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정기 학술대회

| 일자 | 2021년 4월 3일(토)

| 장소 | 대전 유성호텔 3층 킹홀

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[Study design] 무작위 배정, 전향적 연구로 dexmedetomidine과 standard therapy(midazolam과 opioid)를 비교, 3상, 단일 기관 대학병원에서 수행한 연구. 경식도 심장초음파 진단을 받은 18-65세의 남성과 여성(American society of anesthesiologist I-IV) 대상으로, 임산부 또는 24시간 이내 benzodiazepines나 opioid를 투여 받았거나, 불안정하여 어떠한 진정제도 투여 받을 수 없는 경우 제외되었습니다.

[Results] 연구 전체 참여 인원(22명 등록, 1명 취소). Primary endpoint는 진정의 adequacy이며, demographics와 presedation Ramsay 점수는 두 군 간에 통계적으로 다르지 않았습니다. Hemodynamic parameter 중 Standard therapy군에서 dexmedetomidine군 대비, 심박수가 유의하게 더 높았으며 수축기/이완기 혈압이 더 높았습니다. 산소포화도 또는 호흡률은 두 군 간에 통계적 또는 임상적 차이가 없었습니다.

Reference 1. Cooper L, et al. A randomized, controlled trial on dexmedetomidine for providing adequate sedation and hemodynamic control for awake, diagnostic transesophageal echocardiography. J Cardiothorac Vasc Anesth. 2011 Apr;25(2):233-237.

프리세덱스주/프리세덱스프리믹스주

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이 약을 투여 받은 318명 대상 의식하 진정에 대한 2개의 임상시험에서, 호흡저하 (호흡이 8번 미만 또는 기저치로부터 25% 초과 감소)는 의식하 진정에서 2% 이상 발생한 이상반응 중 하나였으며, 호흡률 감소 및 저산소증은 이 약과 대조군 사이에 유사하였습니다. 가장 빈번한 이상반응은 저혈압, 서맥 및 구강건조로 나타났습니다.

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[효능·효과] 1. 집중치료 관리하의 진정: 집중치료 관리하에 초기 삽관되어 인공호흡을 실시하는 환자의 진정 2. 수술 및 시술 시 비삽관 환자의 의식하 진정 : 1)감시하 마취 관리 (Monitored Anesthesia Care, MAC) 2) 의식하 광섬유 삽관(Awake Fiberoptic Intubation. AFI) [용법·용량] 1. 집중치료 관리하의 진정 • 개시 : 10-20분간 1mcg/kg • 유지 : 0.2-0.7mcg/kg/hr. 정맥주입 속도는 원하는 진정 수준을 달성하기 위하여 조절 2. 수술 및 시술 시 비삽관 환자의 의식하 진정 • 개시 : 10분간 1mcg/kg 안과 수술과 같은 침습성이 적은 수술에서는 10분 동안 0.5mcg/kg • 유지 : 0.6mcg/kg/hr. 원하는 임상효과를 얻기위해 0.2~1mcg/kg/hr으로 적정 가능 의식하 광섬유 삽관 환자는 기관 내 튜브가 안전하게 될 때까지 0.7mcg/kg/hr [경고] 이 약은 의사에 의해 투여되어야 하며 환자가 이 약을 투여 받는 동안 지속적으로 감시하여야 한다. 간장애 환자에서는 이 약의 청소율이 감소되기 때문에 간기능이 손상된 환자에게는 용량을 감량하여야 한다. [금기] 이 약의 성분에 대하여 과민증 또는 과거 과민증의 경험이 있는 환자 [신중투여군] 심혈관 질환 환자. 심장기능이 저하된 환자. 순환혈류량이 저하된 환자. 간장애 환자. 신장애 환자 [이상반응] 다양한 조건하에서 임상시험이 실시되었기 때문에 이 약의 임상시험에서 관찰된 이상반응 비율은 다른 약물의 임상시험에서의 비율과 직접적으로 비교할 수 없으며, 실제적으로 관찰되는 비율과 다를 수도 있다. [프리세덱스주 개정년월일] 2019.9.4 [프리세덱스 프리믹스주 개정년월일] 2019.9.3 ※자세한 내용은 제품설명서를 참조하시기 바랍니다.

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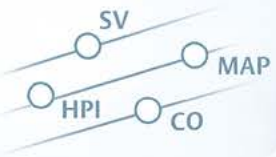

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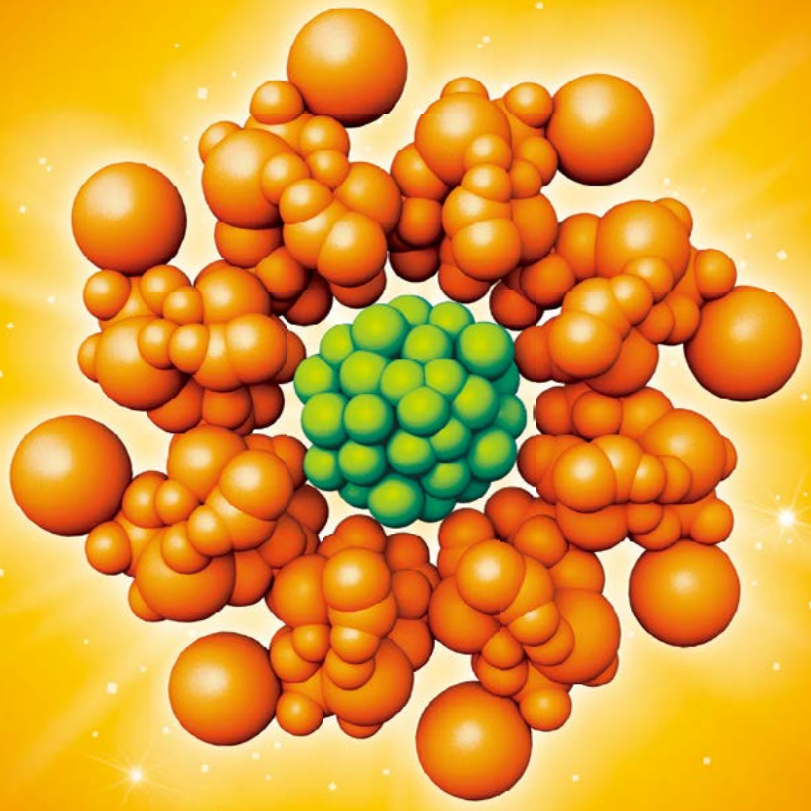

Bridion (sugammadex) offered significantly fast and predictable recovery in most patients with moderate to profound rocuronium-induced neuromuscular blockade (NMB).[1,2]

Reappearance of T_2 for reversal of a NMB : 98% of Bridion (sugammadex) patients had recovered to a TOF ratio of 0.9 compared with only 11% of neostigmine patients within 5 minutes. In comparison, it took 101 min for 98% of patients receiving neostigmine to recover to a TOF ratio of 0.9.[1]

Reappearance of 1-2 PTCs. : The median (range [interquartile range]) time to recovery of the TOF ratio to 0.9 was 2.7 (1.2-16.1 [2.1-4.1]) min in the Bridion (sugammadex) group versus 49.0 (13.3-145.7 [35.7-65.6]) min in the neostigmine group.[2]

Indication of Bridion is reversal of neuromuscular blockade induced by rocuronium or vecuronium.[3]
The safety and efficacy of Bridion for pediatric and adolescents under the age of 18 has not been established.[3]

*** For more information, please refer to the full prescribing information.**

Bridion®(Sugammadex) 100 mg Selected Safety Information

[Indications and Usage] Reversal of neuromuscular blockade induced by rocuronium or vecuronium. **[Dosage and Administration] Adults:** Routine reversal: A dose of 4 mg/kg Bridion is recommended as IV injection if recovery has reached at least 1-2 post-tetanic counts(PTC) following rocuronium or vecuronium induced blockade. A dose of 2 mg/kg Bridion is recommended as IV injection, if spontaneous recovery has occurred up to at least the reappearance of T_2 following rocuronium or vecuronium induced blockade. **Immediate Reversal of Rocuronium-Induced Blockade:** A dose of 16 mg/kg Bridion is recommended if there is a clinical need to reversal neuromuscular blockade soon(approximately 3 minutes) after administration of rocuronium as IV injection. The safety and efficacy with the use of Bridion for immediate reversal following vecuronium induced blockade has not been established. **Renal Impairment:** No dosage adjustment is necessary for patients with mild or moderate renal impairment(creatinine clearance ≥30 mL/min and <80 mL/min). Bridion is not recommended for use in patients with severe renal impairment(creatinine clearance <30 mL/min) or dialysis. **Elderly Patients:** Elderly patients tend to delay recovery from neuromuscular blockade, but dose adjustment is not necessary. **Obese Patients:** The dose of this drug in obese patients should be based on actual weight(ABW). **Hepatic Impairment:** No dosage adjustment is necessary for patients with mild and moderate hepatic impairment. Since no clinical studies have been conducted with patients with hepatic impairment, caution should be taken in patients with severe hepatic impairment or hepatic impairment with coagulation disorders. **[Warnings and Precautions] Contraindications:** Patients with known hypersensitivity to Bridion or any of its components. **Careful Administration:** 1) Patients with renal impairment 2) Patients with hepatic impairment 3) Patients with decrease of cardiac output 4) Patients with edema state 5) Patients with a history of allergic reaction 6) Patients with a history of pulmonary complications(Possible occurrence of bronchospasm) 7) Patients with coagulation disorders 8) Patients with arrhythmia 9) The elderly 10) Pregnant or women who may be pregnant. **Adverse Reactions:** 1) The safety of Bridion has been evaluated based on an integrated safety database of approximately 1,700 surgical patients and 120 healthy adult volunteers. The most commonly reported adverse reactions in patients who experienced surgery were anaesthetic complications. **Immune System:** 1) Hypersensitivity(≥1/1,000, <1/100), the others: Anaesthetic complications(body movement in the middle of anesthesia or operation, coughing, grimacing and suckling of the tracheal tube(≥1/100, <1/10), involuntary awakening during anesthesia(≥1/1,000, <1/100). 2) In clinical trials with surgical patients, hypersensitivity including anaphylaxis has been reported infrequently. The frequency of occurrence of hypersensitivity reactions in post-marketing surveys is unknown. Hypersensitivity reactions that occurred varied from isolated skin reactions to serious systemic reactions(i.e., anaphylaxis, anaphylactic shock) and have occurred in patients with no prior exposure to Bridion. Symptoms associated with these reactions can include: flushing, urticaria, erythematous rash, severe hypotension, tachycardia, swelling of tongue, swelling of pharynx, bronchospasm and pulmonary obstructive events. Severe hypersensitivity reactions can be fatal. 3) Post-marketing clinical trials of obese patients(BMI ≥40 kg/m^2) showed that the adverse reaction profile was generally similar between patients who were administered actual body weight(ABW) and patients who were administered ideal body weight(IBW). **General Cautions:** 1) Ventilatory support is mandatory for patients until adequate spontaneous respiration is restored following reversal of neuromuscular blockade. 2) In order to prevent recurrence of neuromuscular blockade, the recommended doses for routine should be used. 3) When drugs which potentiate neuromuscular blockade are used in the post-operative phase, special attention should be paid to the possibility of recurrence of neuromuscular blockade. 4) Recurrence of neuromuscular blockade may occur due to displacement of rocuronium or vecuronium from BRIDION by other drugs(i.e., Toremifene, fusidic acid). 5) When neuromuscular blockade was reversed intentionally in the middle of anaesthesia in clinical trials, signs of light anaesthesia were noted occasionally(movement, coughing, grimacing and suckling of the tracheal tube). 6) In patients for whom intubation is expected to be difficult, the method of airway maintenance should be considered beforehand. If rocuronium-induced neuromuscular blockade cannot or does not allow airway intubation, it should be promptly restored from neuromuscular blockade. 7) Coagulation parameters should be carefully monitored in patients with known coagulopathies when sug a mmadex is administered. 8) In patients with severe renal failure(creatinine clearance <30 mL/min), the excretion of Bridion or the Bridion-rocuronium complex was delayed; however, in these patients there were no signs of re-occurrence of neuromuscular blockade. This drug is not recommended for use in patients with severe renal impairment. 9) Dedicated studies in patients with hepatic impairment have not been conducted. Patients with severe hepatic impairment or hepatic impairment with coagulation disorders should be cautious when administering this drug. 10) Bridion has not been studied for reversal following rocuronium or vecuronium administration in the ICU. 11) Do not use Bridion to reverse neuromuscular blockade induced by nonsteroidal neuromuscular blocking agents such as succinylcholine or benzylisoquinolinium compounds, steroidal neuromuscular blocking agents, pancuronium other than rocuronium or vecuronium. 12) Conditions associated with prolonged circulation time such as cardiovascular disease, old age or edema state(i.e., severe hepatic impairment) may be associated with longer recovery times. 13) The patients should be carefully observed for the possibility of drug hypersensitivity reactions(including anaphylactic reactions). If any abnormality is observed, appropriate measures should be taken immediately. 14) Each 1 mL solution contains 9.7 mg sodium. If more than 2.4 mL(contain approximately 23 mg sodium) solution needs to be administered, this should be taken into consideration by patients on a controlled sodium diet. 15) In rare instances, cases of marked bradycardia, some of which have resulted in cardiac arrest, have been observed within minutes after the administration of Bridion for reversal of neuromuscular blockade. **Drug Interactions :** 1) Toremifene: For toremifene, which has a relatively high binding affinity for Bridion and for which relatively high plasma concentrations might be present, some displacement of vecuronium or rocuronium from the complex with this drug could occur. 2) Fusidic acid: IV administration of fusidic acid in the pre-operative phase may give some delay in the recovery of the T_4/T_1 ratio to 0.9. No recurrence of neuromuscular blockade is expected in the post-operative phase, since the infusion rate of fusidic acid is over a period of several hours and the blood levels are cumulative over 2-3 days. 3) Hormonal contraceptives: The interaction between 4 mg/kg Bridion and a progestogen was predicted to lead to a decrease in progestogen exposure(34% of AUC). **Pregnancy & Lactation Administration:** There are no clinical trial data for exposure to this drug during pregnancy. It is administered only if the benefits of administration exceed the risk. No data are available regarding the presence of Bridion in human milk, the effects of Bridion on the breast fed infant, or the effects of Bridion on milk production. Breastfeeding is not recommended during the administration of this drug. **Pediatric Administration:** The safety and efficacy of this drug in children aged younger than 18 years of have not been established. **Elderly Administration:** Exercise caution when administering BRIDION to elderly patients who tend to delay recovery from neuromuscular blockade.(Revised: 2021.01.26)

※Before administering BRIDION, please read the full prescribing information.

Study design[1] : This randomised, multicentre, parallel-group trial included 98 adult patients. Patients received intravenous propofol for induction followed by sevoflurane maintenance anaesthesia. Neuromuscular blockade was monitored using acceleromyography and a train-of-four(TOF) mode of stimulation. Patients were randomly allocated to receive sugammadex 2.0 mg/kg or neostigmine 50 μg/kg(with glycopyrrolate 10 μg/kg) at reappearance of the second response of the TOF(mean 16% twitch height of first response) after the last dose of rocuronium. The primary endpoint was the time from sugammadex or neostigmine administration to recovery of the TOF ratio to 0.9.

Study design[2] : This phase Ⅲ, randomized study enrolled surgical patients, aged 18 year or older with American Society of Anesthesiologists physical status Ⅰ-Ⅳ. 74 patients were randomized to receive sugammadex(4.0 mg/kg) or neostigmine(70 μg/kg) plus glycopyrrolate(14 μg/kg). Anesthetized patients received an intubating dose of rocuronium(0.6 mg/kg), with maintenance doses(0.15 mg/kg) as required. Neuromuscular monitoring was performed by acceleromyography. Sugammadex or neostigmine was administered at reappearance of 1-2 posttetanic counts(profound neuromuscular blockade). The primary efficacy parameter was the time from sugammadex or neostigmine-glycopyrrolate administration to return of the train-of-four ratio to 0.9.

References : 1. Blobner M, *et al*. Reversal of rocuronium-induced neuromuscular blockade with sugammadex compared with neostigmine during sevoflurane anaesthesia: results of a randomised, controlled trial. *Eur J Anaesthesiol*. 2010;27(10):874-881. **2.** Jones RK, *et al*. Reversal of profound rocuronium-induced blockade with sugammadex: a randomized comparison with neostigmine. *Anesthesiology*. 2008;109(5):816-824. **3.** Bridion Product Label. Ministry of Food and Drug Safety.

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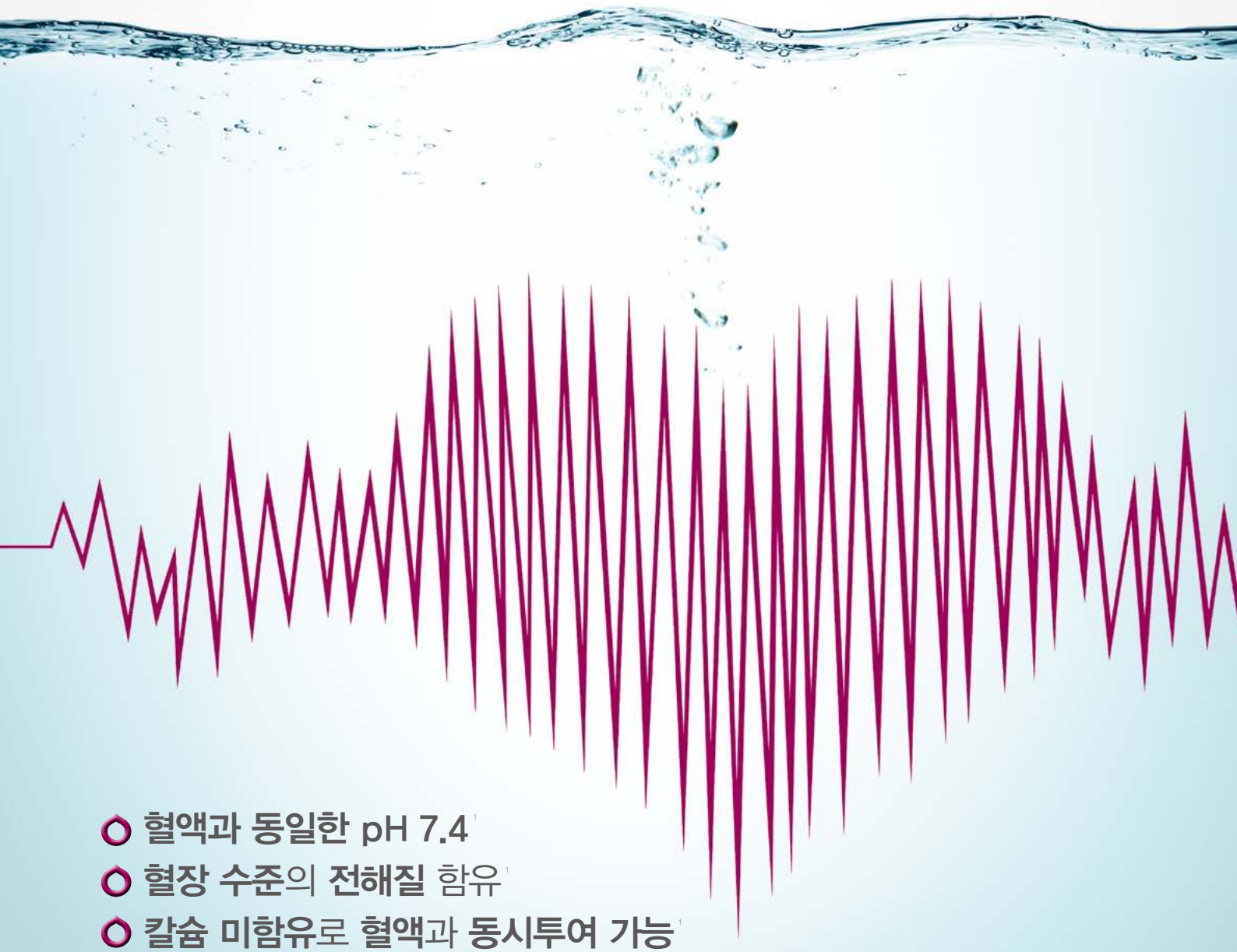

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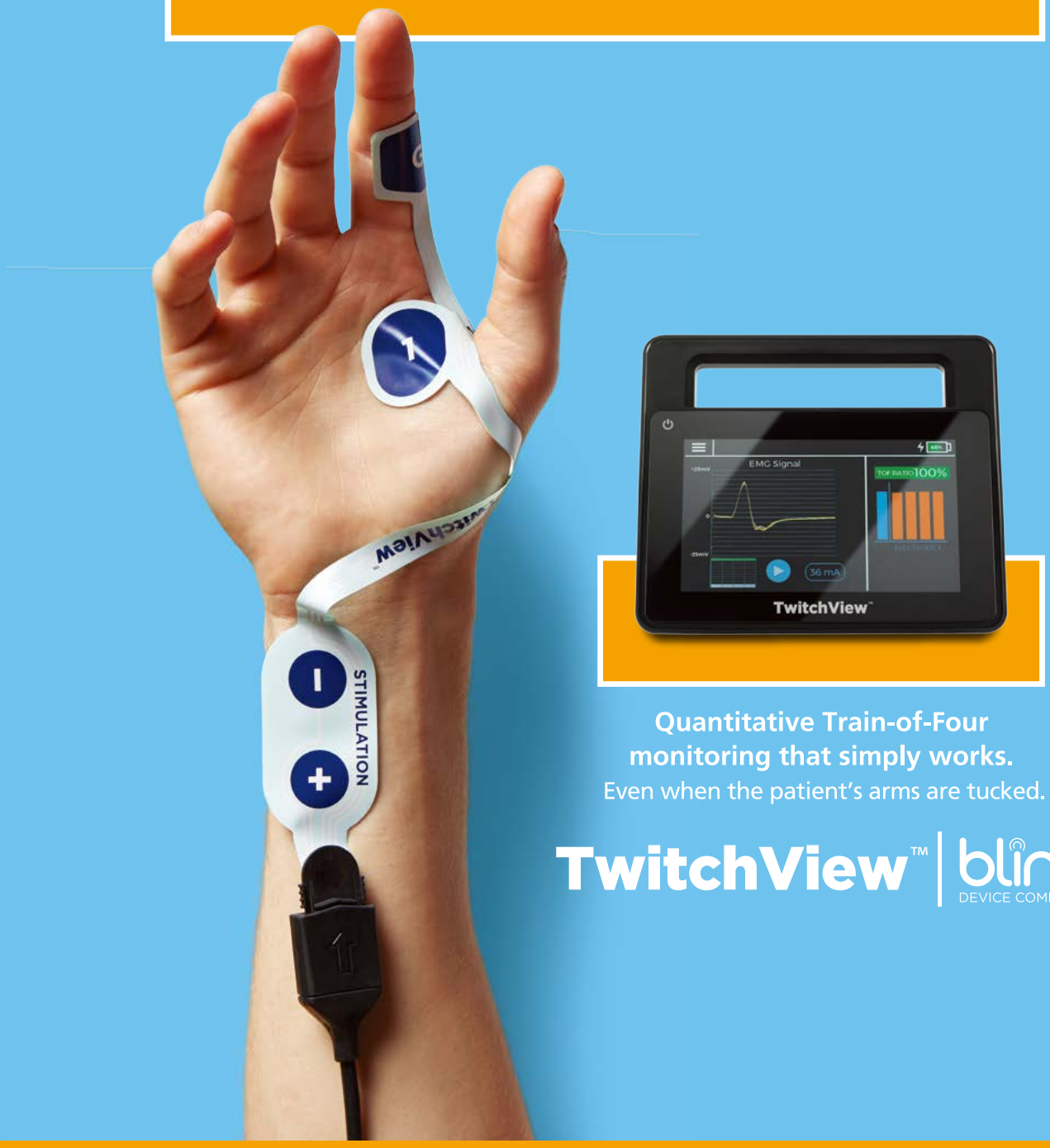

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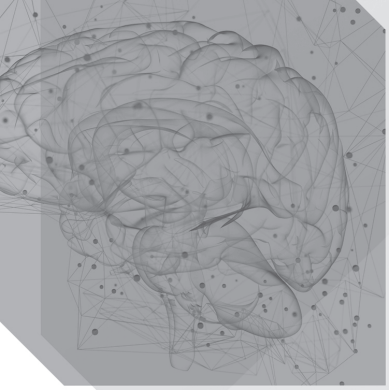
먼저 학회 회원들과 뇌신경마취에 관심있는 여러분의 성원과 적극적인 협조에 힘입어 코로나 상황하에서도 지난 제 27차 학술대회를 성공적으로 마친 것에 깊이 감사드리며, 제 28차 춘계학술대회를 2021년 4월 3일 마련하였습니다.
이번 학회는 저명한 국내외 연자를 모시고 여러분의 진료와 연구에 도움이 될 만한 주제를 논하고자 합니다. Antoun Koht 교수님을 초청하여 수술 중 신경계 감시에 관한 심도 있는 논의를 가집니다. 최근 부각되고 있는 중환자의 목표 체온 관리와 신경계에 미치는 마취제의 영향에 대한 최신 지견에 관해 논하는 기회를 준비하였습니다. 또한 뇌신경마취에서의 수혈, 수액 요법과 수술 후 통증 관리에 대한 논제도 마련하여 최신 동향을 살펴보고자 합니다. 발전적인 피드백을 위한 자유연제 발표도 가질 예정입니다.
이외에도 학술상, 특별연구비 등 풍성하고 다양한 지원을 통해 학회의 활성화를 도모하고자 합니다. 귀한 시간을 내어 학회에 참여하시는 많은 분들에게 알찬 시간이 될 것입니다

회원님 여러분과 뇌신경마취에 관심을 가진 많은 임상의들의 많은 참여를 부탁드립니다.

