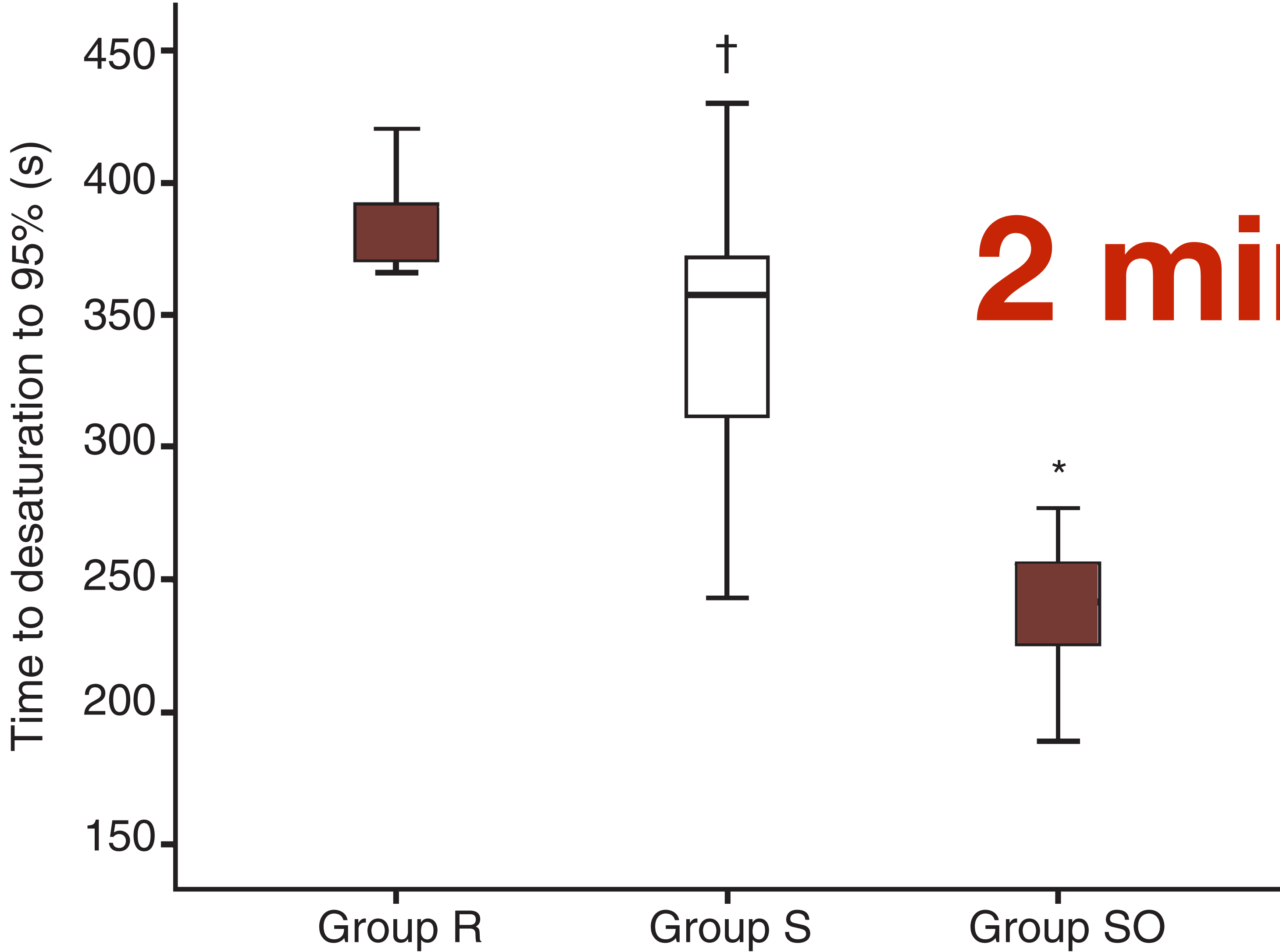
Comparison

- Intubation conditions   👍   👍

- Onset of action   👍   👍

- Duration of action

Duration of action

Predictors of the variability in neuromuscular block duration following succinylcholine