감사합니다.

대한뇌신경마취학회장 **박 성 식** 올림



대한뇌신경마취학회 특별회원 명단

1. HK inno.N(에이치케이 이노엔)

- 서울특별시 중구 을지로 100 (을지로2가, 파인에비뉴 A동) (우편번호) 04551
- **주요품목 :** 수액제(2세대 혈장전해질 수액, 플라스마솔루션 A)

2. (주)Covidien

- 서울특별시 서초구 양재동 215번지 하이브랜드 리빙관 5층 (우편번호) 06771
- **주요품목 :** BIS sensor, Endo-tube 그리고 SpO2 sensor

3. (주)GE

- 부산광역시 북구 덕천동 386-10 세방빌딩 801호, (우편번호) 46567
- **주요품목 :** GE마취기, 초음파장비

4. (주)KCP

- 서울특별시 마포구 연남동 566-55번지 (우편번호) 03990
- **주요품목 :** BIS Brain Monitoring System, GEM Premier 3000 Blood Gas Analyzer

5. 경보제약

- 서울특별시 서대문구 충정로8 종근당빌딩 4층 (우편번호) 03742
- **주요품목 :** 원료 - Cephalosporin계 항생제 원료 합성, Atorvastatin, Clopidogrel 등.
  완제품 - 써전흡입액(Sevoflurane), 네프콤주사액(Nefopam), 옴니덱스(Dexmedetomidine), 세파클러(Cefaclor) 등

6. (주)럭키메디칼

- 서울특별시 동대문구 용두동 235-10 영화빌딩 1층, (우편번호) 02583
- **주요품목 :** Blood/Fluid Warmer, Hyper/Hypothermia, Biosensor A-Line Kit, Breathing Circuit System, Face Mask, Baxter Infusor 외 마취과 관련 소모품

7. 마시모 코리아

- 서울특별시 서초구 서초대로 398 플래티넘타워 2층 (우편번호) 06619
- **주요품목 :** Radical 7 - Noninvasive & Continuous Total Hemoglobin 측정 장비.

8. 에드워드코리아(주)

- 충청남도 천안시 업성동 625-7, (우편번호) 31075
- **주요품목 :** 각종 카테타, Preset, Flowtrack

9. 에이스메디칼

- 서울특별시 성북구 보문동 7가 25-1, 에이스빌딩 B/D 3층 (우편번호) 02873
- **주요품목 :** CA-AutoMed 3000 Series

10. (주)일성신약

- 서울특별시 용산구 원효로 1가 44-7 일성신약, (우편번호) 04315
- **주요품목 :** Suprane, 로큐메론

대한뇌신경마취학회 특별회원 명단

11. (주)프레지니우스 카비
- 서울특별시 강남구 영동대로 316 새마을운동중앙회빌딩 3층 (우편번호) 06177
- **주요품목 :** Volulyte, Voluven, Fresofol MCT

12. (주)한국MSD
- 서울특별시 마포구 공덕동 168 서울신용보증재단빌딩 10층 (우편번호) 04130
- **주요품목 :** 에스메론/노큐론/브리디온(sugammadex)

13. 한국화자이제약
- 서울특별시 중구 퇴계로 110 화이자타워 (우편번호) 04631
- **주요품목 :** 프리세덱스주, 프리세덱스 프리믹스주

14. 하나제약
- 서울특별시 강남구 테헤란로 218 나래빌딩 16층 (우편번호) 06221
- **주요품목 :** 하나구연산펜타닐주(fentanyl), 레미바주(remifentanyl)

15. (주)인성메디칼
- 강원도 원주시 지정면 기업도시로 168 (우편번호 26354)
- 주요품목: TCM4, 토프스캔

16. 보령제약
- 서울특별시 종로구 창경궁로 136 보령빌딩 (우편번호 03127)
- **주요품목 :** 나제론, 팔제론, 스토가

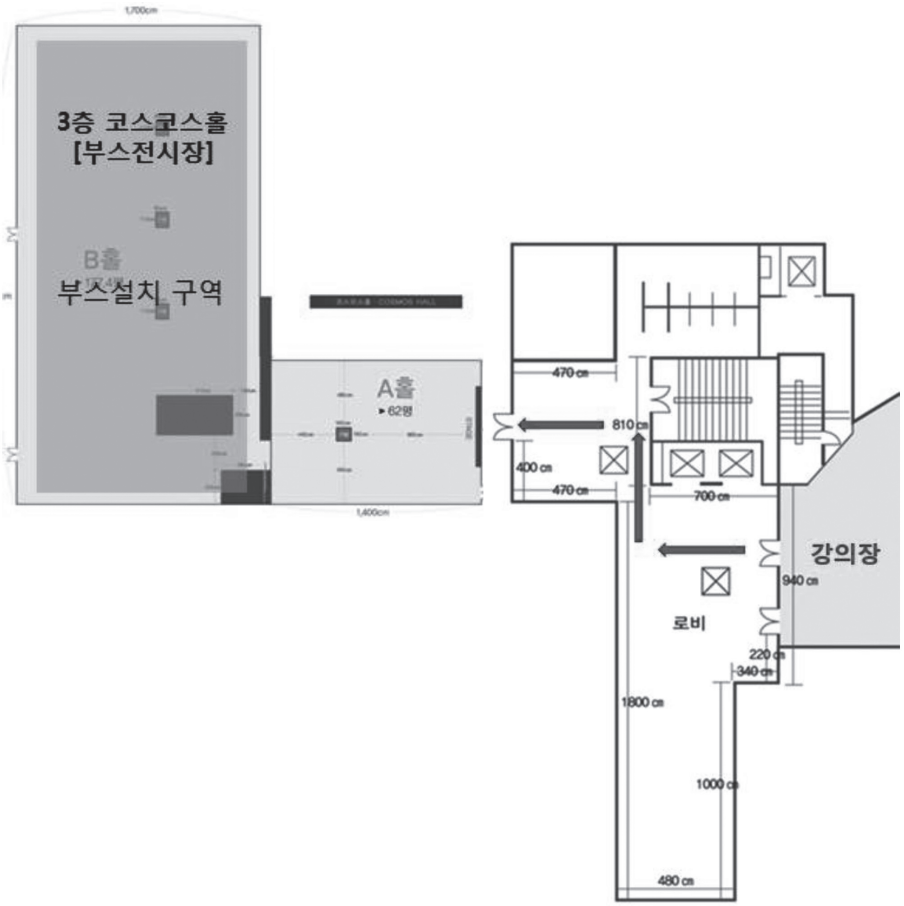
17. 제일약품(주)
- 서울특별시 서초구 사평대로 343 제일약품 사옥 (우편번호 06543)
- **주요품목 :** 슈프레인, 플라스마라이트148주, 펜타스타치

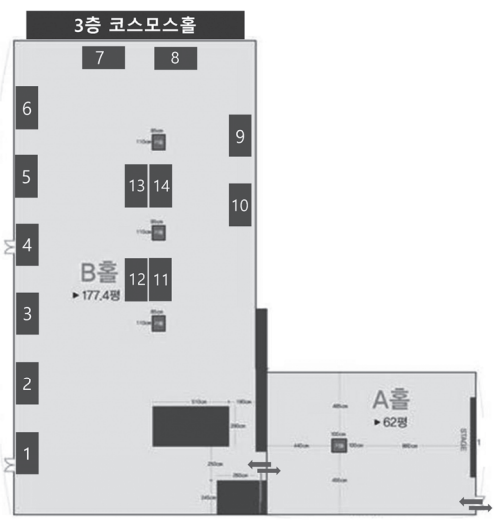
18. 에이치비메디칼(주)
- 서울특별시 성동구 마장로 302 열산빌딩 9층
- **주요품목 :** KoMAC

19. (주)한국다이이찌산쿄
- 서울특별시 중구 을지로5길 26 미래에셋 센터원빌딩 동관15층 (우편번호 04539)
- **주요품목 :** Nasea(나제아), Perdipine(페르디핀)

전시장 도면

3층 코스모스홀





부스 설치 위치

회사명	부스위치	장소
Edwards	1	3층 코스모스홀
경보제약	2	
마시모 코리아	3	
한국다이이찌산쿄	4	
프레지니우스카비	5	
럭키메디칼	6	
에이스메디칼	7	
KCP(유파인메드)	8	
일성신약	9	
보령제약	10	
에이치비메디칼	11	
MSD	12	
Medtronic	13	
하나제약	14	

Q&A

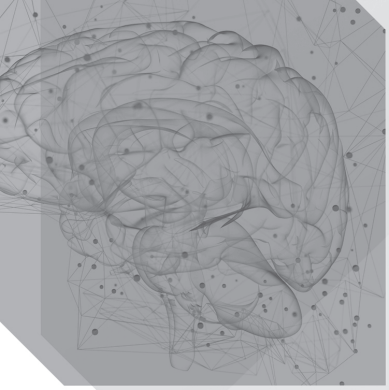
Q&A는 마이크 사용 자제를 위해 온라인 질문지를 이용하여 진행 됩니다.
QR코드를 스캔 하시면 Q&A 질문지가 나옵니다.
궁금하신 사항 질문하여 주시면 성의껏 답변 드리도록 하겠습니다.

설문지

차기 정기학술대회의 프로그램 구성 및 준비와 운영에 대한 참고를 위해
QR코드를 스캔 하시어 설문지 접수 부탁 드립니다.
* 설문지 접수를 해 주신 모든 선생님들께
행사 종료 후 스타벅스 커피 기프티콘을 보내 드립니다.

대한뇌신경마취학회 회보집

QR코드를 스캔 하시면 28회 정기학술대회 회보집을
온라인으로 확인 하실 수 있습니다.

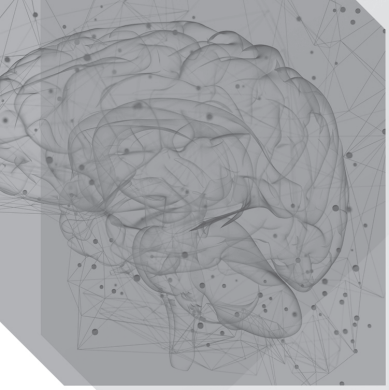


2021년 제28회 대한뇌신경마취학회 정기학술대회

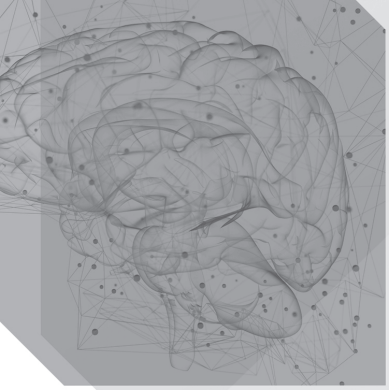
제25권 1호 / 2021. 4

- 일시: 2021년 4월 3일(토)
- 장소: 대전 유성호텔 3층 킹홀
- 진행: Online Web Seminar 동시진행

08:50 – 09:00	Registration	
09:00 – 09:25	General assembly 회장 인사말 학술상 수여 업무보고 재무보고 감사보고 토의사항	
09:25 – 09:30	Opening remark	대한뇌신경마취학회 회장 **박성식**
Session I	**Special invitation lecture**	좌장: **김해규** (부산의대)
09:30 – 10:00	Intraoperative neurophysiological monitoring during neurosurgical anesthesia	**Antoun Koht** (Northwestern University, USA)
10:00 – 10:10	Q & A	
10:10 – 10:20	Coffee Break	
Session II	**Special topics about neuroanesthesia and critical care**	좌장: **임영진** (서울의대)
10:20 – 10:50	Targeted temperature management in critical care patients	**하은진** (서울의대 신경외과)
10:50 – 11:20	Anesthesia-neurotoxicity during neurodevelopment: Should research be continued?	**정우석** (충남의대)
11:20 – 11:50	Anemia and transfusion in intracranial neurosurgery	**이소영** (대구가톨릭의대)
11:50 – 12:10	Q & A	
12:10 – 13:00	Lunch	
Session III	**Fluid and pain management during neuroanesthesia**	좌장: **박성식** (경북의대)
13:00 – 13:30	Fluid management during neurosurgical procedure	**김남오** (연세의대)
13:30 – 14:00	Postoperative pain management for neurosurgical patients	**이형곤** (전남의대)
14:00 – 14:10	Q & A	
14:10 – 14:20	Coffee Break	
Session VI	**Poster presentation**	좌장: **이일옥** (고려의대)
14:20 – 15:20	Poster presentation, Q&A	
15:20	Closing remark	



CONTENTS



CONTENTS

Session I

Special invitation lecture

좌장: **김해규** (부산의대)

Session I

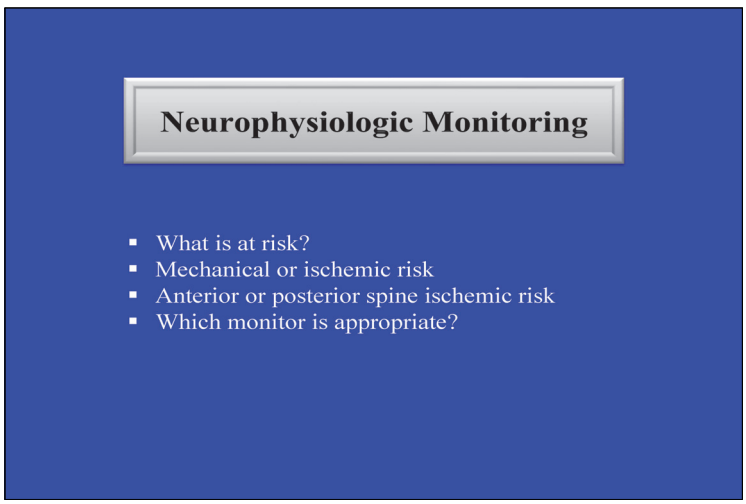
Intraoperative Neurophysiologic Monitoring during Neurosurgical Anesthesia

Antoun Koht, MD., PhD.

Department of Anesthesiology, Neurological surgery & Neurology
Northwestern University, USA

Learning Objectives

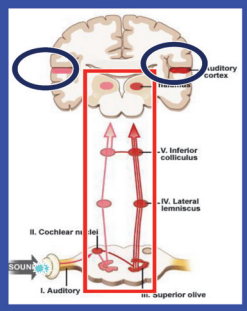
1. Be familiar with the different IOM modalities.
2. Understand the anesthetic effects on IOM
3. Optimizing the diagnosis of IOM changes
4. Participate in the management of IOM changes

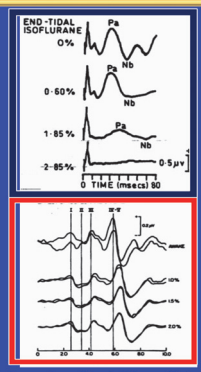


Neurophysiologic Monitoring

- EEG
  Raw & Processed
- ABR
  VEP
- SSEP
  Dermatome Evoked Potentials
  Sensory Cortical Mapping
- MEP
  Motor Cortical Mapping(CMAP)
  EMG
  Cranial Nerves
  Pedicle Screws

Auditory Evoked Potentials

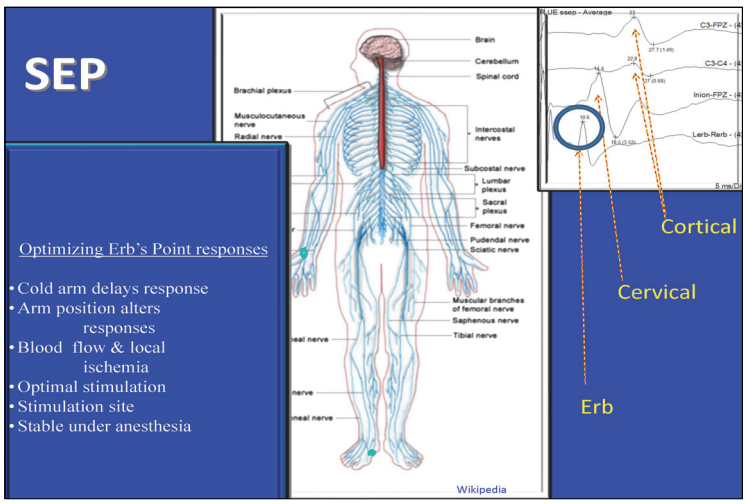


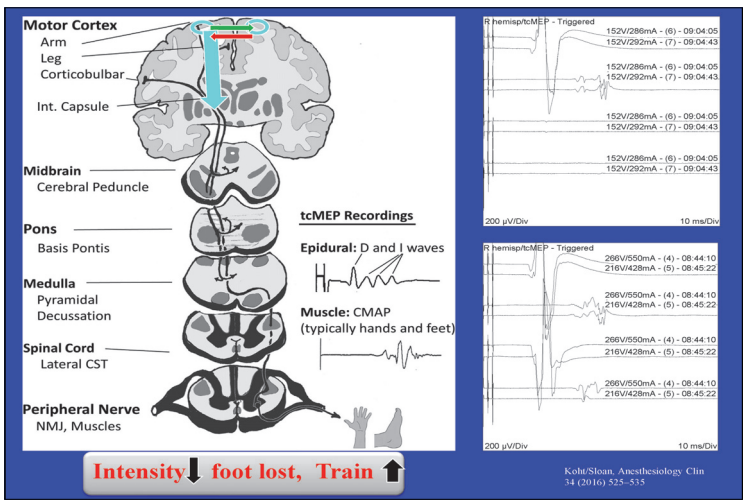


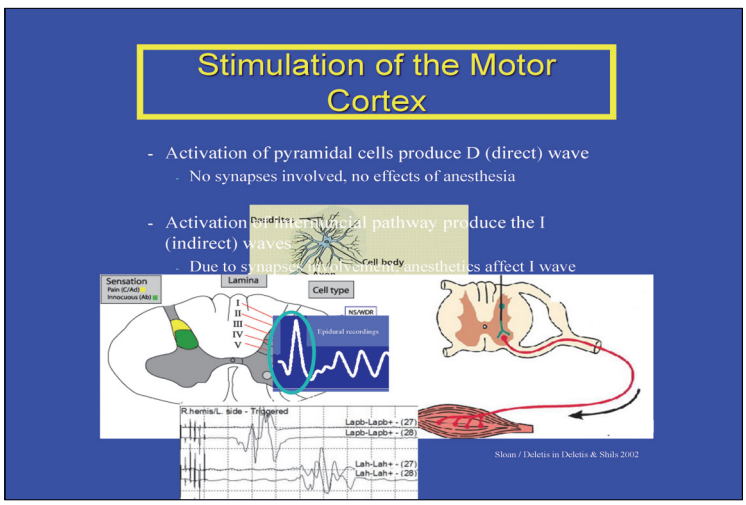
Jérôme Ruel, Jean-Luc Puel, Nuno Trigueiros Cunha Drawings: P. Minary, S. Blatrix

Cranial Nerves EMG / Triggered EMG

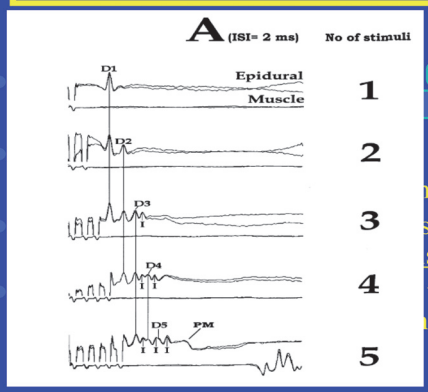
No effects from inhalation agents
No effects of intravenous anesthetics
No effects of sedatives
They are affected by **Muscle Relaxants**

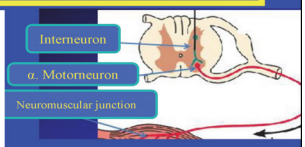

SEP
Optimizing Erb's Point responses
• Cold arm delays response
• Arm position alters responses
• Blood flow & local ischemia
• Optimal stimulation
• Stimulation site
• Stable under anesthesia
Brain
Cerebellum
Spinal cord
Brachial plexus
Musculocutaneous nerve
Radial nerve
Intercostal nerves
Subcostal nerve
Lumbar plexus
Sacral plexus
Femoral nerve
Pudendal nerve
Sciatic nerve
Muscular branches of femoral nerve
Saphenous nerve
Tibial nerve
Wikipedia
Cortical
Cervical
Erb


Motor Cortex
Arm
Leg
Corticobulbar
Int. Capsule
Midbrain
Cerebral Peduncle
Pons
Basis Pontis
Medulla
Pyramidal Decussation
Spinal Cord
Lateral CST
Peripheral Nerve
NMJ, Muscles
tcMEP Recordings
Epidural: D and I waves
Muscle: CMAP (typically hands and feet)
Intensity foot lost, Train
R hemisp/tcMEP - Triggered
152V/286mA - (6) - 09:04:05
152V/292mA - (7) - 09:04:43
200 µV/Div
10 ms/Div
266V/550mA - (4) - 08:44:10
216V/428mA - (5) - 08:45:22
Koht/Sloan, Anesthesiology Clin 34 (2016) 525–535


Stimulation of the Motor Cortex
- Activation of pyramidal cells produce D (direct) wave
- No synapses involved, no effects of anesthesia
- Activation of the pyramidal pathway produce the I (indirect) waves
- Due to synapses involvement, anesthetics affect I wave
Dendrite
Cell body
Sensation
Lamina
Cell type
NS/WDR
Epidural recordings
R.hemis/L. side - Triggered
Sloan / Deletis in Deletis & Shils 2002

The α-Motorneuron Synaptic System

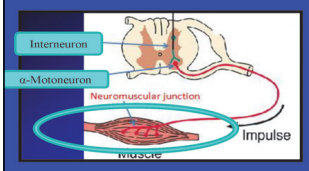


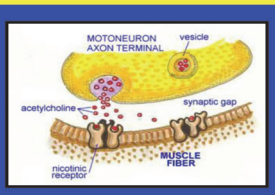


- nd
- s the response,
  se stimulation
- the response
  ultipulse

Deletis et el Clinical Neurophysiology 112 (2001)

The Neuromuscular Junction (NMJ)

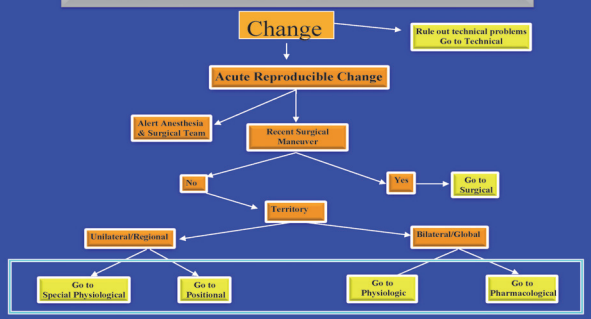




- The third major synaptic location affected by anesthesia
- Also affected by muscle relaxants and drugs that alter acetylcholine transmission
- NMJ is not affected by other anesthetics

J P Sieb, Bonn University

Optimizing Interpretation



Koht/Sloan/Toleikis, Monitoring the nervous system for anesthesiologists, Springer 2017

BIS 40-60

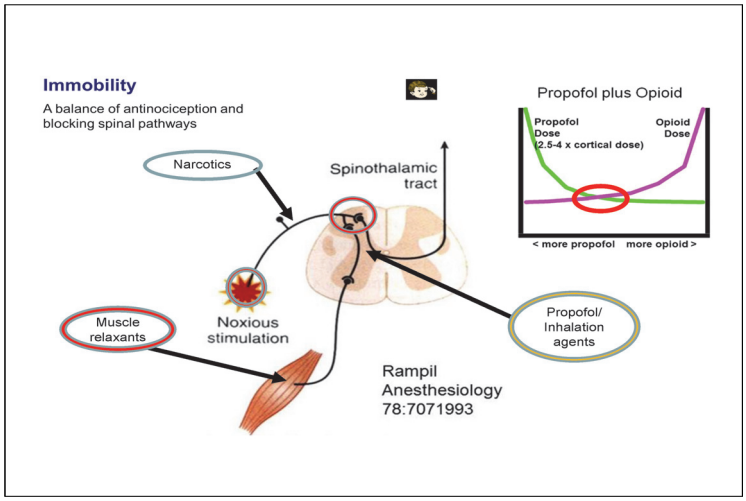
Inhalation agents (Sevoflurane) ≥0.7 MAC

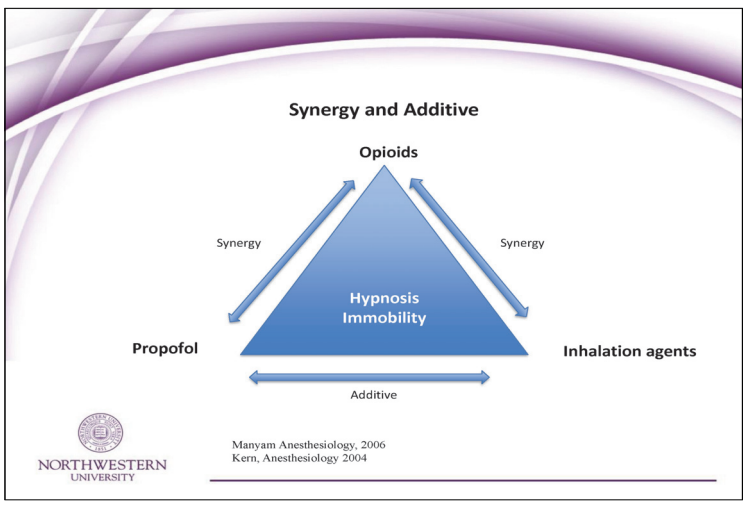
Problems associated with BIS
Not always possible during head surgery
Not reliable all the times
Effects of Ketamine and proximity drilling
Stages of surgery have different stimulation intensities

Problems associated with Inhalation agents
Effects on MEP

Amnesia

Alkire et el, Science November 2008





Receptors & Effects

	GABA	NMDA	Potassium Channels	Glycine	nACH	μ Opioid Rs	Central α2 (α2-AdRs)

Inhalation Agents

	GABA	NMDA	Potassium Channels	Glycine	nACH	μ Opioid Rs	Central α2 (α2-AdRs)
Inhalation agents	**	*	*	**	*		
Reduce Noxious Information		**	*		**	**	*
Unconsciousness	**	*			*		**
amnesia	**	*			*		
Immobility	*			**			

Strong sedation
Strong amnesia
Strong immobilization
Slow cortical EEG
Ratio of immobility to unconsciousness is 3:1

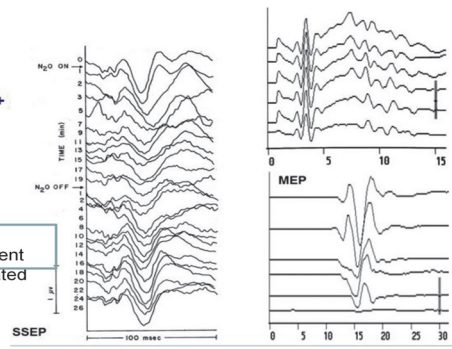
Depress cortical but not cervical SEP
Depress MEP

Nitrous Oxide

Anesthesia:

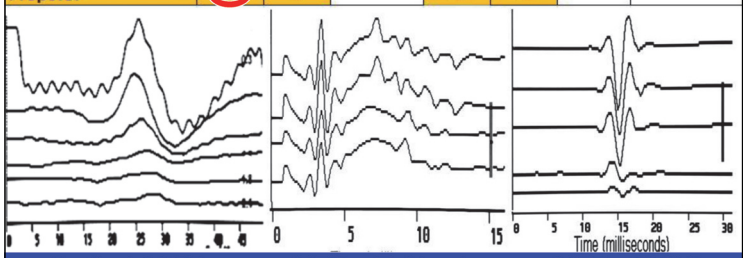
- **Unconscious +**
- **Amnesia +**
- **Immobility +**
- **Block noxious stimuli +++**

- Anesthetic Profile differs from halogenated agents
  - less cortical depression,
  - more antinociception
- Synergistic depression when combined with halogenated agent
- Depression similar to halogenated agents
- *Can be used similar to halogenated agents*



Propofol

	GABA	NMDA	Potassium Channels	Glycine	nACH	μ Opioid Rs	Central α2 (α2-AdRs)
Propofol	**	*		*	*		



Cortical SSEP MEP – Epidural MEP - CMAP

Dexmedetomidine

- Molecular targets are central α2-adrenergic receptors(α 2-AdRs)
- Activation of spinal α 2-AdRs is linked to antinociceptive activities
- Activation of brainstem locus ceruleus (LC) mediate sedation
- No effects on EEG

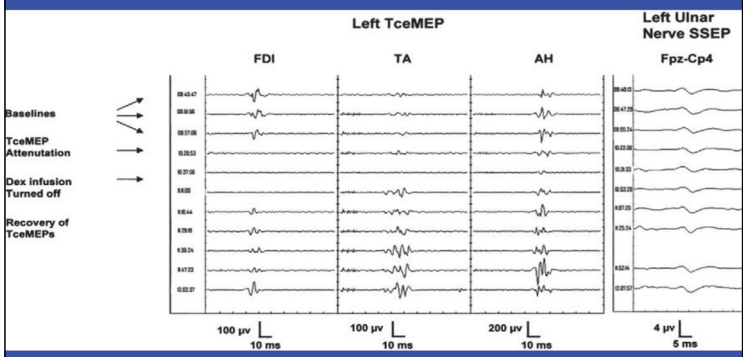
(Sanders and Maze 2007)

Dexmedetomidine

	GABA	NMDA	Potassium Channels	Glycine	nACH	μ Opioid Rs	Central α2 (α2-AdRs)
Dexmedetomidine							**
Reduce Noxious Information		**	*		**	**	*
Unconsciousness	**	*			*		**
amnesia	**	*			*		
Immobility	*			**			

Minor pain relief
Excellent sedation, no amnesia or immobility
Some effects on MEP at high concentration

Dexmedetomidine



13 y, 90kg, propofol 200μg.kg^{-1}.min^{-1}/Remifentanil 0.5μg.kg^{-1}.min-1/ Dex 0.5μg/kg^{-1}.h^{-1}

Mahmoud, Anesthesiology 2007

Opioid

	GABA	NMDA	Potassium Channels	Glycine	nACH	μ Opioid Rs	Central α2 (α2-AdRs)
Opioids						**	
Reduce Noxious Information		**	*		**	**	*
Unconsciousness	**	*			*		**
amnesia	**	*			*		
Immobility	*			**			

Excellent supplement to sedatives
Infusions are better than bolus injections
Minimal effects on neurophysiologic responses
Immobility by blocking the stimulation limb of the reflex

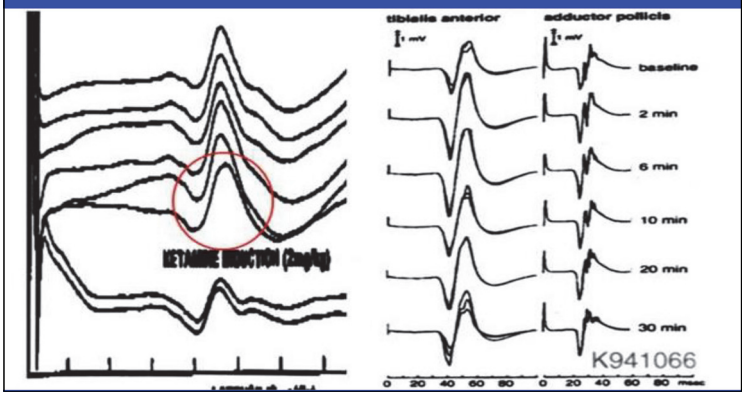
Shortcomings of TIVA

- Awareness (supplement with halogenated agent, benzodiazepine)
- Patient Movement (balance antinociception and spinal cord depression)
- Chronic Pain patients (augment)
- Hyperalgesia from opioids (augment)
- Slow awakening (recovery propofol from slow equilibrating compartments)

TIVA alternatives/supplements

- Inhalational (low dose 0.3-0.5 MAC as tolerated)
- Ketamine - help with chronic pain, reduce opioid hyperalgesia, possible delirium, raises ICP by increased CBF
- Etomidate – substitute for propofol, adrenal suppression and increased mortality in some patients *(awaiting carbo and methyl-carbonyl etomidate)*
- Methohexitol – replace propofol
- Dexmeditomidine – help with chronic pain, more challenging with MEP
- Lidocaine – help with chronic pain and immobility
- Esmolol – help with chronic pain *(very new)*

Ketamine



Lidocaine Infusion

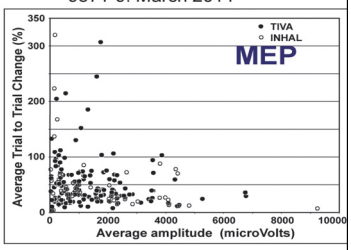
Lidocaine infusion adjunct to total intravenous anesthesia reduces the total dose of propofol during intraoperative neurophysiological monitoring

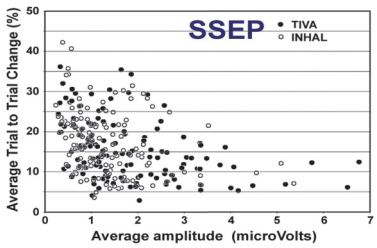
Tod B. Sloan, Paul Mongan, Clark Lyda & Antoun Koht

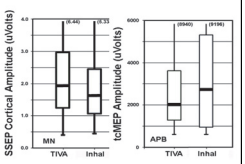
Is Pure TIVA Better?

Amplitude and variability may not be better than with ½ MAC desflurane in patients where recording is possible

Sloan, J Clin Monit Comput DO•I 10.1007/s10877-014-9571-9. March 2014





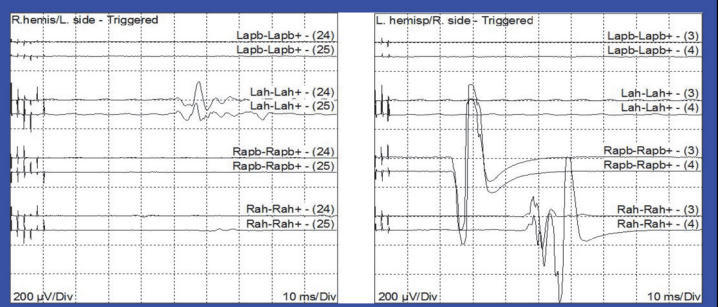


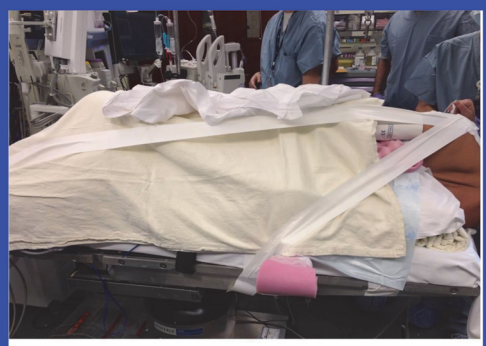
Northwestern University

Agent / Rs / Effects	GABA	NMDA	Potassium Channels	Glycine	nACH	μ Opioid Rs	Central α2 (α2-AdRs)
Propofol	**	*		.	*		
Opioids						**	
Inhalation agents	**	*	*	**	*		
Reduce Noxious Information		**	*		**	**	*
Unconsciousness	**	*			*		**
amnesia	**	*			*		
Immobility				**			

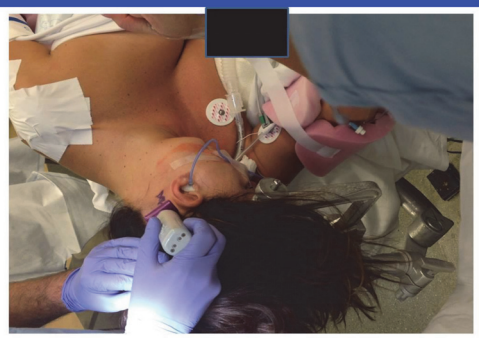
Utilizing **Synergy** and **Additive** effects to optimize condition

What is the Problem? What is the Cause?

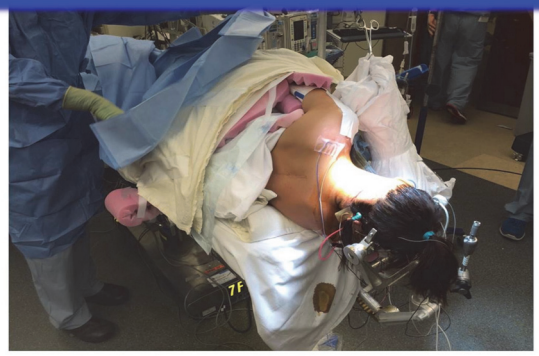




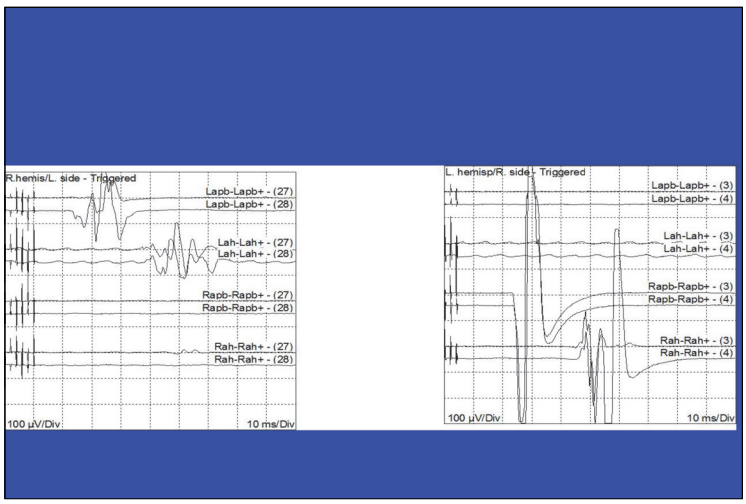
Initial positioning: No signals in left upper extremity

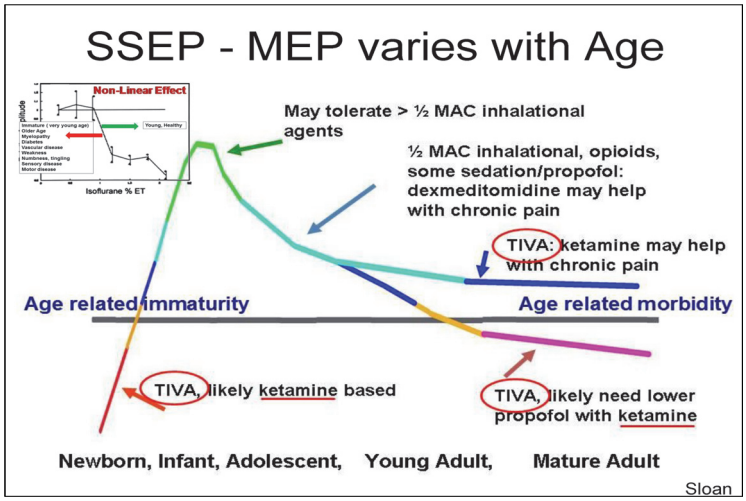


Initial positioning: Note significant tension on left brachial plexus

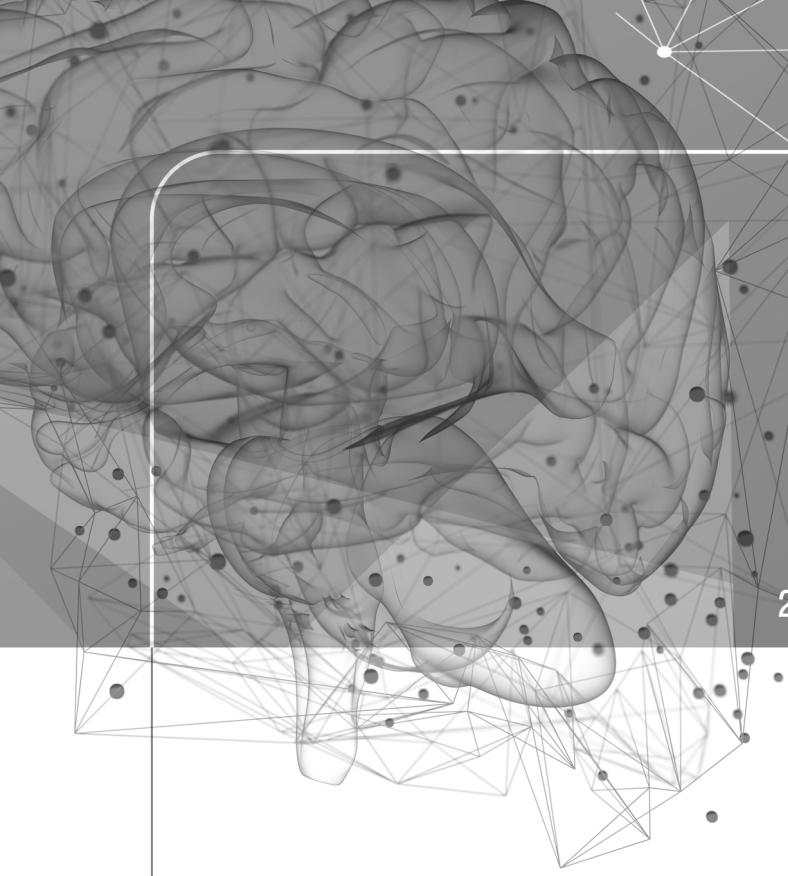


Post repositioning. Signals present in left upper extremity


R.hemis/L. side - Triggered
Lapb-Lapb+ - (27)
Lapb-Lapb+ - (28)
Lah-Lah+ - (27)
Lah-Lah+ - (28)
Rapb-Rapb+ - (27)
Rapb-Rapb+ - (28)
Rah-Rah+ - (27)
Rah-Rah+ - (28)
100 µV/Div
10 ms/Div
L. hemisp/R. side - Triggered
Lapb-Lapb+ - (3)
Lapb-Lapb+ - (4)
Lah-Lah+ - (3)
Lah-Lah+ - (4)
Rapb-Rapb+ - (3)
Rapb-Rapb+ - (4)
Rah-Rah+ - (3)
Rah-Rah+ - (4)
100 µV/Div
10 ms/Div


SSEP - MEP varies with Age
Non-Linear Effect
Isoflurane % ET
May tolerate > ½ MAC inhalational agents
½ MAC inhalational, opioids, some sedation/propofol: dexmeditomidine may help with chronic pain
TIVA: ketamine may help with chronic pain
Age related immaturity
Age related morbidity
TIVA, likely ketamine based
TIVA, likely need lower propofol with ketamine
Newborn, Infant, Adolescent,
Young Adult,
Mature Adult
Sloan


Thank You
Morning in Chicago, Lake Michigan



Session II

Special topics about neuroanesthesia and critical care

좌장: **임영진** (서울의대)

Session II

Targeted temperature management for Neurosurgical patients

하 은 지

서울대학교 의대대학 신경외과

Learning Objectives

1. What is Targeted temperature management ?
2. Effect of TTM
3. Hypothermia
4. Brain edema control and IICP control
5. Fever in NCU
6. Normothermia
7. Shivering management

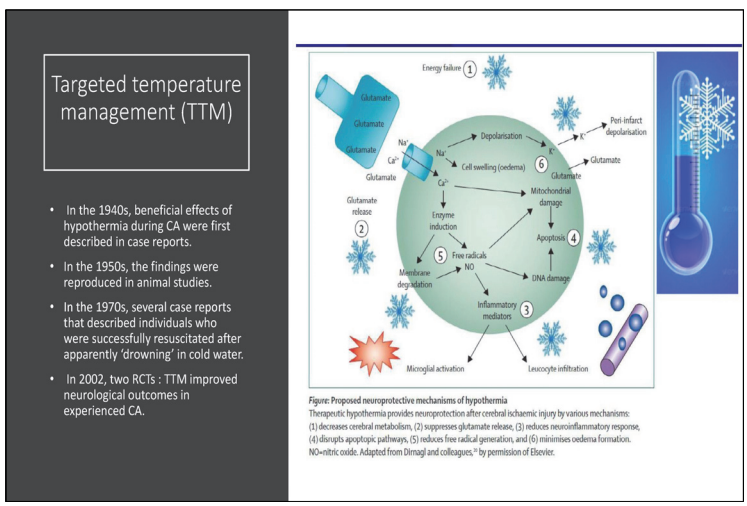
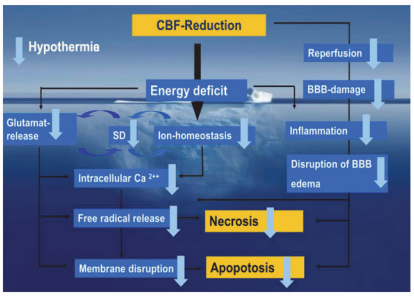


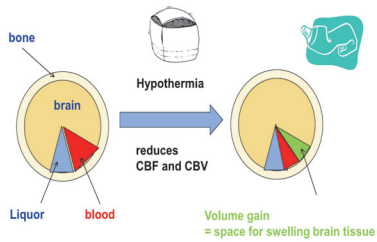
Figure: Proposed neuroprotective mechanisms of hypothermia
Therapeutic hypothermia provides neuroprotection after cerebral ischaemic injury by various mechanisms: (1) decreases cerebral metabolism, (2) suppresses glutamate release, (3) reduces neuroinflammatory response, (4) disrupts apoptopic pathways, (5) reduces free radical generation, and (6) minimises oedema formation. NO=nitric oxide. Adapted from Dirnagl and colleagues,[9] by permission of Elsevier.