A prospective, observational study

Salome Dell-Kuster, Soledad Levano, Christoph S. Burkhart, Frédéric Lelais, André Zemp, Elektra Schobinger, Karl Hampl, Christoph Kindler and Thierry Girard

Comparison

- Intubation conditions 👍 👍

- Onset of action 👍 👍

- Duration of action 🍀 💰

```mermaid
flowchart TD
```

Preoxygenation
at least 4 deep breaths,
preferable: $ETO_2 > 0.8$

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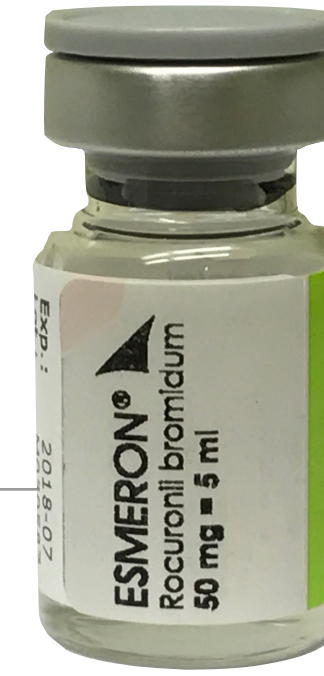   (dose to ideal weight, opt. +20%)

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(TCI oder 10-36 ml/h)

Intubation
Check tube (CO2 !)

Guidelines

Obstetric Anaesthetists' Association and Difficult Airway Society guidelines for the management of difficult and failed tracheal intubation in obstetrics[*]

M. C. Mushambi,[1] S. M. Kinsella,[2] M. Popat,[3] H. Swales,[4] K. K. Ramaswamy,[5] A. L. Winton[6] and A. C. Quinn[7,8]

Algorithm 1 – safe obstetric general anaesthesia

Pre-theatre preparation

Airway assessment
Fasting status
Antacid prophylaxis
Intrauterine fetal resuscitation if appropriate

Plan with team

WHO safety checklist/general anaesthetic checklist
Identify senior help, alert if appropriate
Plan equipment for difficult/failed intubation
Plan for/discuss: wake up or proceed with surgery (Table 1)

Rapid sequence induction

Check airway equipment, suction, intravenous access
Optimise position – head up/ramping + left uterine displacement
Pre-oxygenate to $F_{ET}O_2 \geq 0.9$/consider nasal oxygenation
Cricoid pressure (10 N increasing to 30 N maximum)
Deliver appropriate induction/neuromuscular blocker doses
Consider facemask ventilation (P_{max} 20 cmH$_2$O)

1st intubation attempt

If poor view of larynx optimise attempt by:
- reducing/removing cricoid pressure
- external laryngeal manipulation
- repositioning head/neck
- using bougie/stylet