Cellular Effect of Temperature Management

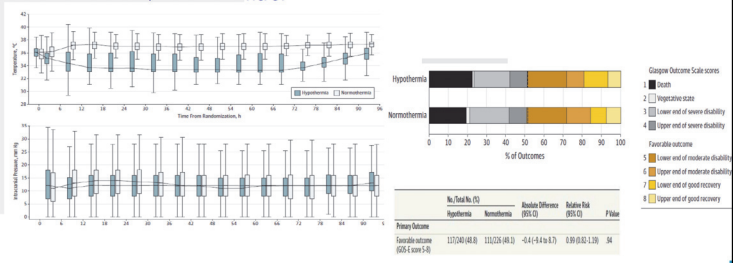


Action mechanisms of therapeutic hypothermia(TH)

- Reduction in cerebral metabolism($CMRO_2$) by 6-7% per 1℃
  - Less O_2 and glucose consumption
- Promotion of cerebral vasoconstriction
  - ↓ICP
  - ↓Edema



POLAR-RCT: ICP unchanged despite sufficient temperature control



The NEW ENGLAND JOURNAL of MEDICINE

Hypothermia for Intracranial Hypertension after Traumatic Brain Injury

JAMA | Original Investigation | CARING FOR THE CRITICALLY ILL PATIENT

Effect of Early Sustained Prophylactic Hypothermia on Neurologic Outcomes Among Patients With Severe Traumatic Brain Injury
The POLAR Randomized Clinical Trial

Effect of TTM _ Summaries

Evidence for the clinical usefulness of hypothermia in the NCCU

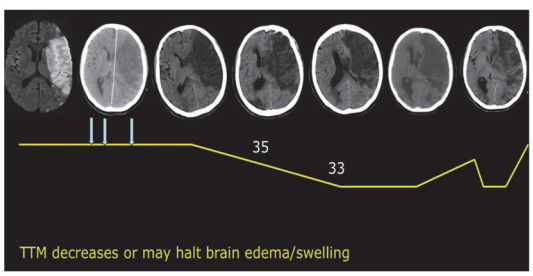
Clinical Scenario	Efficacy of TH	Type of Evidence	General Protocol	Level of Evidence
Cardiac arrest	Effective	2 phase III RCTs	32–34°C for 12–24 h	Level I
TBI	Ineffective	Multiple phase III RCTs, ongoing studies	32–34°C for 24 h	Level I
Cardiac arrest (PEA or asystolic)	Possible	Observational case series	32–34°C for 12–24 h	Level IIb
Increased ICP	Effective	Multiple RCTs and cohort studies	32–35°C titrated to ICP	Level II
Ischemic stroke	Feasible	Small feasibility trials, ongoing phase III trial	35.5°C for non-mechanically ventilated patients 32–35°C for mechanically ventilated patients	Level III
Intracerebral hemorrhage	Unknown	Observational case series	33–35°C	Level III
Subarachnoid hemorrhage	Unknown	Observational case series	33–35°C	Level III
Spinal cord injury	Feasible	Nonrandomized Prospective Study	33°C for 48 h	Level III

The majority is neurosurgical patients

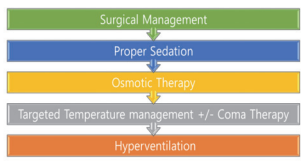
TABLE 1. Primary Diagnoses of Intensive Care Unit Patients

Diagnosis	No. of Patients (%)
All vascular	209 (48.8)
Embolic stroke	57 (13.3)
Subarachnoid hemorrhage	55 (12.9)
Other hemorrhagic stroke	89 (20.8)
Carotid artery stenosis	8 (1.9)
All traumatic brain injury	137 (32.0)
Closed head injury	129 (30.1)
Gunshot wound	8 (1.9)
All spine	30 (7.0)
Trauma	26 (6.0)
Degenerative	4 (0.9)
Seizure/epilepsy	15 (3.5)
Tumor	13 (3.0)
Infectious	12 (2.8)
Neurological	11 (2.6)
Total	428 (100.0)

Illustrative case



IICP management Strategy



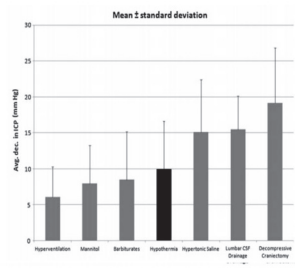
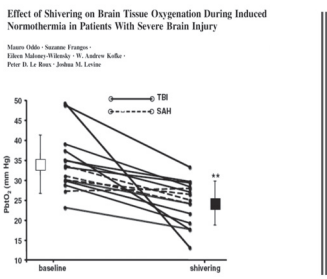
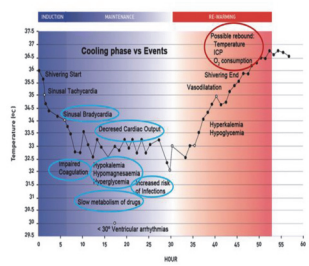


Table 2 Clinical studies of therapeutic mild-moderate hypothermia: effect on ICP, before and after treatment

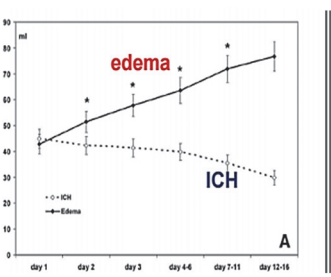
Study	*N*	During cooling (mean ICP, mmHg)	Before cooling (mean ICP, mmHg)	*P* value	Target temperature (°C)
Jiang et al. [39]	215	18–20[a]	28–29[a]	<0.05	33–35
Polderman et al. [65][b]	64	14	37	<0.01	32–34
Gal et al. [24]	30	12	18	0.0007	34.5
Lavinio et al. [44]	24	18.3	23.1	<0.05	34
Metz et al. [57]	10	14.5	24	<0.01	32.5–33
Sahuquillo and Vilalta [77][c]	23	16.8	23.8	<0.001	32.5

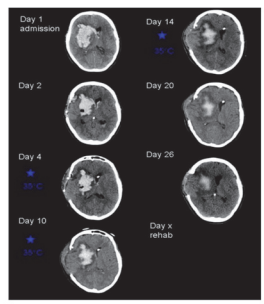
High Quality Therapeutic Hypothermia is key





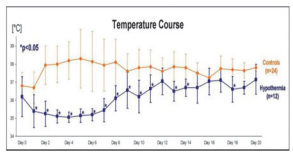
Personalized and disease specific duration





Personalized and disease specific duration

- Early Diffuse cerebral edema and IICP period : Hypothermia
- Vasospasm period : normothermia



Illustrative case

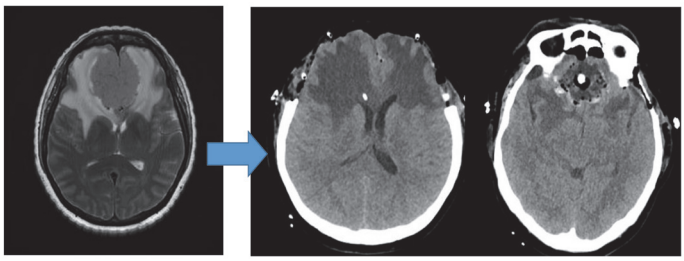
- F/42

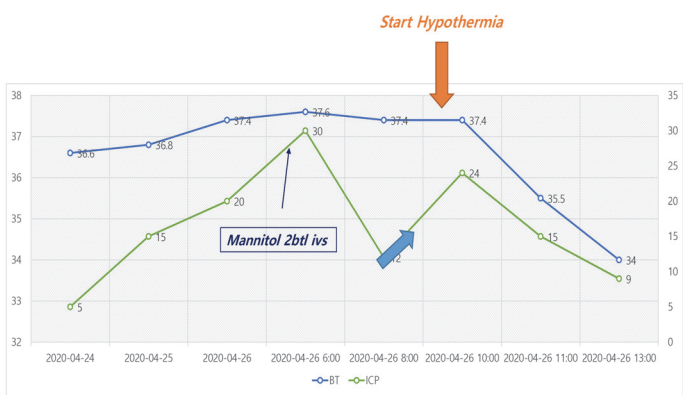
olfactory groove meningioma

B) papilledema, visual loss d/t IICP

s/p craniotomy and tumor removal 2020-04-24

s/p pentothal coma therapy 2020-04-24~2020-05-02





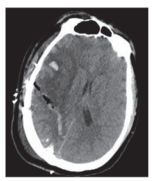
Illustrative case

M/15

#. Sturge-Weber Syndrome

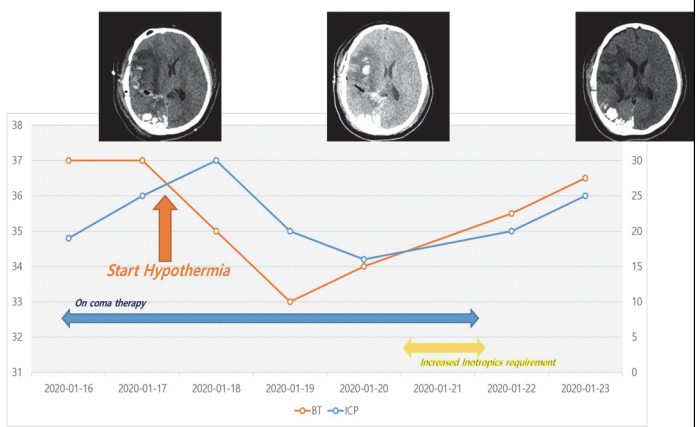
- s/p Rt. Posterior Quadrantectomy ('20.01.15)

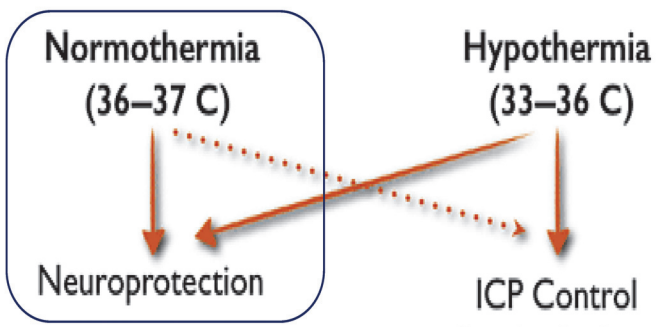
#. Post-Op Acute ICH, r/o Hemorrhagic Infarction, Rt. T-P ('20.01.16)



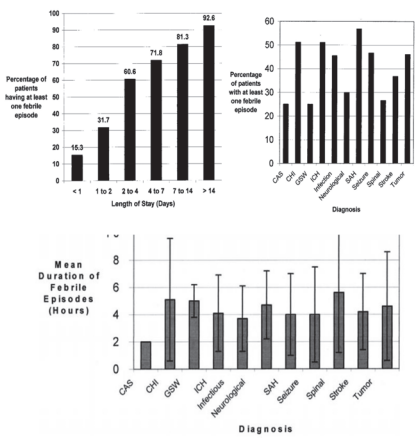
On POD 1
E3-4M6V4 → E2M4Ve

Pupil 2p/2p

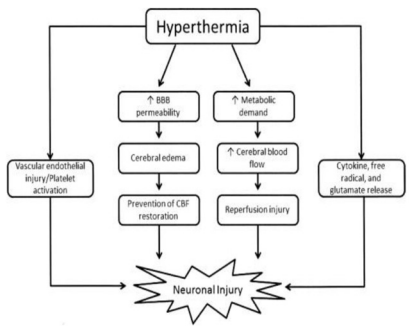




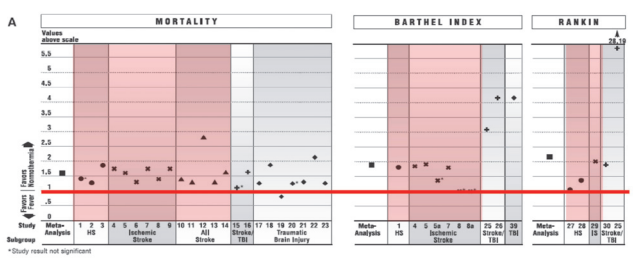
Fever in neurosurgical patients



Cellular effect of hyperthermia



Fever after stroke detrimental



Fever effect on various neurosurgical disease

	Effects on outcome
TBI	1. A negative association between early peak fever greater than 39℃ and **hospital Mortality** 2.**Prolonged coma or unawareness**, diabetes insipidus and **poor outcomes**
ICH	1. **High mortality and poor functional outcome** at 3 months on mRS 2. Duration of fever was independently associated with **poor outcome** in those who survived past 72 hours
SAH	1. Even a single episode of fever after SAH is associated with **poorer outcome**s even in best-grade patients. 2. **↑ Vasospasm** 3. More **severe functional disability** and **cognitive impairment** among survivors

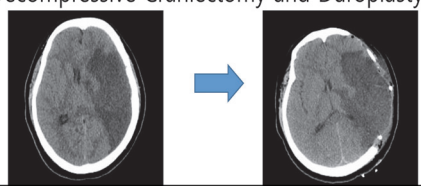
Illustrative case

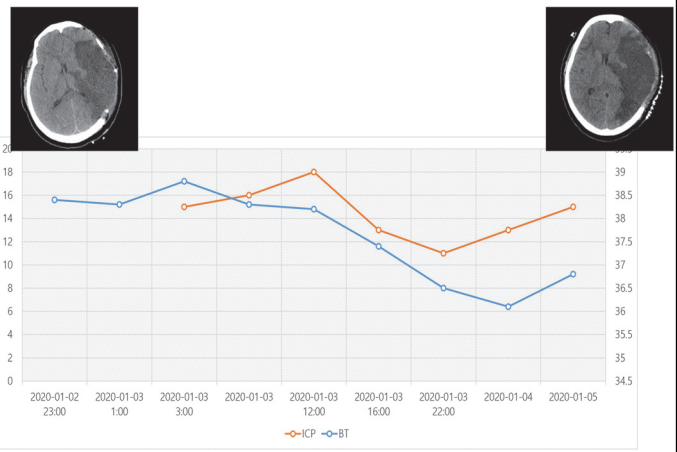
F/41

#. Lt. dICA Occlusion, Lt. MCAt Total Infarction

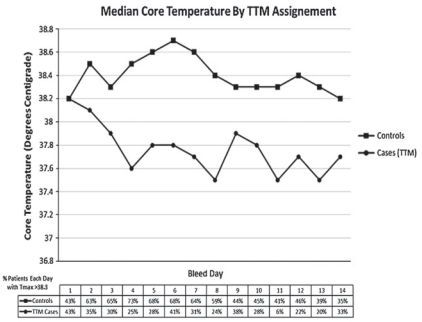
-> Sx : Altered Mentality, Global Aphasia, Rt. Hemiparesis
(Ictus '19.12.30 20:40)

- s/p IA Thrombectomy -> Fail ('19.12.31)
- s/p Decompressive Craniectomy and Duroplasty ('20.01.02)





Better temperature modulation



%Patients Each Day with Tmax >38.3	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Controls	43%	63%	65%	73%	68%	68%	64%	59%	44%	45%	43%	46%	39%	35%
TTM Cases	43%	35%	30%	25%	38%	43%	31%	24%	38%	28%	6%	22%	30%	33%

Neeraj Badjatia et al. Neurocritical Care 2014

Dilemma

- BSAS

Badjatia *Stroke*. 2008

Score	Definition
0	**None:** no shivering noted on palpation of the masseter, neck, or chest wall
1	**Mild:** shivering localized to the neck and/or thorax only
2	**Moderate:** shivering involves gross movement of the upper extremities (in addition to neck and thorax)
3	**Severe:** shivering involves gross movements of the trunk and upper and lower extremities

Method	Dosage	Mechanism
Basic management		
Acetaminophen	650–1000 mg orally q6h	Central fever control
Buspirone	30–60 mg orally q8h	α-2 receptor agonist
Skin counterwarming	Bair Hugger® polar air cooling system, Arizant, Augustine Medical Inc., Eden Prairie, MN, USA	Vasodilatation
Advanced management for persistent shivering		
Magnesium sulfate	0.5–1.0 g/h for target serum magnesium of 1–2 mmol/l (3–4 g/d)	Vasodilatation
Clonidine	15–60 μg/h (1.5–3 μg/kg/h)	α-2 receptor agonist
Dexmedetomidine	0.2–1.5 μg/kg/h	α-2 receptor agonist
Meperidine	25–100 mg i.v. q4h (or 0.5–1.0 mg/kg/h)	α-2 receptor agonist; κ-receptor agonist; NMDA-receptor antagonism; inhibition of biogenic amine reuptake
Pethidine	25–50 mg i.v. q4h	α-2 receptor agonist; κ-receptor agonist
Fentanyl	50–200 μg/h	Opioid-receptor agonist
Advanced management for refractory shivering		
Propofol	75–300 mg/h	Impairs vasoconstriction and shivering threshold
Rocuronium/vecuronium	Usually not needed and should be avoided because of increased incidence of critical illness polyneuropathy	Paralysis

q4h: Every 4 h; q6h: Every 6 h; q8h: Every 8 h; i.v.: Intravenous.

처방명

- ***===== Anti-shivering management =====***
- ***다음 순서대로 의사 지시하에 shivering management 합니다.***
- ***각 step 내에서도 shivering 조절되지 않을 경우 다음 단계로 넘어갑니다.***
- ***== step I***
- ***1> Buspirone 10mg tid***
- ***2> MgSO4 20ml 5 vial + N/S 900ml MIV 20cc/hr.target serum Mg 2-4mEq/l.***
- ***3> [prn]Tylenol 650mg tid***
- ***.***
- ***== step II***
- ***1> Consider dexmedetomidine infusion***
- ***Dexmedetomidine 1μg/kg loading 후 maintain 0.3μg/kg/h***
- ***Shivering control 되지 않을 경우 15분 간격으로 0.3μg/kg/h씩 1.0μg/kg/h까지 증량 (Bradycardia에 주의, asystole시 atropine 1mg IVS, Dexmedetomidine D/C***
- ***2> Meperidine***
- ***Meperidine 50mg bolus and continuous infusion 25mg/hr***
- ***Shivering 조절되지 않을 경우 30분 뒤 50mg/hr 까지 증량***
- ***3> combination method : dexmedetomidine + meperidine***
- ***4> Propofol***
- ***5> consider neuromuscular blocker***
- ***nimbex_ 0.2mg/kg IVS, then 2mcg/kg/min으로 start -> 1-3mcg/kg/min Bedside shivering scale에 따라 titration***
- ***N-M blocker 로 shivering control 되면 Dexmedetomidine, meperidine tapering***
- ***----------***

Proper sedation in neuroICU

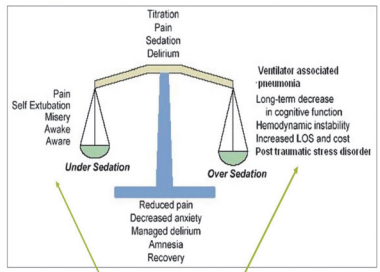
Set the goal

Light sedation

Deep sedation

- ICP control
- Hemodynamically unstable_MI
- Severe ARDS
- Status epilepticus

Titrating the sedation



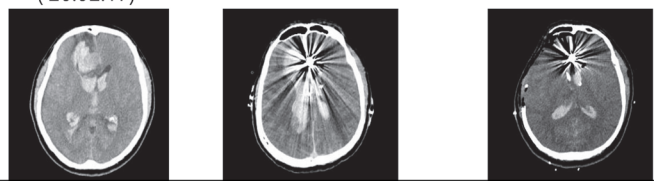
Both of them prolong ICU, hospital stay and increase costs

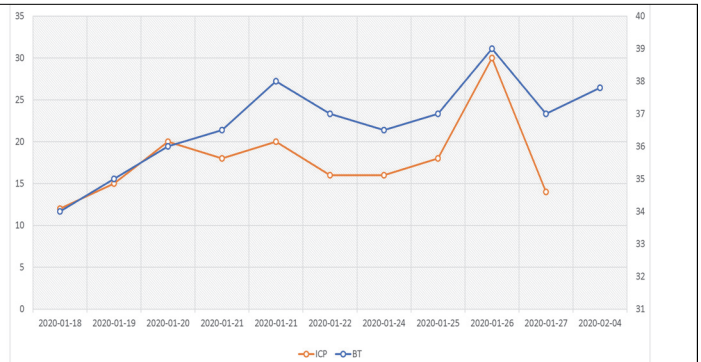
Illustrative case

M/52

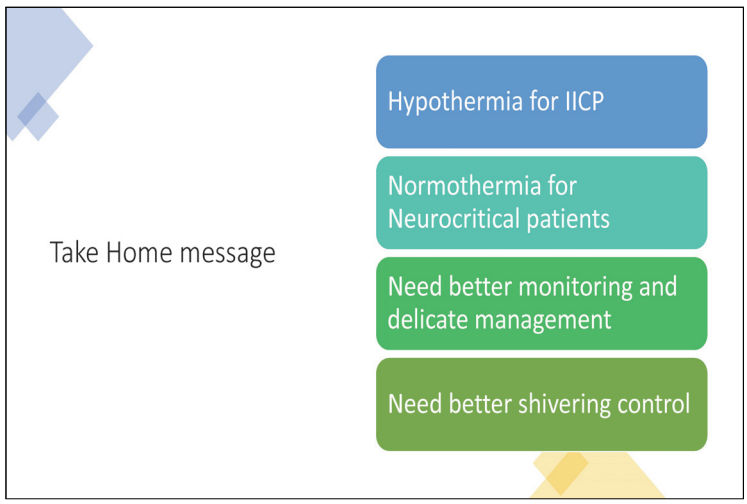
#. Ruptured An, DACA, HH5/mF4 (Ictus '20.02.17 6A)

- s/p EVD Insertion, Both K ('20.02.17)
- s/p Coil Embolization ('20.02.17)
- s/p Decompressive Craniectomy and ICH/IVH Evacuation ('20.02.17)





	2020-01-18	2020-01-19	2020-01-20	2020-01-21	2020-01-21	2020-01-22	2020-01-24	2020-01-25	2020-01-26	2020-01-27	2020-02-04
BT	34	35	36	36.5	38	37	36.5	37	39	37	37.8
ICP	12	15	20	18	20	16	16	18	30	14	
shivering	(-)	(-)	(++)	(+++)	(+++)	(-)	(-)	(-)	(+++)	(+)	
sedatives	PTT	PTT tapering	Precedex -> off			PPF + nimbex	PPF + nimbex	off		Precedex	


Take Home message
Hypothermia for IICP
Normothermia for Neurocritical patients
Need better monitoring and delicate management
Need better shivering control

Session II

Anesthesia-neurotoxicity during neurodevelopment: Should research be continued?

정 우 석

충남대학교 의과대학 마취통증의학과

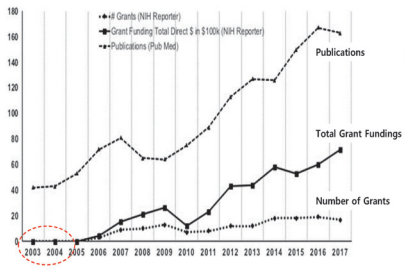
Learning Objectives

1. How 'Anesthesia-induced Neurotoxicity' research started.
2. What do current studies suggest?
3. Is there a need for more research in this field?

Introduction

Anesthesia-neurotoxicity during neurodevelopment

Anesthesia-induced neurotoxicity is one of the hottest topics in pediatric anesthesia in the past 20 years.



San. J Neurosurg Anesthesiol. 2018

What happened?

1. How it began…

2. What recent studies suggest…

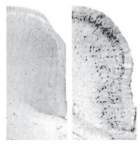
How the field started…

Early Exposure to Common Anesthetic Agents Causes Widespread Neurodegeneration in the Developing Rat Brain and Persistent Learning Deficits — Jevtovic-Todorovic. J Neuro. 2003

Postnatal day (PND) 7 rats.

: Midazolam (9mg/kg i.p.) + N_2O (75%), isoflurane (0.75%) (6 hours)

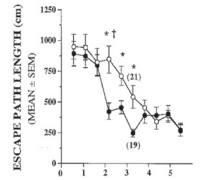
Widespread Neuronal cell death!



p-caspase3 staining

Long-lasting impairment of learning and memory!

Morris water maze



Animal studies (2003~present)

Following studies continuously reported neurotoxicity in young animals. — Walters et al. Neurotoxicology & Teratology. 2017; Jevtovic-Todorovic. Anesthesiology. 2018

: Widespread neuronal cell death in mice, rats, guinea pigs, sheep, non-human primates

: Structural changes accompanied with changes in synaptic transmission in mice.

Small changes during neurodevelopment have been shown to be associated with Neurodevelopmental disorders — Meridith. . Neurosci. Biobehav. Rev. 50:. 2015

Animal studies also suggest that anesthesia-induced neurotoxicity can cause long-lasting behavioral impairments (learning & memory, anxiety, sociability, etc)

Concerns regarding early anesthesia in young children!

How the field started…

Clinical studies began to be published 2009, reporting conflicting results.

Hansen et al. Curr Anesthesiol Rep. 2013

Early Exposure to Anesthesia and Learning Disabilities in a Population-based Birth Cohort *Wilder et al. Anesthesiology. 2009*

A Retrospective Cohort Study of the Association of Anesthesia and Hernia Repair Surgery With Behavioral and Developmental Disorders in Young Children

DiMaggio et al. J Neurosurg Anesthesiol. 2009

: retrospective cohort study

: children undergoing inguinal hernia repair under anesthesia (age <3 years)

Conclusion

Children who underwent hernia repair (<3 yrs) were more than twice as likely to be diagnosed with a developmental or behavioral disorder.

FDA safety statement!

FDA Safety Announcement (2016.12.14, 2017.04.27)

U.S. Food and Drug Administration
Protecting and Promoting Your Health

Drug Safety Communications

FDA review results in new warnings about using general anesthetics and sedation drugs in young children and pregnant women

Safety Announcement

[12-14-2016] The U.S. Food and Drug Administration (FDA) is warning that repeated or lengthy use of general anesthetic and sedation drugs during surgeries or procedures in children younger than 3 years or in pregnant women during their third trimester may affect the development of children's brains.

The need for high quality prospective clinical studies!

3 landmark clinical studies after the FDA statement

Pediatric Anesthesia and NeuroDevelopment Assessment study

Sun. JAMA. 2016

PANDA STUDY
PEDIATRIC ANESTHESIA AND NEURODEVELOPMENT ASSESSMENT

MASK study *Warner. Anesthesiology. 2018*

(Mayo Anesthesia Safety in Kids)

GAS study *McCann. Lancet. 2019*

(General Anesthesia and Spinal)

All 3 studies reported the same results

: *Early anesthetic exposure (<2 hr) is not associated with deficits in general intelligence*

General anesthesia or Awake-regional anesthesia Study (GAS)

Neurodevelopmental outcome at 5 years of age after general anaesthesia or awake-regional anaesthesia in infancy (GAS): an international, multicentre, randomised, controlled equivalence trial *McCann. Lancet. 2019*

: international, multicenter, randomized controlled trial / the only true prospective study

: *general anesthesia (sevoflurane)* vs *regional anesthesia* for inguinal hernia repair (age <6 months).

: IQ (primary outcome) & various development testing at 5 yrs (242 pt GA vs 205 pt Spinal)

Interpretation Slightly less than 1 h of general anaesthesia in early infancy does not alter neurodevelopmental outcome at age 5 years compared with awake-regional anaesthesia in a predominantly male study population.

After PANDA, MASK, GAS…

Vutskitis et al. Anesthesiology. 2019

EDITORIAL VIEWS

GAS, PANDA, and MASK

No Evidence of Clinical Anesthetic Neurotoxicity!

THE OPEN MIND

Barnes. A & A. 2019

"Pediatric Anesthetic Neurotoxicity": Time to Stop!

"Human evidence over-whelmingly suggests that any effect of well-conducted pediatric anesthesia is insignificant or nonexistent."

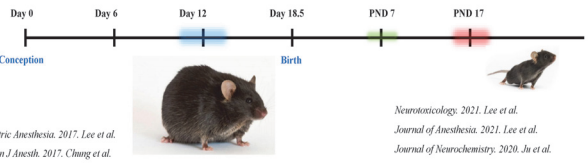
"... the possibility of harm from prolonged or multiple anesthetic exposures, hypotheses which can never be disproven."

"Neither funds nor researchers are unlimited; we must recognize that an unjustified research commitment in one area has an opportunity cost for other, perhaps more valuable, areas."

So, should we stop?

This is of great importance to me, since my lab has been only studying the neurotoxic effects of anesthesia in young mice since 2014.

Pediatric Anesthesia. 2015. Chung et al.



Pediatric Anesthesia. 2017. Lee et al.
Korean J Anesth. 2017. Chung et al.

Neurotoxicology. 2021. Lee et al.
Journal of Anesthesia. 2021. Lee et al.
Journal of Neurochemistry. 2020. Ju et al.
Front Cell Neuro. 2020. Ju et al.
Neurotoxicology. 2019. Ju et al.
Anesthesiology. 2017. Chung et al.

So, should we stop?

I agree that the effects of anesthesia regarding general cognition is subtle (if it exists), and that it is difficult to prove the neurotoxic effects from multiple anesthetic exposures.

In fact, I have started studying the PND in old mice (starting 2019).

However, I still believe there is a need for further research.

Why further studies are necessary

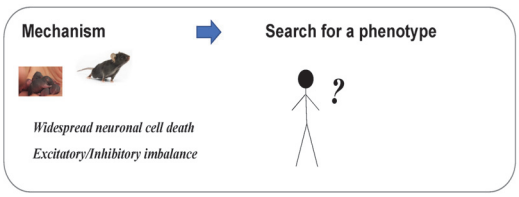
: My personal perspective

Anesthesia-neurotoxicity during neurodevelopment

An important fact about anesthesia-induced neurotoxicity: What to look for?

In most diseases, a phenotype is first identified in humans, and possible mechanisms are studied using animal models.

But, in the case of "Anesthesia-induced Neurotoxicity", a possible mechanism was first discovered in animals, and then there was a search for a phenotype.



Thus, we actually don't know what to look for!

What should we be looking for?

Early clinical studies mostly focused on intelligence, academic achievements, or incidence of neurodevelopemental disorders (based on animal studies and general concerns).

More recent studies have performed wide-range of tests, trying to identify a possible phenotype due to early anesthetic exposure.

: Educational Outcomes, Cognitive functions, Motor abilities, Social and Behavioral outcomes, Reading and Language skills, etc

Few studies suggest that although early anesthesia does not alter general cognitive function, but it may *affect specific aspects of development* *Warner. Anesthesiology. 2018* *Anesthesiology. 2020. Wallkden et al.*

Early anesthetic exposures may affect certain aspects of development

Neuropsychological and Behavioral Outcomes after Exposure of Young Children to Procedures Requiring General Anesthesia

The Mayo Anesthesia Safety in Kids (MASK) Study

Warner. Anesthesiology. 2018

Matched cohort study, 1994 to 2007

Unexposed (411) Single exposure (380) Multiple exposures (206)

Exposure	Intelligence Quotient vs. Unexposed Children
Single	0.5 points lower (95% CI, −2.8 to 1.9; $P = 0.70$)
Multiple	1.3 points lower (95% CI, −3.8 to 1.2; $P = 0.32$)

Primary outcome

Anesthesia before the age of 3 yr was not associated with deficits in general intelligence.

Secondary Outcome: Processing speed and fine motor abilities were decreased in children with multiple exposures; there were no significant differences in attention, memory, executive function, expressive language, visual-motor abilities, or visual-spatial abilities between unexposed and either exposure category.

Secondary Outcome: Parents of children with multiple exposures reported more problems related to executive function, behavior, and reading (but not math); parents of children with a single exposure reported more problems related to executive function and reading.

Conclusion:

Early anesthesia was not associated with deficits in general intelligence (primary outcome). Although secondary outcomes must be interpreted cautiously, anesthetic exposures are associated with a pattern of changes *in specific neuropsychological domains*.

Early anesthetic exposures may affect certain aspects of development

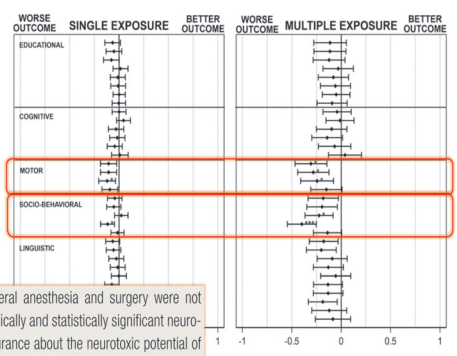
Anesthesiology. 2020. Wallkden et al.

ANESTHESIOLOGY

Early Childhood General Anesthesia and Neurodevelopmental Outcomes in the Avon Longitudinal Study of Parents and Children Birth Cohort

Graham J. Walkden, M.B.Ch.B., Hannah Gill, F.R.C.A., Ph.D., Neil M. Davies, Ph.D., Alethea E. Peters, B.M.B.Ch., Ingram Wright, D.Clin.Psychol., Ph.D., Anthony E. Pickering, F.R.C.A., Ph.D.

Anesthesiology 2020; 133:1007–20



Conclusions: Early childhood general anesthesia and surgery were not associated with a global picture of clinically and statistically significant neuro-degenerative effects, providing reassurance about the neurotoxic potential of general anesthesia. Exposure to anesthesia and surgery was associated with significantly lower motor and social linguistic performance.

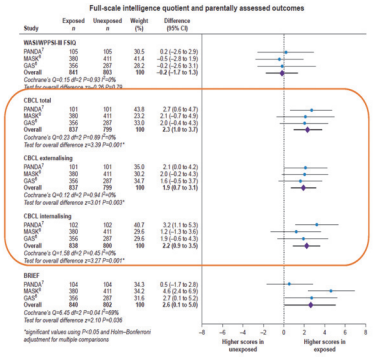
Early anesthetic exposures may affect certain aspects of development

Prospectively assessed neurodevelopmental outcomes in studies of anaesthetic neurotoxicity in children: a systematic review and meta-analysis

BJA. 2021. Ing et al.

: A meta-analysis of prospective studies evaluating neurodevelopmental outcomes in children exposed to a single general anesthetic procedure compared with unexposed children

Exposure to general anesthesia was not associated with difference in general intelligence. ***However, there was increases in parental reports of behavioral problems.***



Child Behavior Checklist (CBCL)

: a checklist for the parents (118 questions)

: detect emotional and behavioral problems in children (6-18 yrs).

: *Internalizing behaviors* reflect mood disturbance (anxiety, depression, and social withdrawal). *Externalizing behaviors* reflect conflict with others and violation of social norms.

Early anesthetic exposures may affect certain behaviors

Recent animal studies also report similar results.

BJA. 2021. Neurodecker et al.

Infant isoflurane exposure affects social behaviours, but does not impair specific cognitive domains in juvenile non-human primates

Isoflurane exposure in rhesus macaques during infancy was associated with decreased social behavior and increased anxiety behaviors (no change in cognitive function).

J of Neurochemistry. 2020. Ju et al

Increasing the interval between repeated anesthetic exposures reduces long-lasting synaptic changes in late post-natal mice

Sevoflurane exposures in young mice was associated with hypoactivity and increased anxiety behavior (no change in learning and memory).

Based on recent studies (clinical/animal), future studies should focus on specific behaviors rather than general cognitive function.

But the problem is, we do not know what to look for.

Maybe.... Addiction???

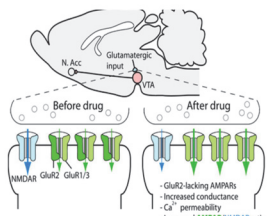
Why *Addiction*???

Use of addictive drugs leads to changes in neuronal structure and function that cause long-lasting or permanent neurotransmission abnormalities.

Luscher et al. Neuron. 2011

Such synaptic changes may lead to drug-induced adaptations later in life.

Luscher et al. Neuron. 2011

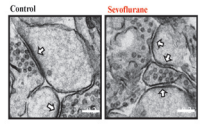


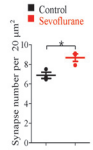
Thus, drugs that cause changes in synaptic transmission may influence addiction behavior later in life.

General Anesthesia!!!

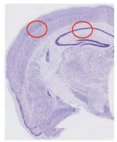
Anesthetic exposure in young mice induce long-lasting changes in the synapse

General anesthesia in young mice (PND17) increases excitatory synapses and induces change in excitatory/inhibitory synaptic transmission.





Neurotoxicology. 2018. Ju et al.



Sevoflurane, ketamine induce changes in excitatory/inhibitory synaptic transmission (cortex, hippocampus).

Neurotoxicology. 2020. Lee et al. *Journal of Neurochemistry. 2020. Ju et al.*

Early Anesthesia & Addiction: Is there a connection?

Our hypothesis:

Multiple anesthetic exposures during neurodevelopment may affect addiction behavior later in life.

Choice of drug: Ketamine

: Ketamine is often used in pediatric patients

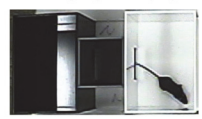
: Ketamine induces changes in synaptic transmission *J of Anesthesia. 2021. Lee et al.*

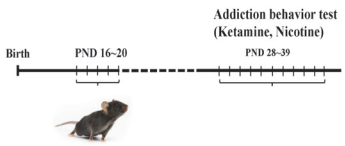
: Ketamine is also a recreational drug (called special K), and abused world wide.

Addiction. 2012. Morgan et al.

Can early ketamine exposures affect addiction behavior in later life?

Conditioned place preference (CPP) test

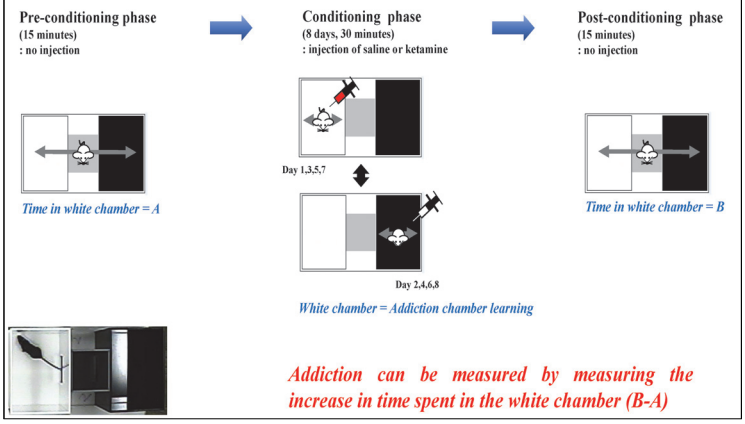




Mice received NSS or Ketamine (35mg/kg, ip) for 5 consecutive days

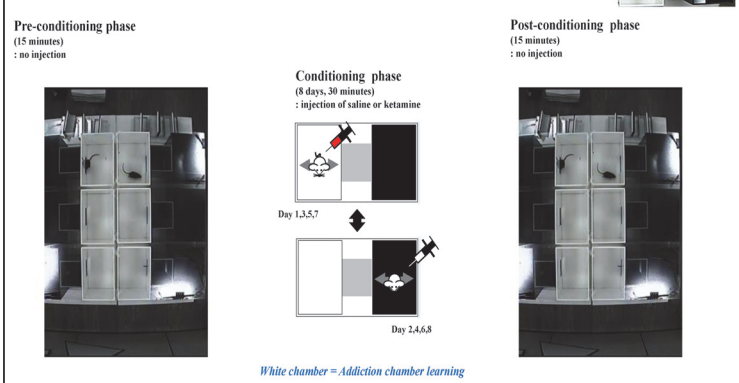
Do early ketamine exposed mice become addicted more easily?

Behavior test for addiction: Conditioned Place Preference (CPP) test

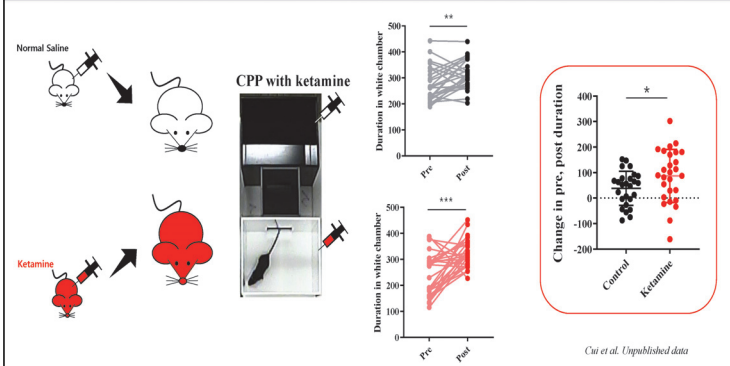


Addiction can be measured by measuring the increase in time spent in the white chamber (B-A)

Can early ketamine exposures affect addiction behavior in later life?



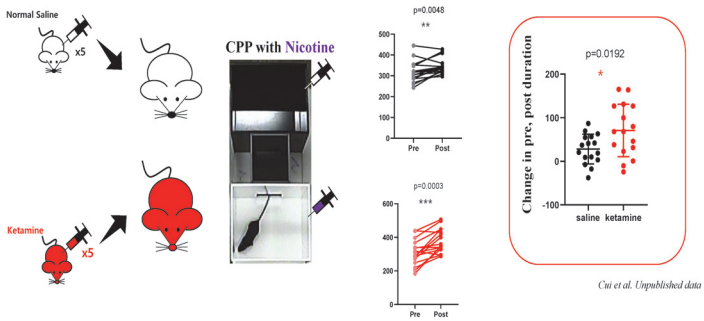
Can early ketamine exposures affect addiction behavior in later life?



Early ketamine injected mice show increased addiction to ketamine in later age!!!

Can early ketamine exposures affect addiction behavior in later life?

The effects could be limited to ketamine addiction. Thus, we tried another drug (nicotine).



Cui et al. Unpublished data

Early ketamine injected mice show increased addiction to Nicotine in later age!!!

Can early ketamine exposures affect addiction behavior in later life?

Mice that received early injection of ketamine showed increase addiction behavior to both ketamine and nicotine, suggesting .

Cui et al. Unpublished data

Although our data is limited to ketamine, our results suggest that early anesthetic exposures may have long-lasting effects on addiction behavior.

Unfortunately, our results are not the 1st to show that ketamine exposures in young mice may increase addiction

Garcia-Carachure et al. 2020. Neuropsychopharmacology

ARTICLE

Enduring effects of adolescent ketamine exposure on cocaine- and sucrose-induced reward in male and female C57BL/6 mice

Israel Garcia-Carachure[1], Francisco J. Flores-Ramirez[1], Samuel A. Castillo[1], Anapaula Themann[1], Miguel A. Arenivar[1], Joshua Preciado-Pita[1], Arturo R. Zavala[1], Mary Kay Lobo[2] and Sergio D. Iñiguez[1]

Can early ketamine exposures affect addiction behavior in later life?

Garcia-Carachure et al. 2020. Neuropsychopharmacology

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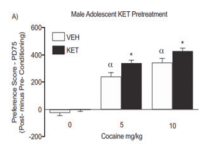


: C57BL/6 mice received ketamine for 15 consecutive days (PND35-49).
: Ketamine (antidepressant dose, 20mg/kg)

: Ketamine-exposed mice displayed increase preference to cocaine and sucrose (CPP test).

Thus, although the age & dose was different, this paper is the first to report that injections of ketamine (as an anti-depressants) in young mice led to increased addiction behavior in mice

Possible mechanisms have not been studied…

Conclusion

So, should we stop (studying neurotoxicity)?

I agree that the evidence strongly suggests that the effects of anesthesia regarding general cognition is subtle.

However, recent studies suggest that early anesthetic exposures may have a more significant effect in specific aspects of development.

Thus, further studies identifying impairments in specific aspects of development may provide valuable insights regarding the possible neurotoxic effects of early anesthesia.

Session II

Anemia and Transfusion in Intracranial Neurosurgery

이 소 영

대구가톨릭대 의과대학 마취통증의학과

Learning Objectives

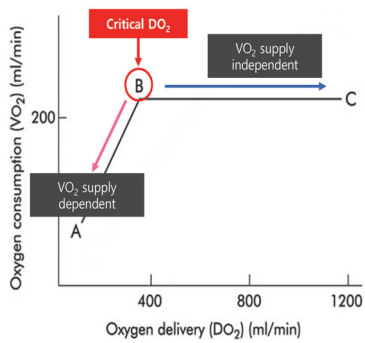
1. Anemia와 transfusion이 가지는 risk와 benefit을 이해할 수 있다.
2. Restrictive transfusion strategy와 Liberal transfusion strategy를 비교할 수 있다.
3. Intracranial neurosurgery에서 RBC transfusion에 대한 근거를 비교 및 이해할 수 있다.
4. Blood conservation strategy로 어떤 방법들이 사용되는지 설명할 수 있다.

Contents

Anemia

- Hemoglobin(Hb) levels <12g/dL in women, and <13g/dL in men (World Health Organization)
- Oxygen delivery reserve (DO_2/VO_2 ≒ 3-4)
  - Capacity to tolerate certain degree of anemia

Rationale for transfusion



$DO_2 = Q \times CaO_2$

$CaO_2 = (1.34 \times Hb \times SaO_2) + (0.0031 \times PaO_2)$

RBC transfusion increases the oxygen-carrying capacity and improve tissue oxygenation

Thorax 2002; 57: 170–7

Risk of Blood Transfusion

- Immunologic reaction
- Transmission of infections
- Circulatory overload
- Fever/Hypothermia
- Coagulopathy
- Increase morbidity and mortality

- Thromboembolic event
- Respiratory failure
- Prolonged intubation
- Wound infection
- Sepsis
- Increased hospital length of stay

Optimal transfusion practice

Providing RBC to maximize clinical outcomes,
while avoiding unnecessary transfusion

Restrictive vs Liberal transfusion strategy

- **Restrictive transfusion strategy** - transfusion not indicated until the hemoglobin level is **7-8 g/dL**
- **Liberal transfusion strategy** - transfusion not indicated until the hemoglobin level is **9-10 g/dL**

JAMA. 2016;316(19):2025-2035

NIH Consensus Statement Available on Perioperative Red Cell Transfusion

- A hemoglobin of less than 10 g/dL or a hematocrit of less than 30 per cent indicates a need for perioperative red cell transfusion.
- Most patients with hemoglobin values >10 g/dL rarely need perioperative transfusions, whereas those with acute anemia and hemoglobin values <7 g/dL will more frequently need blood.

AJPH 1988;78(12):1588

JAMA | Special Communication

Clinical Practice Guidelines From the AABB Red Blood Cell Transfusion Thresholds and Storage

Jeffrey L. Carson, MD; Gordon Guyatt, MD; Nancy M. Heddle, MSc; Brenda J. Grossman, MD, MPH; Claudia S. Cohn, MD, PhD; Mark K. Fung, MD, PhD; Terry Gernsheimer, MD; John B. Holcomb, MD; Lewis J. Kaplan, MD; Louis M. Katz, MD; Nikki Peterson, BA; Glenn Ramsey, MD; Sunil V. Rao, MD; John D. Roback, MD, PhD; Aryeh Shander, MD; Aaron A. R. Tobian, MD, PhD

- Systemic review for randomized clinical trials evaluating Hb thresholds for RBC transfusion (1950-May 2016) and RBC storage duration (1948-May 2016)
- 31 RCTs, 12587 participants
- To compare restrictive thresholds (Hb 7-8 g/dL) with liberal threshold (Hb 9-10 g/dL)

A restrictive transfusion threshold is safe in most clinical setting

JAMA. 2016;316(19):2025-2035

JAMA | Special Communication

Patient Blood Management Recommendations From the 2018 Frankfurt Consensus Conference

Markus M. Mueller, MD; Hans Van Remoortel, PhD; Patrick Meybohm, MD, PhD; Kari Aranko, MD, PhD; Cécile Aubron, MD, PhD; Reinhard Burger, PhD; Jeffrey L. Carson, MD, PhD; Klaus Cichutek, PhD; Emmy De Buck, PhD; Dana Devine, PhD; Dean Fergusson, PhD; Gilles Folléa, MD, PhD; Craig French, MB, BS; Kathrine P. Frey, MD; Richard Gammon, MD; Jerrold H. Levy, MD; Michael F. Murphy, MD, MBBS; Yves Ozier, MD; Katerina Pavenski, MD; Cynthia So-Osman, MD, PhD; Pierre Tiberghien, MD, PhD; Jimmy Volmink, DPhil; Jonathan H. Waters, MD; Erica M. Wood, MB, BS; Erhard Seifried, MD, PhD; for the ICC PBM Frankfurt 2018 Group

Table 2. Clinical Recommendations: Red Blood Cell Transfusion Thresholds

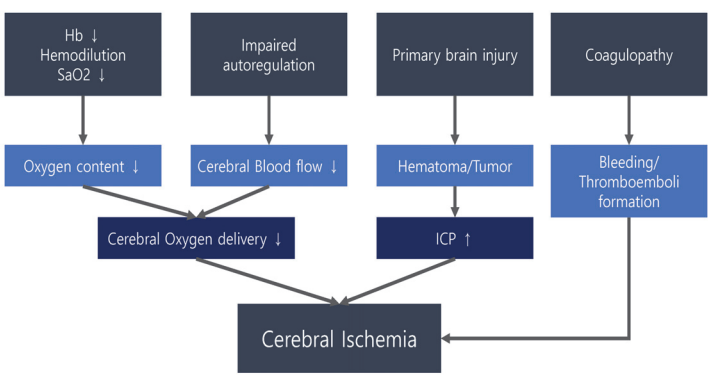
Clinical Recommendation	Level of Evidence
CR5—Restrictive RBC transfusion threshold (hemoglobin concentration <7 g/dL) in critically ill but clinically stable intensive care patients	Strong recommendation, moderate certainty in the evidence of effects
CR6—Restrictive RBC transfusion threshold (hemoglobin concentration <7.5 g/dL) in patients undergoing cardiac surgery	Strong recommendation, moderate certainty in the evidence of effects
CR7—Restrictive transfusion threshold (hemoglobin concentration <8 g/dL) in patients with hip fracture and cardiovascular disease or other risk factors	Conditional recommendation, moderate certainty in the evidence of effects
CR8—Restrictive transfusion threshold (hemoglobin concentration 7-8 g/dL) in hemodynamically stable patients with acute gastrointestinal bleeding	Conditional recommendation, low certainty in the evidence of effects

Abbreviations: CR, clinical recommendation; RBC, red blood cell.