Fail

Ventilate with facemask
Communicate with assistant

Success

Verify successful tracheal intubation

Proceed with anaesthesia and surgery

Plan extubation
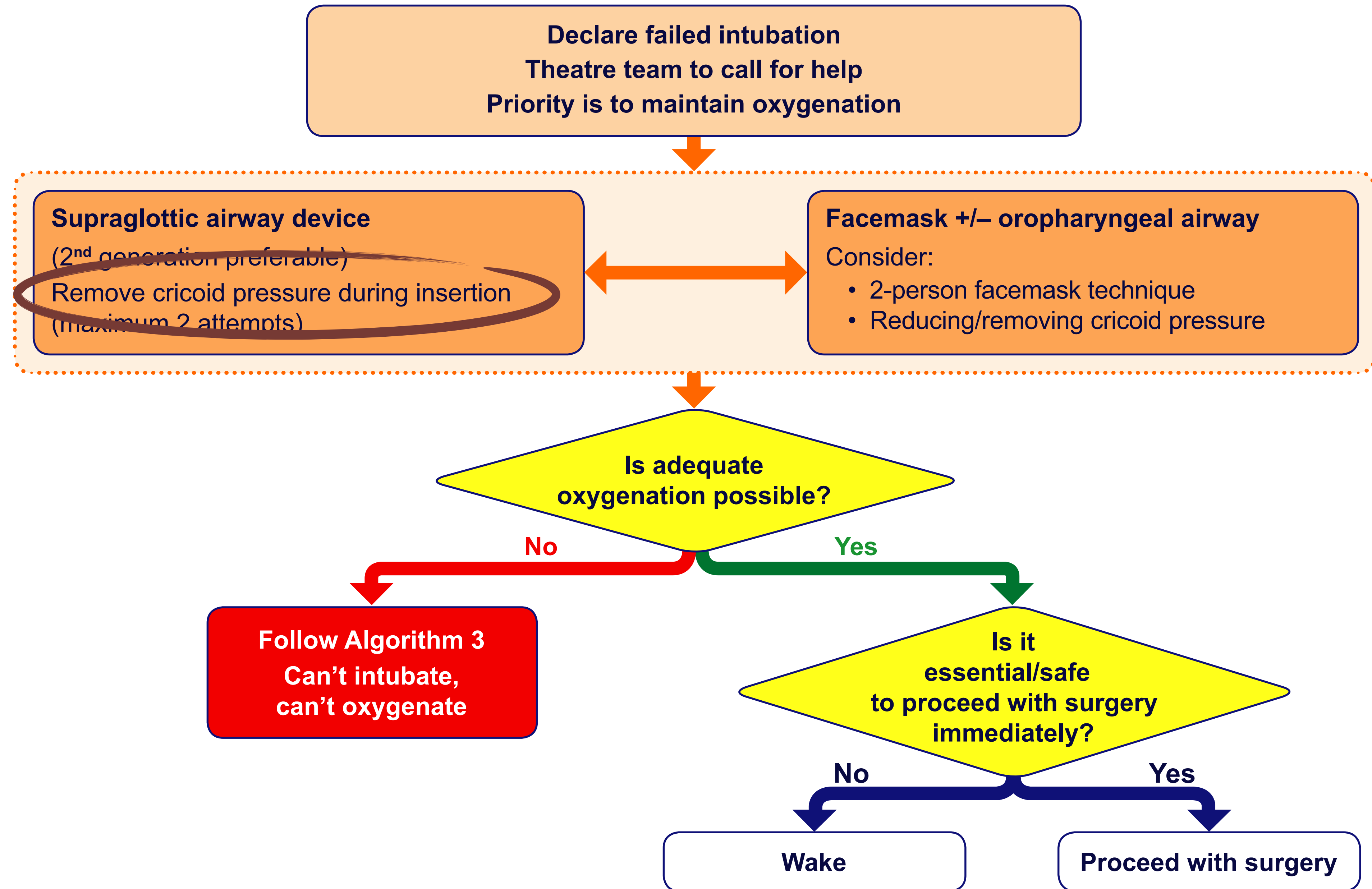
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│ 3. Rocuronium 1 mg/kg            │
│ 4. Cricoid pressure              │
│ 5. Apnea oder gentle mask        │
│    ventilation                   │
│ (Pmax <20 cm$H_2O$)              │
│                                  │
│   NMBA after propofol, do not    │
│   wait for apnea.                │
│   Intubation 50 sec after        │
│   rocuronium                     │
│   (dose to ideal weight, opt.    │
│   +20%)                          │
└──────────────────────────────────┘
             │
             ▼
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│       Intubation         │
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Preeclampsia, cardiovasc. disease:
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Check tube (CO2 !)

SPECIAL ARTICLE

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Failed tracheal intubation during obstetric general anaesthesia: a literature review

S.M. Kinsella,[a] A.L. Winton,[a] M.C. Mushambi,[b] K. Ramaswamy,[c] H. Swales,[d] A.C. Quinn,[e] M. Popat[f]

[a]Department of Anaesthesia, St Michael's Hospital, Bristol, UK
[b]Department of Anaesthetics, Leicester Royal Infirmary, Leicester, UK
[c]Department of Anaesthesia, Northampton General Hospital, Northampton, UK
[d]Department of Anaesthesia, University Hospitals Southampton Foundation Trust, Southampton, UK
[e]Department of Anaesthesia, James Cook University Hospital, Middlesbrough, UK
[f]Department of Anaesthesia, Oxford University Hospitals NHS Trust, Oxford, UK

Failed intubation	1 in 390
Death	1 in 90
Front of neck	1 in 60

Awaken the patient?

Trend χ^2: 27.4 ($P<0.0001$)
Slope: 1.8 %.year^{-1}
95%CI: 1.1 - 2.4
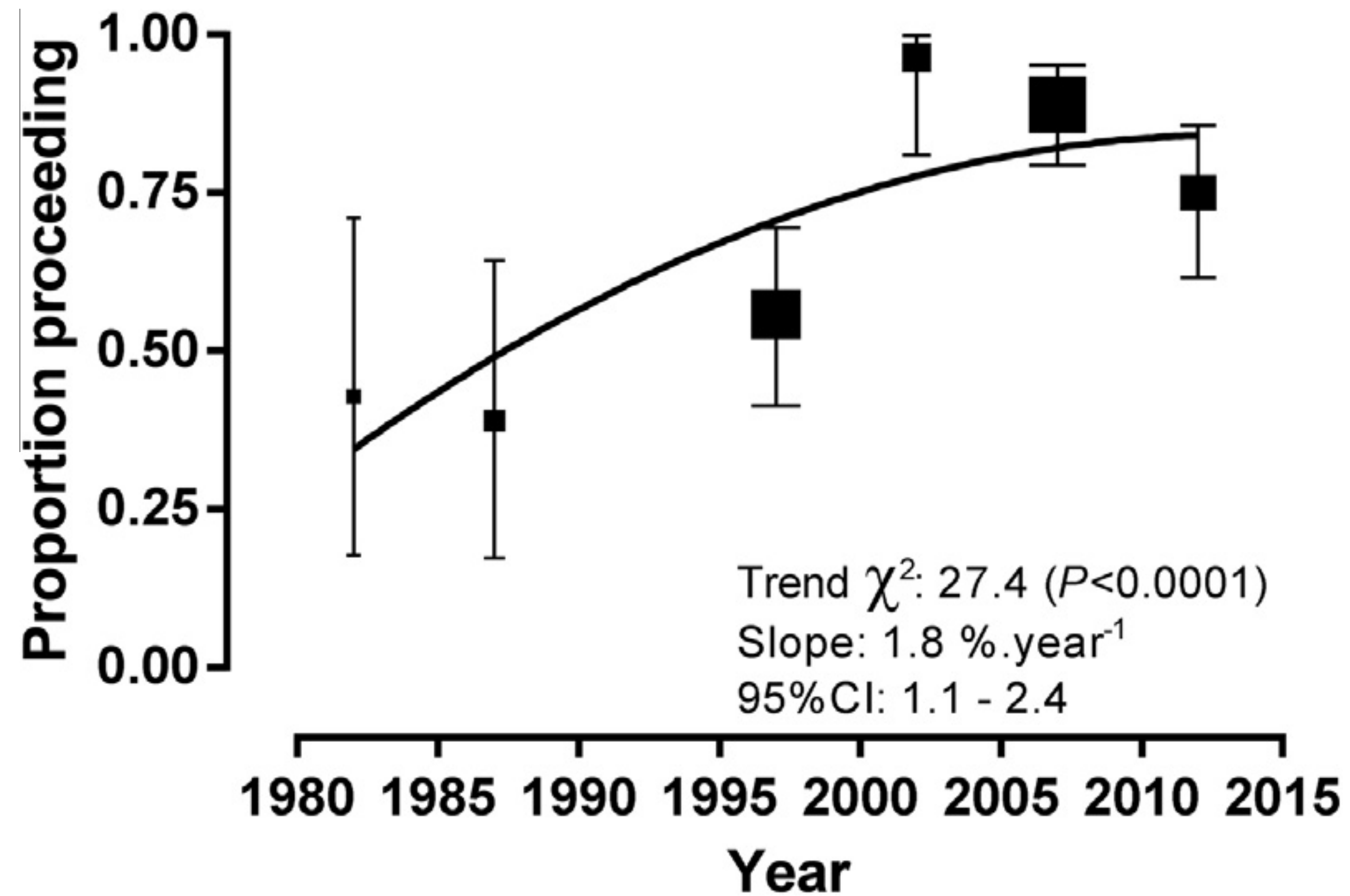
Patient and surgery factors associated with the incidence of failed and difficult intubation