JAMA. 2019;321(10):983-997

Brain

- **High metabolic requirement**
  - Weight of brain : 2% of total body weight
  - Oxygen consumption : 20% of total body oxygen utilization (≒ 50 mL/min)
  - Cerebral blood flow (CBF) : 12-15% of cardiac output (≒ 50mL/100g/min)
- **Very limited energy storage capacity**



Textbook of Neuroanesthesia and Neurocritical Care

Traumatic Brain Injury (TBI)

- Currently, there is insufficient evidence to make strong recommendations regarding which hemoglobin threshold to use as a transfusion trigger
- Considerable practice variability in hemoglobin transfusion thresholds for TBI patients.

Guidelines for the Management of Severe Traumatic Brain Injury, Fourth Edition

Neurosurgery 80:6–15, 2017 DOI:10.1227/NEU.0000000000001432 www.neurosurgery-online.com

No mention of RBC transfusion

Original Investigation | CARING FOR THE CRITICALLY ILL PATIENT

Effect of Erythropoietin and Transfusion Threshold on Neurological Recovery After Traumatic Brain Injury
A Randomized Clinical Trial

Claudia S. Robertson, MD; H. Julia Hannay, PhD; José-Miguel Yamal, PhD; Shankar Gopinath, MD; J. Clay Goodman, MD; Barbara C. Tilley, PhD; and the Epo Severe TBI Trial Investigators

- RCT of 200 patients with closed head injury
- Erythropoietin or placebo(saline) x transfusion threshold of 7 g/dL or 10g/dL
- **Favorable outcome rates** were 42.5% for the transfusion threshold of 7 g/dL vs 33.0% for 10 g/dL **(P =0.28)**
- 21.8% of **thromboembolic events** for threshold 10 g/dL vs 8.1% for 7 g/dL (P=0.009)

JAMA. 2014;312(1):36-47

Progressive hemorrhagic injury after severe traumatic brain injury: effect of hemoglobin transfusion thresholds

Aditya Vedantam, MD[1], **Jose-Miguel Yamal, PhD**[2], **Maria Laura Rubin, MS**[2], **Claudia S. Robertson, MD**[1], and **Shankar P. Gopinath, MD**[1]

[1]Department of Neurosurgery, Baylor College of Medicine, Houston, Texas

[2]Department of Biostatistics, University of Texas School of Public Health, Houston, Texas

- Secondary analysis of data from RCT 'the effects of erythropoietin and blood transfusions on neurological recovery after severe TBI'
- The adjusted risk of **severe Progressive hemorrhagic injury** was 2.3 times higher for patients with a transfusion threshold of **10 g/dl** (p = 0.02)

J Neurosurg. 2016; 125(5):1229–1234

ACS TQIP BEST PRACTICES IN THE MANAGEMENT OF TRAUMATIC BRAIN INJURY

Table 2. Goals of Treatment

Pulse Oximetry ≥ 95%	ICP 20 - 25 mmHg	Serum sodium 135-145
PaO_2 ≥ 100 mmHg	$PbtO_2$ ≥ 15 mmHg	INR ≤ 1.4
$PaCO_2$ 35-45 mmHg	CPP ≥ 60 mmHg *	Platelets ≥ 75 x 10^3 / mm^3
SBP ≥ 100 mmHg	Temperature 36.0-38°C	Hemoglobin ≥ 7 g/dl
PH 7.35-7.45	Glucose 80-180 mg/dL	

REVIEW Open Access

WSES consensus conference guidelines: monitoring and management of severe adult traumatic brain injury patients with polytrauma in the first 24 hours

Edoardo Picetti[1*], Sandra Rossi[1], Fikri M. Abu-Zidan[2], Luca Ansaloni[3], Rocco Armonda[4], Gian Luca Baiocchi[5], Miklosh Bala[6], Zsolt J. Balogh[7], Maurizio Berardino[8], Walter L. Biffl[9], Pierre Bouzat[10], Andras Buki[11,12], Marco Ceresoli[13,14], Randall M. Chesnut[15], Osvaldo Chiara[16], Giuseppe Citerio[14,17], Federico Coccolini[3], Raul Coimbra[18], Salomone Di Saverio[19], Gustavo P. Fraga[20], Deepak Gupta[21], Raimund Helbok[22], Peter J. Hutchinson[23,24], Andrew W. Kirkpatrick[25], Takahiro Kinoshita[26], Yoram Kluger[27], Ari Leppaniemi[28], Andrew I. R. Maas[29], Ronald V. Maier[30], Francesco Minardi[3], Ernest E. Moore[31], John A. Myburgh[32], David O. Okonkwo[33], Yasuhiro Otomo[34], Sandro Rizoli[35], Andres M. Rubiano[36,37], Juan Sahuquillo[38], Massimo Sartelli[39], Thomas M. Scalea[40], Franco Servadei[41], Philip F. Stahel[42], Nino Stocchetti[43,44], Fabio S. Taccone[45], Tommaso Tonetti[1], George Velmahos[46], Dieter Weber[47] and Fausto Catena[48]

- Hb threshold of **7 g/dL** in TBI polytrauma patients
- High thresholds for RBC transfusions in patients "at risk" (i.e., elderly and/or with limited cardiovascular reserve) may be considered

World Journal of Emergency Surgery 2019;14:53

Subarachnoid Hemorrhage (SAH)

- Anemia is very common
- In about 80% of patients, Hb level drops below 11 g/dL
- Special concern
  - **vasospasm** and **cerebral ischemia**
    → Increase likelihood to benefit from blood transfusion
  - Classic Triple-H therapy (→ Currently hypertensive therapy)
    : based on the rationale that decreasing blood **viscosity** results in increasing CBF

Blood transfusion and increased risk for vasospasm and poor outcome after subarachnoid hemorrhage

MICHELLE J. SMITH, M.D., PETER D. LE ROUX, M.D., J. PAUL ELLIOTT, M.D., AND H. RICHARD WINN, M.D.

Department of Neurosurgery, University of Pennsylvania, Philadelphia, Pennsylvania; Department of Neurosurgery, Rocky Mountain Neurosurgical Alliance, Denver, Colorado; and Department of Neurosurgery, Mt. Sinai School of Medicine, New York, New York

- Function of binding and unloading NO may be altered in transfused RBCs
- RBC transfusion is associated vasospasm development

J Neurosurg. 2004;101:1–7

Red Blood Cell Transfusion Increases Cerebral Oxygen Delivery in Anemic Patients With Subarachnoid Hemorrhage

Rajat Dhar, MD; Allyson R. Zazulia, MD; Tom O. Videen, PhD; Gregory J. Zipfel, MD; Colin P. Derdeyn, MD; Michael N. Diringer, MD

- Transfusion 1 unit of RBC to patients with SAH and Hb < 10 g/dL
- 15% rise in Hb and arterial oxygen content → 18% rise in DO_2 (P=0.017)
- Global CBF remained stable (40.5±8.1 to 41.6±9.9)

RBC transfusion to anemic patient with SAH resulted in a significant **rise in cerebral DO_2 without lowering global CBF**

Stroke. 2009; 40:3039-3044

Critical Care Management of Patients Following Aneurysmal Subarachnoid Hemorrhage: Recommendations from the Neurocritical Care Society's Multidisciplinary Consensus Conference

Michael N. Diringer · Thomas P. Bleck · J. Claude Hemphill III · David Menon · Lori Shutter · Paul Vespa · Nicolas Bruder · E. Sander Connolly Jr. · Giuseppe Citerio · Daryl Gress · Daniel Hänggi · Brian L. Hoh · Giuseppe Lanzino · Peter Le Roux · Alejandro Rabinstein · Erich Schmutzhard · Nino Stocchetti · Jose I. Suarez · Miriam Treggiari · Ming-Yuan Tseng · Mervyn D. I. Vergouwen · Stefan Wolf · Gregory Zipfel

- Data supporting restrictive transfusion In medical patients do **NOT** apply to SAH
- Patients should receive packed RBC transfusions to maintain Hb level **above 8-10 g/dL** (moderate quality evidence, strong recommendation)

Neurocrit Care 2011;15:211–240

Anemia After Aneurysmal Subarachnoid Hemorrhage Is Associated With Poor Outcome and Death

Oliver G.S. Ayling, MD, MSc; George M. Ibrahim, MD, PhD; Naif M. Alotaibi, MD, MSc; Peter A. Gooderham, MD; R. Loch Macdonald, MD, PhD

- A secondary analysis on 413 subjects in the COSCIOUS-1 study
- Hb ≥10 g/dL vs Hb <10 g/dL
- **Hb ≥10 g/dL** was associated with **improved neurological outcomes** (extended Glasgow outcome scale) at 12 weeks after SAH with no differences In mortality
- Supporting liberal transfusion threshold after SAH

Stroke. 2018;49:1859-1865

Intracranial tumor surgery

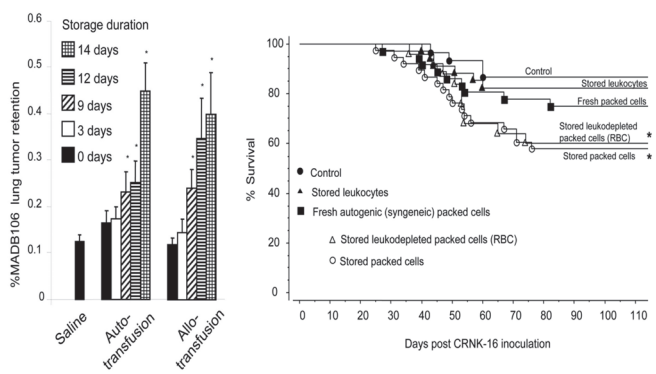
- Depending on the type of tumor, surgical procedure, incidence of transfusion may be variable
  - Low – Astrocytoma, low-grade glioma, transsphenoidal pituitary excision
  - high– meningioma, cerebellopontine tumor
- Relation between **transfusion and tumor progression**

Blood Transfusion Promotes Cancer Progression: A Critical Role for Aged Erythrocytes

Shir Atzil, M.A. [Graduate Student][1], Michal Arad, M.A. [Graduate Student][1], Ariella Glasner, M.A. [Graduate Student][1], Noa Abiri, M.A. [Graduate Student][1], Roi Avraham, M.A. [Graduate Student][1], Keren Greenfeld, M.A. [Graduate Student][1], Ella Rosenne, M.A. [Graduate Student][1], Benzion Beilin, M.D. [AssociateProfessor and Head][2], and Shamgar Ben-Eliyahu, Ph.D. [Professor and Head][1,3,4]

- Fischer 344 rats : Two syngeneic tumor models (MADB106 mammary adenocarcinoma, CRNK-16 leukemia)
- Blood transfusion is independent and significant **risk factor for cancer progression** in both models
- 4-folds increase in lung tumor retention, 2 folds mortality rates

Anesthesiology. 2008;109(6):989–997



- **Aged erythrocytes** (9 days and older) mediated the effect

Anesthesiology. 2008;109(6):989–997

Restrictive transfusion threshold is safe in high-risk patients undergoing brain tumor surgery

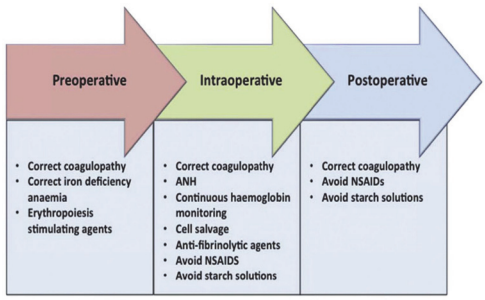
Yasmine Alkhalid[a], Carlito Lagman[a], John P. Sheppard[a], Thien Nguyen[a], Giyarpuram N. Prashant[a], Alyssa F. Ziman[d], Isaac Yang[a,b,c,e,f,g,*]

- Retrospective study
- 25 patients underwent open craniotomy for tumor resection
- A restrictive transfusion threshold (**Hb <8g/L**) did not significantly influence in hospital mortality or complication rates, length of stay

Clin Neurol Neurosurg 163 (2017) 103–107

Perioperative blood conservation strategy

- Conflicting evidences toward blood transfusion
- Importance of the application of blood conservation strategy
- **Systemic approach (3 pillars of care)**
  - Preoperative
  - Intraoperative
  - postoperative



British Journal of Anaesthesia. 2018;120(5):988e998

Preoperative management

- Assessment of anemia before surgery 4-8 weeks before surgery, if possible
  - Iron deficiency anemia – oral/IV iron
  - Chronic kidney disease patient – erythropoietin (EPO)? → Potential risk of thrombotic complication exist
- Correction of coagulopathy
- Antiplatelet, Oral anticoagulant drugs

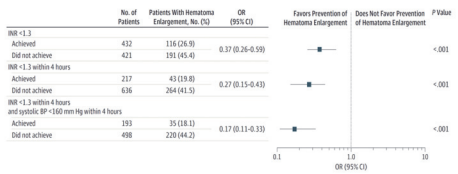
British Journal of Anaesthesia. 2018;120(5):988e998

Original Investigation

Anticoagulant Reversal, Blood Pressure Levels, and Anticoagulant Resumption in Patients With Anticoagulation-Related Intracerebral Hemorrhage

Joji B. Kuramatsu, MD; Stefan T. Gerner, MD; Peter D. Schellinger, MD; Jörg Glahn, MD; Matthias Endres, MD; Jan Sobesky, MD; Julia Flechsenhar, MD; Hermann Neugebauer, MD; Eric Jüttler, MD; Armin Grau, MD; Frederick Palm, MD; Joachim Röther, MD; Peter Michels, MD; Gerhard F. Hamann, MD; Joachim Hüwel, MD; Georg Hagemann, MD; Beatrice Barber, MD; Christoph Terborg, MD; Frank Trostdorf, MD; Hansjörg Bäzner, MD; Aletta Roth, MD; Johannes Wöhrle, MD; Moritz Keller, MD; Michael Schwarz, MD; Gernot Reimann, MD; Jens Volkmann, MD; Wolfgang Müllges, MD; Peter Kraft, MD; Joseph Claasen, MD; Carsten Hobohm, MD; Markus Horn, MD; Angelika Mikowski, MD; Heinz Reichmann, MD; Hauke Schneider, MD; Elk Schimmel, MD; Gereon R. Fink, MD; Christian Dohmen, MD; Henning Stetefeld, MD; Otto Witte, MD; Albrecht Günther, MD; Tobias Neumann-Haefelin, MD; Andras E. Racs, MD; Martin Nueckel, MD; Frank Erbguth, MD; Stephan P. Kloska, MD; Arnd Dörfler, MD; Martin Köhrmann, MD; Stefan Schwab, MD; Hagen B. Huttner, MD

Figure 3. Adjusted Graphical Regression Analysis of Combined Associations of INR Reversal, Systolic Blood Pressure, and Timing With Hematoma Enlargement



- Retrospective cohort study (2006-2012)
- 1176 spontaneous ICH patients with oral anticoagulants (INR >1.5)
- **Reversal of INR <1.3 within 4 hours** and SBP < 160 mmHg at 4 hours were associated with lower rates of hematoma enlargement

JAMA. 2015;313(8):824-836

SpHb monitoring

- Non-invasive, continuous, real-time Hb monitoring method
- Concern : clinical reliability of SpHb
- With the current technology, SpHb cannot replace lab-Hb
- Supplement for intermittent and delayed nature of Lab-Hb
  - Earlier identification of attainment of the Hb threshold
  - Avoidance of excessive multi unit transfusion

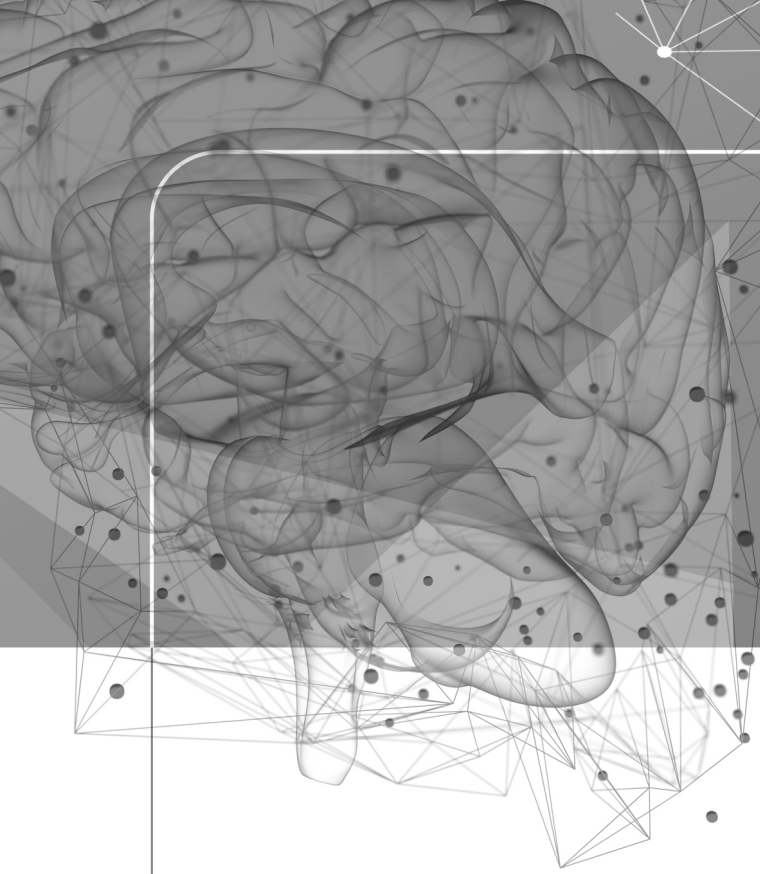
Anesth Analg. 2013;117:902–7
Anest Analg. 2016;122(2):556-72

Summary

- Risk and benefit of anemia and transfusion in neurosurgical patients
  - **Anemia** : blood viscosity ↓, CBF ↑, Cerebral hypoxia an ischemic injury ↑, potentially poorer neurological outcome
  - **Transfusion** : cerebral oxygen delivery ↑, Secondary brain injury ↓, thromboembolic event ↑, progressive hemorrhagic injury ↑
  - Both anemia and transfusion is associated with increase in mortality

Summary

- Transfusion thresholds from other populations may not directly apply to patients undergoing neurosurgery
- Further large investigations are needed for transfusion thresholds
- Perioperative blood conservative strategies
- Correcting causes of anemia and coagulopathy preoperatively
- Utilizing non-invasive SpHb monitoring with intermittent Lab-Hb to detect early decrease in Hb and reduce rough RBC transfusion



Session III

Fluid and pain management during neuroanesthesia

좌장: **박성식** (경북의대)

Session III

Fluid management during neurosurgical procedure

김 남 오

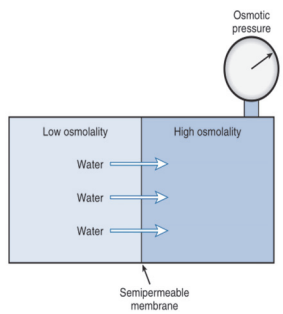
연세대학교 의과대학 마취통증의학과

Learning Objectives

1. Know the physical determinants of water movement between the intravascular space and the central nervous system
2. Know the differences of crystalloids and colloids and make suggestions for the types and volumes of fluids to be administered

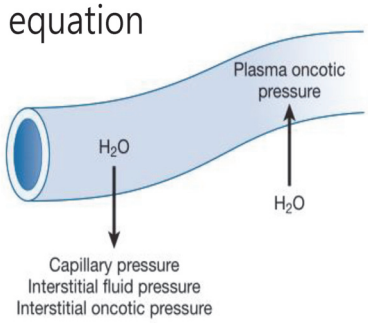
Osmolarity, oncotic pressure and intravascular volume

- Capillary endothelium (semipermeable)
  - permeable; water, electrolytes, glucose
  - impermeable; protein, molecules >35 kDa



Cottrell and Patel's Neuroanesthesia 6E, Ch. 9 Fluid management during craniotomy

Starling equation

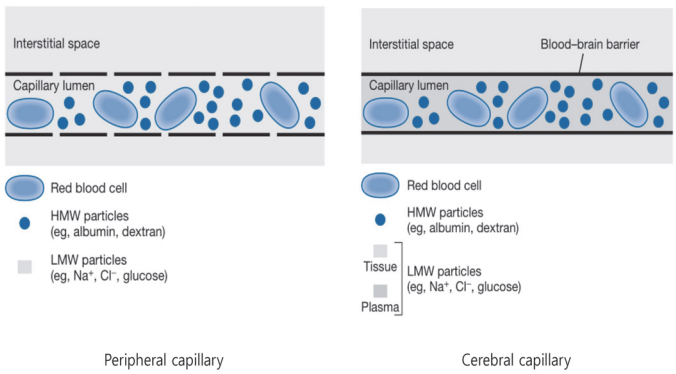


$$Q = kA\,[(Pc - Pi) - \sigma(\pi c - \pi i)]$$

Determinants of Fluid Movement between Vasculature and Tissues

- Q > 0 (slightly greater than zero)
  - net outward flux of fluid from the vessels into the tissue extracellular space.
- fluid is cleared from the tissue by the lymphatic system
  - preventing the development of edema

Fluid Movement between Capillaries and the Brain



Fluid Movement between Capillaries and the Brain

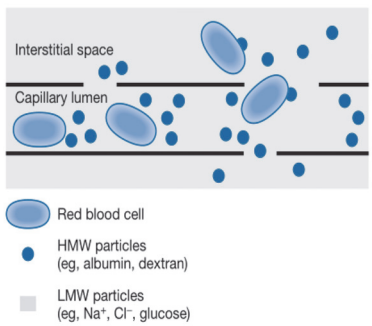
- movement of water in peripheral tissues
  - concentration of large macromolecules (oncotic gradient)
- movement of water in CNS system
  - Osmolar gradient : determined by relative concentrations of all osmotically active particles, including most electrolytes

Fluid Movement between Capillaries and the Brain

- Situation : large volume of iso-osmolar crystalloid

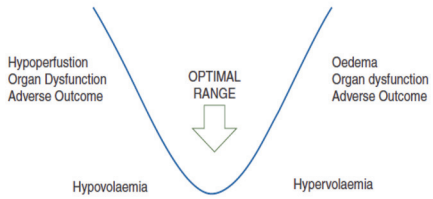
Peripheral capillary	Cerebral capillary
Unchanged hydrostatic pressure but dilution of plasma proteins ↓ decrease in intravascular oncotic pressure ↓ peripheral tissue edema	No change in ICP

Disruption of BBB



Goal of fluid therapy

- General principle (1)
  - to maintain cerebral perfusion : cellular O2 delivery
  - Normovolemia : adequate ciculating volume, normal MAP



British Journal of Anaesthesia 109 (1): 69–79 (2012)

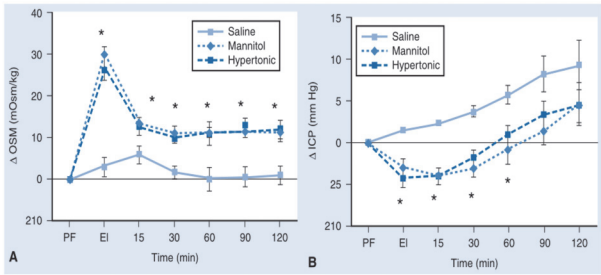
Goal of fluid therapy

- General principle (2)
  - Avoid hypo-osmolarity: Preventing cerebral edema
  - Maintain osmolarity & colloid oncotic pressure (COP)
  - Avoid glucose containing solutions
  - hyperglycemia is detrimental to cerebral metabolism
  - not osmotically active, leaving to free water

SOLUTIONS FOR INTRAVENOUS USE

Fluid	Osmolarity (mOsm/L)	Oncotic Pressure (mmHg)
Lactated Ringer's solution	>273	0
D5 lactated Ringer's solution	525	0
0.9% saline	308	0
D5 0.45% saline	406	0
0.45% saline	154	0
20% mannitol	1098	0
Hetastarch (6%)	310	31
Dextran 40 (10%)	≈300	169
Dextran 70 (6%)	≈300	69
Albumin (5%)	290	19
Plasma	295	26

Hyperosmolar Solutions



Hyperosmolar Solutions

- Mannitol
  - **biphasic effect** on ICP
    - transient increase: vasodilation of cerebral vessels in response to the sudden increase in plasma osmolality
    - subsequent decrease in ICP :movement of water from the brain's interstitial and intracellular spaces into the vasculature
  - high dose of mannitol (ie, 2 g/kg) : increase in **serum potassium concentration**
    - Contraindicated in patients with end-stage renal disease or severe congestive heart failure patients.