R. Schnittker,[1] **S.D. Marshall**[2] and **J. Berecki-Gisolf**[3]

Difficult & failed intubation: **1 in 200**
(4092 of 861'533 = 0.5%)

Failed intubation: **1 in 10'500**
(82 of 861'533 = 0.009%)

Failed intubation if difficult: **1 in 50**
(82 of 4092 = 2%)

ANESTHESIOLOGY

Frequency and Risk Factors for Difficult Intubation in Women Undergoing General Anesthesia for Cesarean Delivery: A Multicenter Retrospective Cohort Analysis

Sharon C. Reale, M.D., Melissa E. Bauer, D.O., Thomas T. Klumpner, M.D., Michael F. Aziz, M.D., Kara G. Fields, M.S., Rachel Hurwitz, B.S., Manal Saad, B.S., Sachin Kheterpal, M.D., M.B.A., Brian T. Bateman, M.D., M.Sc.; Multicenter Perioperative Outcomes Group Collaborators*

	caesarean	general
Difficult & failed intubation: (295 of 14'537 = 2.0%)	**1 in 50**	1 in 200
Failed intubation: (18 of 14'537 = 0.12%)	**1 in 800**	1 in 10'500
Failed intubation if difficult: (18 of 295 = 6.0%)	**1 in 16**	1 in 50

Risk factors associated with difficult intubation

Table 3. Associations between Obstetric Patient Characteristics and Odds of Difficult Intubation

Characteristics	Site-adjusted Odds Ratio (95% CI)	Site- and Factor-adjusted Odds Ratio (95% CI)	Risk of Difficult Intubation
Overall			1:49
Age			
Less than 35 yr	Reference	Reference	1:55
35–39 yr	1.66 (1.24–2.21)	1.65 (1.23–2.21)	1:36
40 yr or more	2.14 (1.33–3.44)	2.17 (1.34–3.51)	1:32
Body mass index			
Less than 25 kg/m²	Reference	Reference	1:156
25–39.9 kg/m²	1.55 (0.88–2.73)	1.48 (0.84–2.60)	1:57
40 kg/m² or higher	2.71 (1.53–4.8)	2.02 (1.12–3.63)	1:28
Race/ethnicity			
Asian or Pacific Islander	0.89 (0.388–2.06)	0.89 (0.383–2.07)	1:87
Black	1.46 (1.06–2.02)	1.34 (0.96–1.87)	1:41
Hispanic	2.06 (1.07–4.0)	1.91 (0.98–3.75)	1:32
White	Reference	Reference	1:57
Other/unknown	1.17 (0.86–1.59)	1.10 (0.80–1.52)	1:45
ASA status			
I or II	Reference	Reference	1:57
III	1.61 (1.25–2.07)	1.23 (0.93–1.63)	1:40
IV–VI	2.01 (1.17–3.48)	1.65 (0.93–2.92)	1:38
Year of delivery, 2004–2011*	1.21 (0.88–1.67)	1.37 (0.98–1.92)	1:41
Mallampati score			
I or II	Reference	Reference	1:63
III	2.37 (1.72–3.27)	2.05 (1.46–2.86)	1:28
IV	4.6 (2.61–8.2)	3.79 (2.10–6.85)	1:12
Small hyoid-to-mentum distance†	3.03 (1.27–7.3)		1:15
Limited jaw protrusion†	2.67 (1.04–6.9)		1:21
Limited mouth opening†	8.2 (3.72–17.9)		1:9
Altered neck anatomy†	1.85 (0.89–3.86)		1:42
Cervical spine limitation†	4.5 (1.54–13.0)		1:14
Labor to cesarean status	1.11 (0.78–1.59)	1.20 (0.82–1.75)	1:41
Induction of labor	1.13 (0.62–2.06)	1.03 (0.54–1.94)	1:33
Presence of preterm delivery	1.02 (0.67–1.55)	0.98 (0.63–1.51)	1:53
Presence of multiple gestation	1.09 (0.58–2.05)	1.09 (0.57–2.09)	1:49
Presence of preeclampsia or eclampsia	1.67 (1.16–2.40)	1.28 (0.87–1.89)	1:33

All odds ratio and CI values were obtained *via* combination of point estimates and standard errors from 65 imputed data sets using Rubin's rules, except where otherwise specified.

*Reference 2012 to 2019. †Due to missingness of 40% or more, site-adjusted odds ratios and CI values for factors obtained using complete case analysis and factors not included in site- and factor-adjusted model were estimated using multiple imputation.

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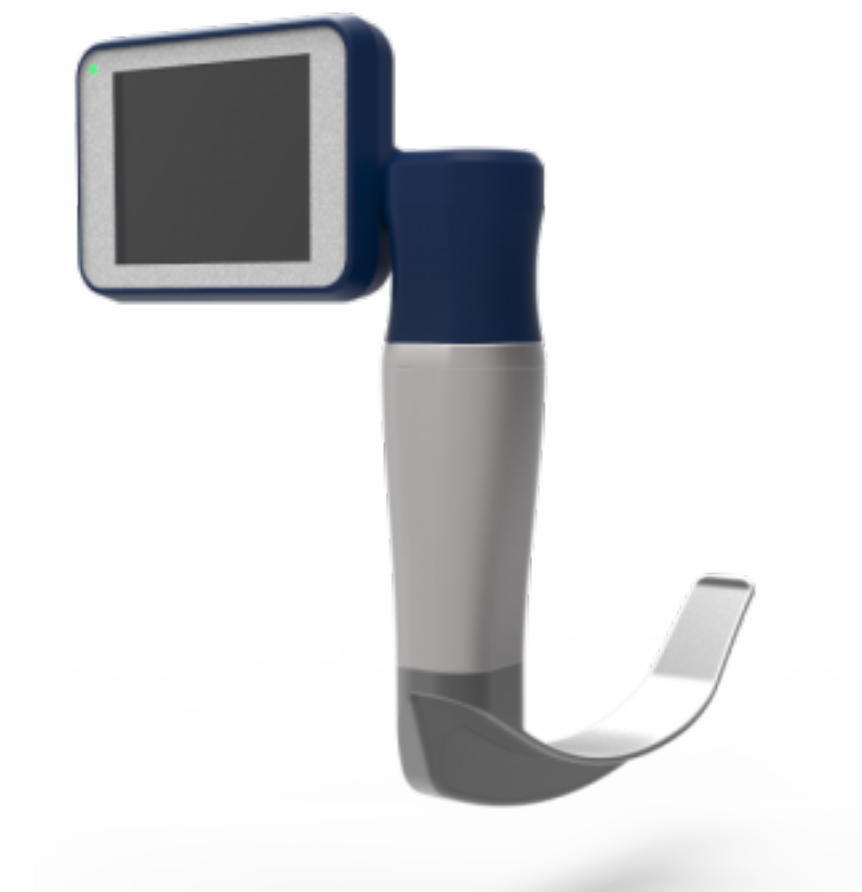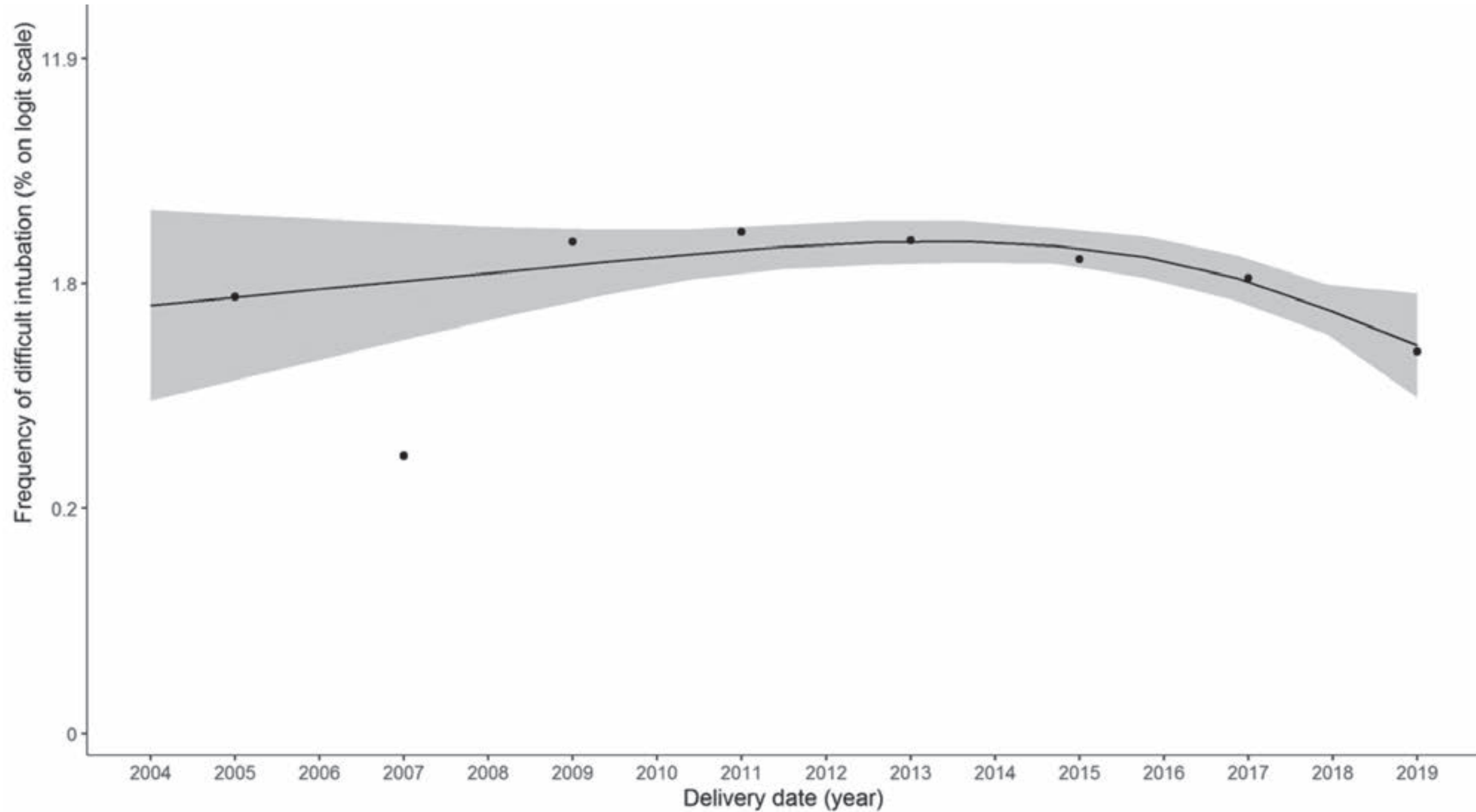ASA, American Society of Anesthesiologists.

Are we improving?

18 / 18 failed intubations

Preoxygenation
at least 4 deep breaths,
preferable: $ETO_2>0.8$

1. Alfentanil 0.5mg iv
2. Propofol 2 (-3) mg/kg
3. Rocuronium 1 mg/kg
4. Cricoid pressure
5. Apnea oder gentle mask ventilation
(Pmax <20 cmH_2O)

NMBA after propofol, do not wait for apnea.
Intubation 50 sec after rocuronium
(dose to ideal weight, opt. +20%)

Preeclampsia, cardiovasc. disease:
Remifentanil 1 µg/kg (instead of
alftentanil) slow bolus,
followed by infusion
(TCI oder 10-36 ml/h)