Hyperosmolar Solutions

- Hypertonic saline (3%)
  - supplementation in moderate to severe hyponatremic states
  - Rapid rises in Na (>3-4mEq/L/hr) must be avoided to prevent **central pontine myelinolysis**
- treatment option for electrolyte derangements
  - SIADH, cerebral salt wasting syndrome

Hypo-osmolar crystalloids

- 0.45% saline or 5% glucose in water
- Lactated Ringer's solution : 273 mOsm/L

- Reduction in plasma osmolality
  - movement of water across the BBB into the cerebral tissue
  - Brain edema, increase in the ICP

- Electrolyte derangements
  - Diabetes insipidus

Iso-osmolar crystalloids

- 0.9% normal saline : 308 mOsm/L
  - Slightly hyperosmolar compared to serum plasma: 295 mOsm/L
  - No changes in the plasma osmolality
  - large volumes -> hyperchloremic metabolic acidosis
  - subsequent AKI d/t renal tubular acidosis

Iso-osmolar crystalloids

- Balanced crystalloid solution : 295 mOsm/L
  - lower overall osmolarity (< 0.9% NaCl)
  - addition anion buffer (lactate, gluconate, acetate) → metabolizied HCO_3^-
  - do not cause acidosis
  - negative effect
    - D-lactate => cardiac toxicity, encephalopathy
    - reliance of hepatic metabolism

Balanced Crystalloid

Balanced Crystalloids Versus Saline for Perioperative Intravenous Fluid Administration in Children Undergoing Neurosurgery: A Randomized Clinical Trial

Mariana F. Lima, MD,† Iuri S. Neville, MD,‡ Sergio Cavalheiro, MD, PhD,§ Dafne C. Bourguignon, MD, PhD,‖ Paolo Pelosi, MD, FERS,¶ and Luiz M.S. Malbouisson, MD, PhD**

- **Balanced Crystalloids vs. Saline in children undergoing neurosurgery**
  - Randomized clinical trial multiple-crossover trial : 53 patients (age range, 6mo to 12 y)
  - Primary endpoint: absolute difference in serum chloride concentrations (post-preop ΔCl^-) measured after surgery and at baseline
  - Secondary outcome: ① post-preop Δ of other electrolytes and base excess (BE), ② hyperchloremic acidosis incidence, ③ the brain relaxation score, a 4-point scale evaluated by the surgeon for assessing brain edema

J Neurosurg Anesthesiol 2019;31:30–35

TABLE 2. Before to After Surgery Variations ($_{post\text{-}preop}\Delta$) of Electrolytes and BE

	Saline Group	Balanced Group	*P*
$_{post\text{-}preop}\Delta Cl^-$ (mmol/L)	6 (3.5 to 8.5)	0 (−1.0 to 3.0)	<0.001
$_{post\text{-}preop}\Delta Na^+$ (mmol/L)	4 (1.5 to 7.5)	3.0 (0 to 5.0)	0.127
$_{post\text{-}preop}\Delta Mg^{++}$ (mg/dL)	−0.2 (−0.3 to −0.1)	0.15 (0 to 0.3)	<0.001
$_{post\text{-}preop}\Delta K^+$ (mmol/L)	−0.2 (−1.2 to 0.1)	−0.35 (−0.5 to −0.1)	0.802
$_{post\text{-}preop}\Delta iCa^{++}$ (mmol/L)	0.02 (−0.02 to 0.06)	0.025 (−0.02 to 0.07)	0.872
$_{post\text{-}preop}\Delta P_i^-$ (mg/dL)	0.3 (−1.5 to 0.8)	0.7 (−0.3 to 1.1)	0.125
$_{post\text{-}preop}\Delta BE$ (mmol/L)	−4.4 (−5.0 to −2.3)	−0.4 (−2.7 to 1.3)	<0.001

Values are presented as medians (interquartile range).
BE indicates base excess.

J Neurosurg Anesthesiol 2019;31:30–35

GLUCOSE-CONTAINING SOLUTIONS

- Strict glycemic control : improved outcome
  - Van den Berghe et al. (2001)
  - (i.e. target serum glucose 80-110 mg/dL),
  - in critically ill surgical patients was associated
- Vs. increased risk for hypoglycemia
  - Injured brain becomes hypoglycemics suffers metabolic distress at normal glucose level
  - target range : 90-180mg/dL vs. 140-180 mg/dL

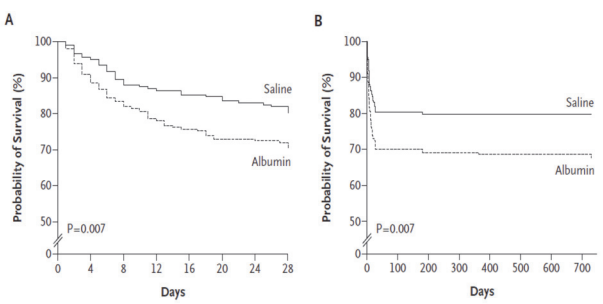
Colloids

- composed of large molecules (>40 kDa) which are relatively impermeable to the capillary membranes
- better to correct the changes in colloid oncotic pressure (COP) in patients with brain or spinal cord injury
- Undesired effect
  - dose-dependent effect on coagulation
  - renal toxicity
  - anaphylactoid reaction
  - tissue deposition (pruritus)

Colloid - albumin

- **Albumin vs. Saline in patients with TBI (SAFE trial)**
  - post hoc follow-up study of patients with traumatic brain injury who were enrolled in the SAFE study : 460 patients
  - Mortality after 24 months f/u
    - albumin group (33.2%) vs. saline group (20.4%) : RR, 1.63 (1.17 to 2.26), P = 0.003

N Engl J Med 2007;357:874-84.



- Limitation
  - Not originally randomized,
  - Imbalance in patients' characters,
  - 4% albumin(hypo-osmolar) used
  - albumin specific hazard

N Engl J Med 2007;357:874-84.

Colloid - others

- Starch-containing solution
  - dilutional reduction of coagulation factors
  - interfere directly with platelets and the factor VIII complex
  - effects on coagulation are proportional to the average molecular weight of the starch preparation
- Dextrose
  - Caution: Platelet function ↓

Crystalloid vs. Colloid

- **HES vs. Saline for volume replacement** among high-risk patietns undergoing major abdominal surgery
  - 775 adult patients at increased risk of postoperative kidney injury undergoing major abdominal surgery
  - The primary outcome : composite of death or major postoperative complications at 14 days after surgery

CONCLUSIONS AND RELEVANCE Among patients at risk of postoperative kidney injury undergoing major abdominal surgery, use of HES for volume replacement therapy compared with 0.9% saline resulted in no significant difference in a composite outcome of death or major postoperative complications within 14 days after surgery. These findings do not support the use of HES for volume replacement therapy in such patients.

JAMA. 2020;323(3):225-236.

Crystalloid vs. Colloid

	Advantages	Disadvantages
Crystalloids	Cost ↓ Greater urinary flow Interstitial fluid replacement	Transient effect Peripheral/pulmonary edema
Colloids	Infusion volume ↓ Plasma volume ↑ Peripheral edema ↓	Greater cost Coagulopathy Osmotic diuresis Pulmonary edema
Hypertonic fluid	Small initial volume Promote urinary flow Peripheral edema ↓	Hypertonicity Transient effect Delayed IICP

Crystalloid vs. Colloid

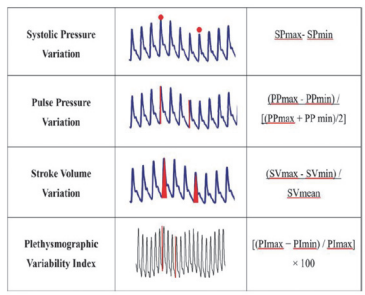
- In situations requiring substantial volume administration
  - multiple trauma
  - aneurysm rupture
  - cerebral venous sinus laceration
  - fluid administration to support filling pressure during barbiturate coma

⬇

isotonic crystalloid + colloid

Goal-directed therapy

- Aim to maximize stroke volume and cardiac output using a minimally invasive cardiac output monitor
- Arterial Pressure Monitoring for Prediction of Volume Responsiveness
  - SPV (systolic pressure variation)
  - PPV (pulse pressure variation)
  - SVV (stroke volume variation)
  - PVI (Pleth Variability Index)



Anesthesiology 2020; 133:929–35

Dynamic changes in arterial waveform derived variables and fluid responsiveness in mechanically ventilated patients: A systematic review of the literature*

Paul E. Marik, MD, FCCM; Rodrigo Cavallazzi, MD; Tajender Vasu, MD; Amyn Hirani, MD

	Correlation (r)	AUC
PPV	.78 (.74–.82)	0.94 (0.93–0.95)
SPV	.72 (.65–.77)	0.86 (0.82–0.90)
SVV	.72 (.66–.78)	0.84 (0.78–0.88)
LVEDAI	—	0.64 (0.53–0.74)
GEDVI	—	0.56 (0.37–0.67)
CVP	.13 (−.01–.28)	0.55 (0.48–0.62)

Crit Care Med. 2009 Sep;37(9):2642-7.

Transfusion

- The lower limit of acceptable hemoglobin or hematocrit has not been well defined
  - Avoidance of transfusion - hematocrit 21% (Hemoglobin 7 g/dl)
  - except in the context of ongoing hemorrhage
- A practical approach is to consider the rate of surgical blood loss
  - slow - maintain a normal intravascular volume with isotonic crystalloid solution or with an appropriate colloid.
  - Packed RBC administered when the hematocrit approaches 21%.
  - Increase rate - blood transfusion begin at a higher hematocrit.

Session III

Postoperative pain management for neurosurgical patients

이 형 곤

전남대학교 의과대학 마취통증의학과

Learning Objectives

1. 개두술 후 급성 및 만성통증의 발생률과 치료의 중요성을 이해한다.
2. 개두술 후 급성 및 만성통증의 발생 기전에 대해 이해한다.
3. 개두술 후 급성 및 만성 통증의 약물 치료 및 중재적 시술에 대해 설명한다.

Pain following craniotomy has been neglected in the past, mostly because of the common belief that craniotomy pain is mild to moderate in intensity, and it has been the subject of limited and inconsistent research. However, accumulating evidence shows that approximately 60% of postcraniotomy patients experience moderate or severe pain in the early postoperative period, or present with persistent pain with neuropathic elements several months postsurgery. Acute postsurgical pain is hypothesized to progress to chronic postsurgical pain in part because of inadequate analgesia in the early perioperative period. Thus, postcraniotomy pain approach might balance between proper analgesia establishment, while having an awake and cooperative patient to accomplish neurological evaluation and suboptimal pain treatment that might induce an implicated postoperative course, resulting in increased healthcare expenditures. The traditional approach with low-dose opioids is often insufficient and can cause well recognized side effects. Newer multimodal analgesic approaches have proven beneficial in a variety of other surgical patient populations. The combined use of multiple nonopioid analgesics offers the promise of improved pain control and reduced opioid administration, while preserving the clinical neurologic exam. These interventions can begin prior to surgery and continue beyond the operating room into the ICU, general inpatient unit, and outpatient recovery period. They can also be integrated into Enhanced Recovery after Surgery (ERAS) protocols. The evidence to support a multimodal approach is growing; anesthesiologists and neurosurgeons should seek to incorporate multimodal analgesia into the perioperative care of craniotomy patients. The combined use of multiple nonopioid analgesics offers the

promise of improved pain control and reduced opioid administration, while preserving the clinical neurologic exam. Specifically, acetaminophen and gabapentinoids should be considered for craniotomy patients, both preoperatively and postoperatively. The gabapentinoids have the added benefit of reduced nausea. Scalp blocks have moderate quality evidence supporting their use over incisional infiltration alone, with analgesia that extends into the postoperative period. Intraoperative dexmedetomidine reduces postoperative opioid requirements with the added benefit of reduced postcraniotomy hypertension. Methocarbamol, NSAIDs, ketamine, and intravenous lidocaine require further data regarding safety and efficacy in craniotomy patients.

Session VI

Poster presentation

좌장: **이일옥** (고려의대)

P-1

Effects of external laryngeal manipulation on cervical spine motion during videolaryngoscopic intubation under manual in-line stabilization: a randomized crossover trial

김윤정, 최승은, 오형민, 박희평

서울대학교 의과대학 마취통증의학과

Background: External laryngeal manipulation (ELM) can improve laryngeal view during videolaryngoscopic intubation. We hypothesized that ELM would reduce cervical spine motion during videolaryngoscopic intubation under manual in-line stabilization (MILS) by reducing the force required to lift the videolaryngoscope.

Methods: In this randomized crossover trial, 27 neurointerventional patients underwent two consecutive videolaryngoscopic intubation attempts under MILS. ELM was applied to all patients in either the first or second attempt. In the second attempt, we tried to reproduce the percentage of glottic opening score obtained in the first attempt. Using lateral cervical spine radiographs, cervical spine motion during intubation (cervical spine angle during intubation minus cervical spine angle before intubation, primary outcome measure) was compared with versus without ELM at the occiput–C1, C1–C2, and C2–C5 segments. The intubation success rate and intubation time (secondary outcome measures) were recorded.

Results: Cervical spine motion during intubation at the occiput–C1 segment was significantly smaller with than without ELM (7.4° [4.6°] vs. 11.5° [4.8°], mean difference [98.33% confidence interval] −4.1° [−5.8° to −2.3°], $P < 0.001$), showing a reduction of 35.7%. Cervical spine motion during intubation at the C1–C2 and C2–C5 segments was not significantly different with versus without ELM. All intubations were achieved successfully regardless of the application of ELM. The intubation time was significantly longer with than without ELM (33.0 [25.0 to 43.0] vs. 26.0 [20.0 to 35.0] s, $P = 0.002$).

Conclusions: ELM is a useful method to reduce upper cervical spine motion during videolaryngoscopic intubation under MILS.

keywords: External laryngeal manipulation, videolaryngoscopic intubation, cervical spine motion

P-2

Tension pneumothorax after endotracheal tube insertion at tracheostomy site: A case report

김종원, 배성일, 조영일, 황예란, 이수희, 옥성호, 손주태

경상대학교 의과대학 마취통증의학과

Percutaneous tracheostomy can induce many complications because of its invasive and poor patient condition. One of the most critical complications during tracheostomy tube insertion is tube misplacement, resulting in loss of airway and/or injury to surrounding structures. A 59-year-old man diagnosed with tracheal stenosis after ventilator care for acute respiratory failure was scheduled for spine surgery after tracheostomy under local anesthesia. After patient was sedated with midazolam (5 mg) and then fentanyl (25, 25, and 50 ❍g), percutaneous tracheostomy was performed . After the surgery, the otolaryngologist said that when the reinforced endotracheal tube (diameter 7.5) was inserted, it was very difficult to be inserted and forcefully was inserted. The lung sound was confirmed with a stethoscope, and anesthesia was induced with sodium thiopental (300 mg) followed by cisatracurium (12 mg). Anesthesia was maintained with desflurane, N2O and O2, and mechanical ventilation was started. However, oxygen saturation decreased to 85% and capnograghic waveforms were not confirmed. Bronchoscope was inserted through endotracheal tube, but no tracheal cartilage was observed. Only empty space was observed. After removal of the tube, the tracheostomy site was closed with wet gauze and mask ventilation was performed. The saturation rises and a capnograghic wave forms appear. The endotracheal tube (diameter 7.5) was intubated using a video laryngoscope and the endotracheal tube was fixed on top of the tracheostomy site. After chest radiography, pneumothorax was confirmed and chest tube was inserted and patient was transferred to intensive care unit. Then, on computed chest tomography, fistula lesions associated with lungs were identified just below the tracheostomy site. We suspect that when the endotracheal tube through tracheostomy site was forcefully inserted, the tube penetrated the tracheal membrane and entered the pleural cavity, leading to pneumothorax.

keywords: tension pneumothorax, tracheostomy, endotracheal tube

P-3

The efficacy and safety of perioperative use of melatonin for postoperative delirium in patients undergoing surgery: A systematic review and meta-analysis

윤경섭, 고은지, 유해선, 신혜원

고려대학교 의과대학 안암병원 마취통증의학과

Introduction: Melatonin is an endogenous hormone, which has a major role in control of circadian rhythm and sleep regulation and other effects on the immune system, neuroprotection, and oxidant/anti-oxidant activity. There has been interest in the perioperative use of melatonin as a measure to prevent postoperative delirium with conflicting result findings. The aim of this study was to determine the efficacy and the safety of perioperative melatonin use on the incidence of postoperative delirium in patients undergoing surgery.

Methods: We systematically searched PubMed, EMBASE, Cochrane CENTRAL, and Google Scholar for eligible randomized controlled trials (RCTs) examining the perioperative use of melatonin to prevent postoperative delirium up to January 2021. The primary outcome was to examine the efficacy of melatonin, assessed by measuring the incidence of postoperative delirium. The secondary outcome was to examine the efficacy and the safety of melatonin, assessed by the length of hospital and ICU stay, the in-hospital mortality, and the incidence of adverse events. This meta-analysis was performed using RevMan 5.3.

Results: We identified 11 RCTs with 2,020 patients. Incidence of postoperative delirium was lower in melatonin group compared to control group (risk ratio [RR], 0.61; 95% CI, 0.39 to 0.95; I^2 = 72%; P = 0.03). In subgroup analysis for delirium incidence according to follow-up periods (early period; up to 3 days, late period; 7 days~2weeks), incidence of delirium in melatonin group was significantly lower at early period in melatonin group (RR, 0.43; 95% CI, 0.25 to 0.74; I^2 = 72%; P = 0.03), however that was not significantly changed at late period (RR, 0.97; 95% CI, 0.64 to 1.47; I^2 = 49%; P = 0.87) compared to control group. There were no differences in the length of hospital stay (MD, 1.76 days; I^2 = 97%; P = 0.41), the length of ICU stay (MD, -0.13 days; I^2 = 0%; P = 0.81), in-hospital mortality (RR, 1.43; I^2 = 0%; P = 0.31). There were no bene fits or harms of melatonin were demonstrated for the incidence of adverse event such as nausea (RR, 0.63; P = 0.75), dizziness (RR, 2.28; P = 0.29), hypotension (RR, 2.30; P = 0.75), headache (RR, 0.90; P = 0.89) and GI disorders (RR, 2.20; P = 0.12) among groups. Serious adverse events were not reported in any studies.

Conclusion: The use of perioperative use of melatonin decrease the incidence of postoperative delirium especially early postoperative period (up to 3 days) in patients undergoing surgery. However, this meta-analysis was limited by the small number of RCTs and high heterogeneity. In the future, adequately powered clinical trials are warranted to provide more certainty on the use of melatonin for the prevention of postoperative delirium.

keywords: Delirium, Melatonin, Postoperative, Surgery

Reference

1. Forad AH, et al. The Heathy Heart-Mind Trial: randomized controlled trial of melatonin for prevention of delirium. J Am Geriatr Soc 2020; 68: 112-119.
2. Ng KT, et al. The effect of melatonin on delirium in hospitalized patients: A systematic review and meta-analysis with trial sequential analysis. J Clin Anesth 2020; 59: 74-81.

P-4

Easily applicable negative pressure tent for COVID-19 patient who need airway management

Seong-Ho Ok[1,2], Miyeong Park[1], Ju-Tae Sohn[2], Heon-Keun Lee[2]

[1]Department of Anesthesiology and Pain Medicine, Gyeongsang National University Changwon Hospital
[2]Department of Anesthesiology and Pain Medicine, Gyeongsang National University College of Medicine

Introduction

According to the WHO report, new cases of COVID-19 decreased until Jan. 2021 at the peak of December last year, but the number of new cases has increased again, reaching 11.92 million.
For safety of health worker, The Korean Society of Anesthesiologists recommended to use another room for tracheal intubation before general anesthesia or apply rapid sequence intubation with minimal mask bagging by expert anesthesiologist. We prepared a new method suitable for our situation and practiced before this case and could perform the airway management of COVID-19 patient for general anesthesia safely and economically.

Preparation for COVID-19 patient

*Design and production of easily applicable negative presser tent
*Training of tracheal intubation and extubation in new negative pressure tent
*Simulation of the expected course during anesthesia on the day of surgery

Clinical Course

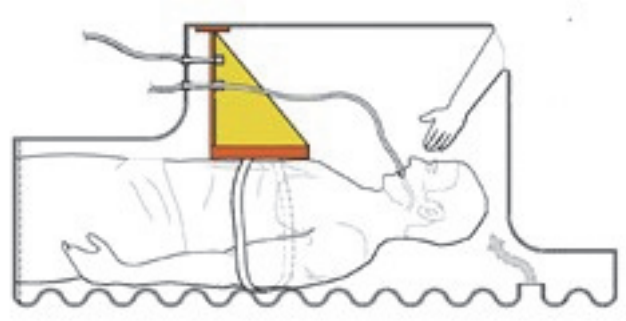
1. Admission to OR using a Patient Isolation Transportation Unit (PITU)
2. Open the PITU to cover patient with new negative pressure tent
3. Patient monitoring and start of induction
4. Tracheal intubation with Videolaryngoscope
5. Connect to circuit of anesthesia machine and check EtCO2
6. Remove negative pressure tent and move the patient from PITU to operation table
7. Laparoscopic appendectomy was done in 35 min

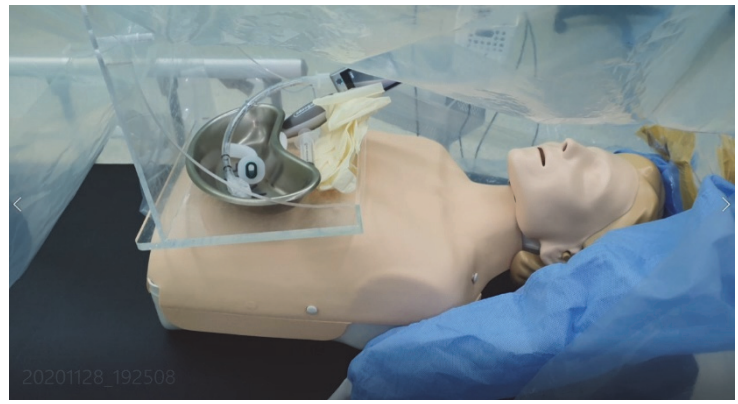
8. Return the intubated patient to opened PITU and cover with negative pressure tent
9. Bridion for reversal of muscle relaxation and extubation
10. Build up PITU after removal of the tent
11. Transfer the patient to ICU

Discussion

*The COVID-19 may be aerosolized more easily than influenza and stay in the air longer.
*A 30-minute period is needed for aerosol clearing of room with 12 air changes per hour after intubation and extubation.
*We thought our easily applicable negative pressure tent with wall suction could efficiently reduce the space for air could be contaminated by aerosol during tracheal intubation and extubation.

keywords: negative pressure tent, aerosol





P-5

The efficacy of scalp nerve block for postoperative pain management in microvascular decompression for hemifacial spasm: A randomized clinical trial

권지혜, 정익수, 이정진

성균관대학교 삼성서울병원 마취통증의학과

Background: Microvascular decompression (MVD) via lateral suboccipital approach to the cerebellopontine angle is widely performed as the preferred method for treating hemifacial spasm (HFS). Since it is a region where many nerves exist (lesser occipital nerve, posterior auricular nerve, etc.), the immediate postoperative pain is usually severe compared to other surgeries and persistent chronic pain or dysesthesia that require a treatment is not rare. Thus, the aim of this study was to evaluate the efficacy of scalp nerve block in patients undergoing MVD for HFS.