Intubation
Check tube (CO2 !)

```
        │
        ▼
┌─────────────────────┐          ┌─────────────────────────┐
│   Sevo max 1 MAC    │          │ Propofol as alternative │
│     100 % O2        │          │      to Sevo:           │
└─────────────────────┘          │     TIVA with BIS       │
        │                        └─────────────────────────┘
        ▼
    ◇ cord clamping ◇
        │
        ▼
┌──────────────────────────────────────┐
│  Fentanyl 2-3 µg/kg                   │
│  Midazolam 3-5 mg, if ø BIS or BIS > 55│
│  Reduce Sevo < 1MAC (uterine tone !)  │
└──────────────────────────────────────┘
        │
        ▼
┌──────────────────────────────────────┐
│  TOF: 4 Twitches: Robinul/Neostigmin  │
│   < 4 Twitches: Sugammadex 200 mg     │
│  TOF< 0.9 after 4-5min: repeat 200mg  │
└──────────────────────────────────────┘
        │
        ▼
```

Postoperative Analgesia:
Working epidural: Morphine 2mg epidural
No epidural
- Paracetamol 1g iv
- Ibuprofen 400mg iv
- Morphine 0.1mg/kg iv (ideal weight)

```
                                              ┌──────────────────────────────┐
          ┌──────────────────────┐            │                              │
          │  Sevo max 1 MAC      │            │  Propofol as alternative to  │
          │  100 % O2            │            │  Sevo:                       │
          │                      │            │  TIVA with BIS               │
          └──────────────────────┘            └──────────────────────────────┘
                    │
                    ▼
              ◇ cord clamping ◇
                    │
                    ▼
          ┌──────────────────────┐
          │                      │
          │  Fentanyl 2-3 µg/kg  │
          │  Midazolam 3-5 mg,   │
          │  if ø BIS or BIS > 55│
          │  Reduce Sevo < 1MAC  │
          │  (uterine tone !)    │
          └──────────────────────┘
                    │
                    ▼
          ┌──────────────────────┐
          │                      │
          │ TOF: 4 Twitches:     │
          │ Robinul/Neostigmin   │
          │ < 4 Twitches:        │
          │ Sugammadex 200 mg    │
          │ TOF< 0.9 after       │
          │ 4-5min: repeat 200mg │
          └──────────────────────┘
                    │
                    ▼
```

Sevo max 1 MAC
100 % O2

Propofol as alternative to Sevo:
TIVA with BIS

cord clamping

Fentanyl 2-3 µg/kg
Midazolam 3-5 mg, if ø BIS or BIS > 55
Reduce Sevo < 1MAC (uterine tone !)

TOF: 4 Twitches: Robinul/Neostigmin
< 4 Twitches: Sugammadex 200 mg
TOF< 0.9 after 4-5min: repeat 200mg

Postoperative Analgesia:
Working epidural: Morphine 2mg epidural
No epidural
- Paracetamol 1g iv
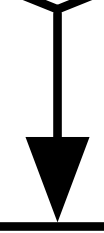- Ibuprofen 400mg iv
- Morphine 0.1mg/kg iv (ideal weight)

cord clamping

Fentanyl 2-3 µg/kg
Midazolam 3-5 mg, if ø BIS or BIS > 55
Reduce Sevo < 1MAC (uterine tone !)

TOF: 4 Twitches: Robinul/Neostigmin
< 4 Twitches: Sugammadex 200 mg
TOF< 0.9 after 4-5min: repeat 200mg

Awake, reflexes
no residual paralysis
Extubation

Postoperative Analgesia:
Working epidural: Morphine 2mg epidural
No epidural
- Paracetamol 1g iv
- Ibuprofen 400mg iv
- Morphine 0.1mg/kg iv (ideal weight)

Optional wound infiltration with bupivacaine
0.25% 20-30ml
TAP block, if consent available

M. Brunner, Th. Girard, March 2023

OBSTETRIC ANAESTHESIA IN SWITZERLAND: WHERE WE COME FROM, WHERE WE ARE, WHERE WE GO

«General Anaesthesia for C-section: How do I do it in 2023?»

Thierry Girard, Basel.

Reference	PMID	doi
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