Patients and method: From January 2021 to March 2021, 13 adult patients undergoing MVD was randomly assigned into a nerve block (NB) group (6 cases) or control group (7 cases). Patients in NB group received a preoperative scalp nerve block (18-22ml of 0.5% ropivacaine) targeting the ipsilateral greater auricular nerve, lesser occipital nerve, greater occipital nerve, supraorbital nerve, and contralateral greater occipital nerve. Patients in the control group did not receive nerve block. Propofol-remifentanil based total intravenous anesthesia was conducted for both groups. The primary outcome was total opioid consumption (the morphine equivalent dose) during postoperative 24 hours. Secondary outcomes included visual analogue scale (VAS), quality of patient recovery at 24 hour using the quality of recovery (QoR), and hospital stay.

Result: The total opioid consumption at 24 hour was significantly lower in the NB group than control group (3.75mg [0-3.75] and 4.5mg [3.75-7.5], P =0.047). The QoR score was not significantly different between two groups (122 [110-130.5] and 121 [107-133], P =0.714). VAS was 2 [2-3] vs. 3 [2-4], respectively (P=0.056) and hospital stay was 6 [6-7] vs 7 [6-7] days, respectively (P=0.622).

Conclusion: In MVD for HFS, preoperative scalp nerve block may provide better pain relieve. Larger study is needed to confirm the efficacy of scalp block in this population.

keywords: Scalp block, Microvascular decompression, Hemifacial spasm

P-6

Incidence and predictors of intraoperative coughing during neurosrugery under general anesthesia without intraoperative neuromuscular blockade

최승은, 김윤정, 오형민, 박희평

서울대학교 의과대학 마취통증의학과

Background: Endotracheal tube can induce some discomfort secondary to irritation of the tracheal mucosa, resulting in coughing. We retrospectively investigated the incidence and predictors of intraoperative coughing during neurosurgery under general anesthesia without intraoperative neuromuscular blockade.

Methods: A total of 571 neurosurgical patients who underwent total intravenous anesthesia, tracheal intubation and no intraoperative neuromuscular blockade were included. Demographic data (sex, age, height, and weight), surgical data (type, position, and duration) and continuous data from ventilator (peak inspiratory pressure [PIP], positive end expiratory pressure and tidal volume), infusion pumps (effect site concentration [Ce] of propofol and remifentanil), and bispectral index monitor (bispectral index and frontal electromyogram [fEMG]) were obtained from electronic medical records and registry files. Intraoperative coughing was screened and confirmed in cases where PIP exceeded 40 cmH_2O during surgery.

Results: Intraoperative coughing occurred in 47 (8.2%) patients and was observed in the first and last 10% of the operation time in 14 (2.5%) and 11 (1.9%) patients, respectively. In multivariable logistic regression analysis, prone position (vs. supine position) (odds ratio [95% confidence interval] 0.29 [0.14-0.60], P = 0.001), Ce of remifentanil (ng/mL) (odds ratio [95% confidence interval] 0.63 [0.47-0.85], P = 0.002), fEMG (dB) (odds ratio [95% confidence interval] 1.06 [1.02-1.10], P = 0.006), PIP (cmH_2O) (odds ratio [95% confidence interval] 1.14 [1.03-1.26], P = 0.012) were significantly associated with intraoperative coughing.

Conclusions: The incidence of intraoperative coughing was 8.2% in neurosugical patients receiving general anesthesia without intraoperative neuromuscular blockade. Supine position (vs. prone position), low Ce of remifentanil, high fEMG, and high PIP were predictive of intraoperative coughing in such patients.

keywords: Intraoperative coughing, neurosurgery

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85	**변효진**	서울특별시 서대문구 연세로 50 (신촌동)	신촌세브란스병원 마취통증의학과
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87	**서대희**	서울특별시 노원구 동일로 1342	상계백병원 마취통증의학과
88	**서형석**	서울특별시 강동구 동남로 892 (상일동)	강동 경희대학교병원 마취통증의학과
89	**성태윤**	대전광역시 서구 관저동로 158	건양대학교병원 마취통증의학과
90	**손제도**	대구광역시 중구 국채보상로 536	으뜸병원
91	**손주태**	경상남도 진주시 강남로 79 (칠암동)	경상대학교병원 마취통증의학과
92	**손지선**	전라북도 전주시 덕진구 건지로 20	전북대학교병원 마취통증의학과
93	**송영**	서울특별시 강남구 언주로 211	강남세브란스병원 마취통증의학과
94	**송현**	광주광역시 동구 필문대로 365	조선대학교병원 마취통증의학과
95	**신상욱**	부산광역시 서구 구덕로 179 (아미동1가)	부산대학교병원 마취통증의학과
96	**신영덕**	충청북도 청주시 흥덕구 1순환로 776	충북대학교병원 마취통증의학과
97	**신용섭**	대전광역시 중구 문화로 282	충남대학교병원 마취통증의학과
98	**신유솜**	부산광역시 서구 감천로 262(암남동)	고신대학교 복음병원 마취통증의학과
99	**신일동**	충청북도 청주시 흥덕구 1순환로 776	충북대학교병원 마취통증의학과
100	**신혜란**	인천광역시 중구 인항로 27 (신흥동3가)	인하대학교병원 마취통증의학과
101	**신혜원**	서울특별시 성북구 인촌로 73 (안암동5가)	고려대학교 안암병원 마취통증의학과
102	**양성원**	서울 서초구 반포대로 222	서울성모병원 마취통증의학과
103	**연준흠**	서울특별시 노원구 동일로 1342	상계백병원 마취통증의학과
104	**오미경**	경기도 구리시 경춘로 153	한양대학교 구리병원 마취통증의학과
105	**오아영**	경기도 성남시 분당구 구미로173번길 82 (구미동)	분당서울대학교병원 마취통증의학과
106	**오용석**	경기 안성시 양성면 덕봉서원로 387-45	우창마취과
107	**오윤미**	부산광역시 부산진구 복지로 75(개금동 633-165)	부산백병원 마취통증의학과
108	**오탁규**	경기도 성남시 분당구 구미로173번길 82 (구미동)	분당서울대학교병원 마취통증의학과
109	**오형민**	서울특별시 종로구 대학로 101	서울대학교병원 마취통증의학과

No.	성 명	주 소	병 원
110	**옥성호**	경남 창원시 성산구 삼정자로 11	창원경상대학병원 마취통증의학과
111	**옥회경**	부산광역시 중구 중구로 121 (대청동4가)	메리놀병원
112	**유건희**	서울특별시 서초구 반포동 505	강남성모병원 마취통증의학과
113	**유병훈**	서울시 노원구 동일로 1342	인제대학교 상계백병원 마취통증의학과
114	**유안희**	서울특별시 동대문구 경희대로 23 (회기동)	경희대학교병원 마취통증의학과
115	**유해선**	서울특별시 성북구 인촌로 73 (안암동5가)	고려대학교 안암병원 마취통증의학과
116	**윤경섭**	서울특별시 성북구 인촌로 73 (안암동5가)	고려대학교 안암병원 마취통증의학과
117	**윤명하**	광주광역시 동구 학 1동 8	전남대학교병원 마취통증의학과
118	**윤앤미선**	대전광역시 중구 문화로 282	충남대학교병원 마취통증의학과
119	**윤지욱**	경상남도 양산시 물금읍 금오로 20	양산 부산대학교병원 마취통증학과
120	**이계홍**	서울특별시 성북구 인촌로 73 (안암동5가)	고려대학교 안암병원 마취통증의학과
121	**이기화**	부산광역시 해운대구 해운대로 875(좌동)	해운대백병원 마취통증의학과
122	**이도원**	부산광역시 서구 구덕로 179 (아미동1가)	부산대학교병원 마취통증의학과
123	**이동헌**	경상남도 창원시 의창구 창이대로 45 (명서동)	창원파티마병원
124	**이보라**	서울특별시 서대문구 연세로 50 (신촌동)	신촌세브란스병원 마취통증의학과
125	**이봉재**	서울특별시 강동구 동남로 892 (상일동)	강동 경희대학교병원 마취통증의학과
126	**이상석**	서울특별시 노원구 동일로 1342	상계백병원 마취통증의학과
127	**이선열**	대전광역시 중구 문화로 282	충남대학교병원 마취통증의학과
128	**이성호**	경상남도 창원시 마산회원구 팔용로 158	삼성창원병원 마취통증의학과
129	**이세진**	서울특별시 용산구 대사관로 59	순천향대학교 서울병원 마취통증의학과
130	**이소영**	대구광역시 남구 두류공원로17길 33	대구가톨릭대학교병원 마취통증의학과
131	**이수희**	경상남도 진주시 강남로 79 (칠암동)	경상대학교병원 마취통증의학과
132	**이슬기**	경북 포항시 남구 희망대로 352	에스포항병원
133	**이승철**	부산광역시 서구 대신공원로 26	동아대학교병원 마취통증의학과
134	**이애령**	제주특별자치도 제주시 제주대학로 102 (아라일동)	제주대학교병원 마취통증의학과
135	**이영준**	인천광역시 부평구 동수로 56	인천성모병원 마취통증의학과
136	**이왕규**	경상남도 창원시 마산회원구 팔용로 158	삼성창원병원 마취통증의학과
137	**이윤기**	서울특별시 서초구 반포동 505	강남성모병원 마취통증의학과

No.	성 명	주 소	병 원
138	**이윤석**	경기도 고양시 일산동구 동국로 27	동국대학교 일산병원 마취통증의학과
139	**이일옥**	서울특별시 구로구 구로동로 148 (구로동)	고려대학교 구로병원 마취통증의학과
140	**이재호**	울산광역시 동구 방어진순환도로 873	울산대학교병원 마취통증의학과
141	**이재훈**	서울특별시 서대문구 연세로 50 (신촌동)	신촌세브란스병원 마취통증의학과
142	**이정림**	서울특별시 서대문구 연세로 50 (신촌동)	신촌세브란스병원 마취통증의학과
143	**이정만**	서울특별시 동작구 여의대방로20길 33	서울대학교 보라매병원 마취통증의학과
144	**이정우**	전라북도 전주시 덕진구 건지로 20	전북대학교병원 마취통증의학과
145	**이정원**	대구광역시 중구 동덕로 130	경북대학교병원 마취통증의학과
146	**이정은**	대구광역시 중구 동덕로 130	경북대학교병원 마취통증의학과
147	**이정진**	서울특별시 강남구 일원로 81	삼성서울병원 마취통증의학과
148	**이정한**	부산광역시 부산진구 복지로 75(개금동 633-165)	부산백병원 마취통증의학과
149	**이준호**	전라북도 전주시 덕진구 건지로 20	전북대학교병원 마취통증의학과
150	**이지영**	서울 서초구 반포대로 222	서울성모병원 마취통증의학과
151	**이지원**	서울특별시 강남구 언주로 211	강남세브란스병원 마취통증의학과
152	**이지현**	부산광역시 서구 대신공원로 26	동아대학교병원 마취통증의학과
153	**이태규**	경기도 성남시 분당구 야탑로 59	분당차병원 마취통증의학과
154	**이한나**	서울특별시 종로구 대학로 101	서울대학교병원 마취통증의학과
155	**이헌석**	경상남도 양산시 강변로 442	단디병원
156	**이현정**	부산광역시 서구 구덕로 179 (아미동1가)	부산대학교병원 마취통증의학과
157	**이형곤**	광주광역시 동구 학 1동 8	전남대학교병원 마취통증의학과
158	**인준용**	경기도 고양시 일산동구 동국로 27	동국대학교 일산병원 마취통증의학과
159	**인치범**	대전광역시 서구 관저동로 158	건양대학교병원 마취통증의학과
160	**임경준**	광주광역시 동구 필문대로 365	조선대학교병원 마취통증의학과
161	**임병건**	서울특별시 구로구 구로동로 148 (구로동)	고려대학교 구로병원 마취통증의학과
162	**임영진**	서울특별시 종로구 대학로 101	서울대학교병원 마취통증의학과
163	**임채성**	대전광역시 중구 문화로 282	충남대학교병원 마취통증의학과
164	**임형선**	전라북도 전주시 덕진구 건지로 20	전북대학교병원 마취통증의학과
165	**장영은**	서울특별시 종로구 대학로 101	서울대학교병원 마취통증의학과

No.	성 명	주 소	병 원
166	**장철호**	서울특별시 강남구 언주로 211	강남세브란스병원 마취통증의학과
167	**전소은**	부산광역시 서구 구덕로 179 (아미동1가)	부산대학교병원 마취통증의학과
168	**전영태**	경기도 성남시 분당구 구미로173번길 82 (구미동)	분당서울대학교병원 마취통증의학과
169	**전영훈**	대구광역시 중구 동덕로 130	경북대학교병원 마취통증의학과
170	**정성태**	광주광역시 동구 제봉로 42	전남대학교병원 마취통증의학과
171	**정성태**	광주광역시 동구 학 1동 8	전남대학교병원 마취통증의학과
172	**정양훈**	경기도 부천시 원미구 조마루로 170	순천향대학교 부천병원 마취통증의학과
173	**정우석**	대전광역시 중구 문화로 282	충남대학교병원 마취통증의학과
174	**정종권**	인천광역시 중구 인항로 27 (신흥동3가)	인하대학교병원 마취통증의학과
175	**정준영**	서울특별시 강동구 동남로 892 (상일동)	강동 경희대학교병원 마취통증의학과
176	**정지선**	서울특별시 강남구 일원로 81	삼성서울병원 마취통증의학과
177	**정진용**	대구광역시 남구 두류공원로17길 33	대구가톨릭대학교병원 마취통증의학과
178	**정창영**	광주광역시 동구 학 1동 8	전남대학교병원 마취통증의학교실
179	**정훈**	대구광역시 북구 대학로 80 (산격동)	경북대학교병원 마취통증의학과
180	**정흥관**	경북 포항시 북구 용흥로 36	포항의료원 마취통증의학과
181	**제이경**	서울특별시 성북구 인촌로 73 (안암동5가)	고려대학교 안암병원 마취통증의학과
182	**조관상**	경북 포항시 남구 희망대로 352	에스포항병원
183	**조아나**	서울특별시 용산구 대사관로 59	순천향대학교 서울병원 마취통증의학과
184	**조아름**	부산광역시 서구 구덕로 179 (아미동1가)	부산대학교병원 마취통증의학과
185	**조영일**	경상남도 진주시 강남로 79 (칠암동)	경상대학교병원 마취통증의학과
186	**조춘규**	대전광역시 서구 관저동로 158	건양대학교병원 마취통증의학과
187	**조한범**	경기도 수원시 영통구 월드컵로 164	아주대학교병원 마취통증학과
188	**주지연**	서울특별시 노원구 동일로 1342	상계백병원 마취통증의학과
189	**지상환**	서울특별시 종로구 대학로 101	서울대학교병원 마취통증의학과
190	**지슬기**	서울특별시 구로구 구로동로 148 (구로동)	고려대학교 구로병원 마취통증의학과
191	**진석준**	서울특별시 송파구 올림픽로43길 88	서울아산병원 마취통증의학과
192	**최승호**	서울특별시 서대문구 연세로 50 (신촌동)	신촌세브란스병원 마취통증의학과
193	**최영림**	경북 포항시 남구 희망대로 352	에스포항병원

No.	성 명	주 소	병 원
194	**최은미**	서울특별시 영등포구 신길로 1	강남성심병원 마취통증의학과
195	**최인철**	서울특별시 송파구 올림픽로43길 88	서울아산병원 마취통증의학과
196	**최재찬**	강원도 원주시 일산로 20	원주세브란스기독병원 마취통증의학과
197	**최정일**	광주광역시 동구 학 1동 8	전남대학교병원 마취통증의학과
198	**최준권**	경기도 고양시 일산동구 동국로 27	동국대학교 일산병원 마취통증의학과
199	**하상희**	서울특별시 서대문구 연세로 50 (신촌동)	신촌세브란스병원 마취통증의학과
200	**하승일**	서울특별시 송파구 올림픽로43길 88	서울아산병원 마취통증의학과
201	**한동우**	서울특별시 강남구 언주로 211	강남세브란스병원 마취통증의학과
202	**한성희**	경기도 성남시 분당구 구미로173번길 82 (구미동)	분당서울대학교병원 마취통증의학과
203	**홍부휘**	대전광역시 중구 문화로 282	충남대학교병원 마취통증의학과
204	**홍정민**	부산광역시 서구 구덕로 179 (아미동1가)	부산대학교병원 마취통증의학과
205	**홍지수**	서울특별시 성북구 인촌로 73 (안암동5가)	고려대학교 안암병원 마취통증의학과
206	**황부영**	부산광역시 서구 구덕로 179 (아미동1가)	부산대학교병원 마취통증의학과
207	**황성미**	강원도 춘천시 삭주로 77	춘천성심병원 마취통증의학과
208	**황정원**	경기도 성남시 분당구 구미로173번길 82 (구미동)	분당서울대학교병원 마취통증의학과
209	**황진영**	서울특별시 동작구 여의대방로20길 33	서울대학교 보라매병원 마취통증의학과

대한뇌신경마취학회 운영위원회

직 책	성 함	소 속
회 장	**박 성 식**	경북의대
부 회 장	**전 영 태**	서울의대
기 획 이 사	**한 동 우**	연세의대
총 무 이 사	**김 현 지**	경북의대
재 무 이 사	**임 병 건**	고려의대
학 술 이 사	**신 혜 원**	고려의대
간 행 이 사	**고 영 권**	충남의대
A P M 이 사	**정 성 태**	전남의대
연 구 이 사	**박 희 평**	서울의대
대 외 협 력 이 사	**최 승 호**	연세의대
수 련 교 육 이 사	**홍 정 민**	부산의대
정 보 이 사	**정 진 용**	대구가톨릭의대
무 임 소 이 사	**최 준 권**	동국의대
	옥 성 호	경상의대
감 사	**이 봉 재**	경희의대
자 문	**손 주 태**	경상의대

대한뇌신경마취학회 회칙

제 1 장 총 칙

제1조 (명칭) 본회는 대한뇌신경마취학회(Korean Society of Neuroscience in Anesthesiology and Critical Care, KSNACC)라 한다.

제2조 (목적) 본회의 목적은 뇌신경마취 분야의 연구와 회원 상호간의 친목을 도모하는데 있다.

제 2 장 회 원

제3조 (회원) 본회의 회원은 정회원, 준회원, 원로회원 및 특별회원으로 구성한다.

제4조 (정회원) 본회의 목적에 찬동하는 대한마취통증의학회 정회원으로 본회의 가입비와 정기회비를 납부하는 사람으로 한다. 정회원은 정기총회의 투표권과 의결권을 갖는다.

제5조 (준회원) 본회의 목적에 찬동하는 사람으로 본회 이사회에서 의결 후 정기총회에서 인준한다.

제6조 (원로회원) 본 회의 목적에 찬동하는 만 65세 이상의 대한뇌신경마취학회 정회원으로 정기회비 일체를 면제한다.

제7조 (특별회원) 본회의 발전에 기여하는 개인 또는 단체로 본회 이사회에서 의결하고 총회에 보고한다.

제 3 장 사 업

제8조 (사업) 본회의 목적을 위하여 다음 각호의 사업을 한다.

1. 정기적인 학술모임
2. 회원의 연구활동 지원
3. 회지의 발간
4. 회원간의 친목활동
5. 기타 본회의 발전을 위한 사업

제9조 (사업의 대상) 본회의 사업은 정회원을 우선적인 대상으로 한다.

제 4 장 임 원

제10조 (임원의 종류) 본 회의 임원 구성은 아래와 같다.

회장 - 1명

부회장 - 1명

이사 - 10명 내외

감사 - 1명

자문 - 약간 명

제11조 (임원의 선출 및 임기) 부회장과 감사는 정기총회에서 정회원의 직접투표에 의해 선출한다. 부회장은 차기 회장으로 자동승계 된다. 이사 및 자문은 회장이 선임한다. 임원의 임기는 2년이며 연임할 수 있다.

제12조 (임원의 의무) 본회의 임원은 아래와 같은 직무를 수행한다.

회 장 : 본회를 대표하며 총회 및 이사회의 의장이 된다.

부회장 : 이사회의 부의장이 되며, 회장 유고 시 그 업무를 담당한다.

이 사 : 이사회 위원으로 담당 업무를 수행한다.

감 사 : 본회의 회무와 재무를 감사한다.

자 문 : 전임 회장으로서 이사회에 참석하여 자문을 한다.

제 5 장 회의 및 조직

제13조 (이사회) 본회는 회무를 수행하기 위하여 이사회를 둔다. 이사회의 구성은 회장, 부회장, 이사와 자문으로 구성한다.

제14조 (회의) 본회는 회무 수행을 위하여 아래와 같은 모임을 갖는다.

1) 정기총회

2) 임시총회

제15조 (총회) 정기총회는 년1회 개최한다. 임시총회는 회장이나 정회원 1/3이상의 요구가 있으면 소집한다.

제16조 (의결정족수) 참석한 정회원 과반수의 찬성으로 의결한다.

제17조 (정기총회의 기능) 총회의 의결사항은 다음과 같다.

1. 본회의 예산, 결산에 관한 사항
2. 사업계획에 관한 사항
3. 임원선출에 관한 사항
4. 준회원의 추천에 관한 사항
5. 회칙 개정에 관한 사항
6. 기타 필요하다고 인정되는 사항

제18조 (이사회의 업무) 이사회는 아래의 사항을 수행한다.

1. 본 회 회무의 운영계획 수립 및 수행
2. 예산 편성 및 집행
3. 회원자격의 심의 의결
4. 기타 학회 운영 및 발전을 위한 사항

제 6 장 재 정

제19조 (재정수입) 본 회의 재정 수입은 다음 사항으로 이루어진다.

1. 회원의 입회비, 연회비 및 등록비
2. 특별회원의 연회비
3. 찬조금과 후원금
4. 본 회의 사업에 따른 소득

제20조 (재정지출) 본 회의 재정 지출은 다음의 사항으로 이루어진다.

1. 정기학술모임
2. 회지 발간
3. 회원의 연구활동 지원
4. 본 회의 기타 사업

제21조 (예산결산) 본 회의 예산, 결산은 정기총회의 승인을 받아야 한다.

제22조 (회계연도) 본 회의 회계연도는 매년 1월 1일부터 12월 31일로 한다.

제 7 장 벌 칙

제23조 (회원자격 상실) 정회원은 정기회비를 3회 미납하였을 시 자동적으로 회원의 자격을 상실한다. 준회원은 정기총회의 결의에 의하여 자격을 상실한다. 특별회원은 이사회에서 의결하고 총회에 보고한 후 자격을 상실한다.

제 8 장 부 칙

제24조 본 회칙에 규정되어 있지 않은 사항은 일반 관례에 따른다.

제25조 본 회칙은 1995년 1월 21일 창립 총회에서 의결함으로써 시행한다.

제26조 본 회칙은 2004년 11월 4일 정기총회에서 의결함으로써 시행한다.

제27조 본 회칙은 2007년 3월 24일 정기총회에서 의결함으로써 시행한다.

제28조 본 회칙은 2008년 3월 15일 정기총회에서 의결함으로써 시행한다.
제29조 본 회칙은 2013년 4월 6일 정기총회에서 의결함으로써 시행한다.
제30조 본 회칙은 2014년 4월 5일 정기총회에서 의결함으로써 시행한다.
제31조 본 회칙은 2016년 4월 2일 정기총회에서 의결함으로써 시행한다.

2021년 제28회 대한뇌신경마취학회 정기학술대회

인 쇄 2021년 3월 31일

발 행 2021년 4월 3일

발 행 인 박성식

편 집 인 신혜원

발 행 처 **대한뇌신경마취학회**
대구광역시 중구 동덕로 130
경북대학교병원 마취통증의학과

인 쇄 처 **다온기획**
경기도 김포시 김포한강1로 240, 블루동 403호
Tel: 031-981-2764 Fax: 031-981-2765
E-mail: daonics@naver.com