Interesting case

19 Jan 2022

R_2 Soravish Sirilertworakul

Sutira Siripoonyothai, M.D.

12 years-old female patient

Diagnosis : Adolescent idiopathic scoliosis

Operation : Scoliosis correction (PDS T_4-L_4)

R_1 History ?

History

- **Chief compliant** : แพทย์นัดผ่าตัด
- **Present illness** : Admission 03/01/2022, Operation 04/01/2022
- 1 yrPTA : Known case Adolescent idiopathic scoliosis onset at age of 10, มีอาการปวด ปวดหลังง่าย อาการปวดไม่สัมพันธ์กับท่าทาง ไม่มีอาการชาหรืออ่อนแรง ออกกำลังกายได้ปกติ ไม่มีอาการเหนื่อยง่ายกว่าเพื่อน นอนราบได้ ไม่มีหอบเหนื่อยตอนกลางคืน ไม่มีขาบวม
- 1 dPTA แพทย์นัดมาผ่าตัด อาการพอๆเดิม ไม่มีไข้ ไม่ไอน้ำมูก ไม่เหนื่อย

Scoliosis

- Scoliosis is an abnormal lateral curvature of the spine.

Idiopathic (70%)	Infantile (Birth to 3 years) Juvenile (4 years to 10 years) Adolescent (10 years to skeletal maturity)
Neuromuscular	Cerebral palsy, Poliomyelitis
Myopathic	Muscular dystrophy (e.g. Duchene)
Congenital	Hemivertebrae, Congenital fused ribs
Mesenchymal	Marfan syndrome, Osteogenesis imperfecta
Trauma	Vertebral fracture, Post-radiation

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History

- No underlying disease
- No history of drug/food allergy
- No history of smoking or alcohol drinking
- No previous anesthesia
- Functional class I

R_1 Physical examination ?

Physical Examination

- BW 47 kg. Ht 157 cm BMI 19.06 kg/m^2
- V/S : BT 36.7 °C, PR 66/min, RR 18/min BP 95/55 mmHg
- GA : Good conscious, well cooperative
- HEENT : - no pale conjunctivae, anicteric sclerae
  - no sunken eyeballs, no dry lips, no dry tongue

Physical Examination

- Heart : Normal S_1S_2, no murmur, PMI 5th ICS, no heaving, no thrill
  No engorgement of neck vein, pulse full and regular
- Lungs : No dyspnea, No Tachypnea
  Clear and equal breath sound BL, no adventitious sound
- Extremities : No edema, no ecchymosis
- Neuro : $E_4V_5M_6$, motor grade V/V all, Sensory intact
- Spine : Normal C-spine alignment
  Lateral curvature alignment of Thoraco-lumbar spine

Physical Examination

- **Airway assessment :**
  - Full neck flexion and head extension
  - Mallampati grade 1
  - Thyromental distance > 6 cm
  - Mouth opening > 3 cm
  - Normal dental examination

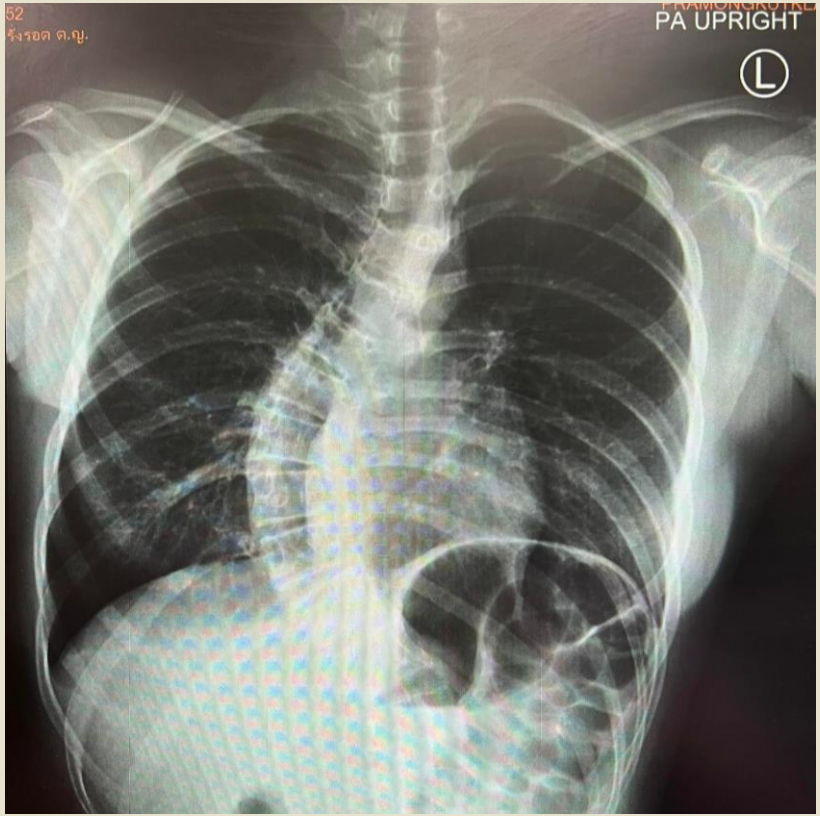
R_1 Investigation ?

Investigation

- CBC : Hb 10.3 g/dL, Hct 36.5 %, Plt 316,000/ul
- BUN 10.2 mg/dl, Cr 0.69 mg/dL (GFR 116 ml/min/1.73 m^2)
- Electrolyte : Na 139 K 3.44 Cl 104.3 HCO_3 23.4
- Covid PCR : Negative

Chest X-ray

- Scoliosis at Thoracolumbar level of Spine (Cobb angle 56°)
- No active pulmonary disease
- No cardiomegaly



Chest X-ray

Cobb angle

- Cobb angle > 40-50° ⟶ Consider surgical treatment

- Cobb angle > 60° ⟶ Associated with decrease pulmonary function

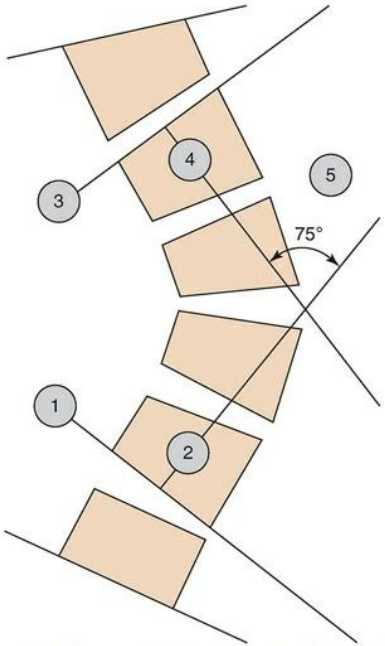


FIGURE 58.3. Measurement of the curve in scoliosis using Cobb angle. (*Reprinted with permission from Levine DB. Scoliosis.* Curr Opin Rheumatol. *1990;2[1]:190-196.*)

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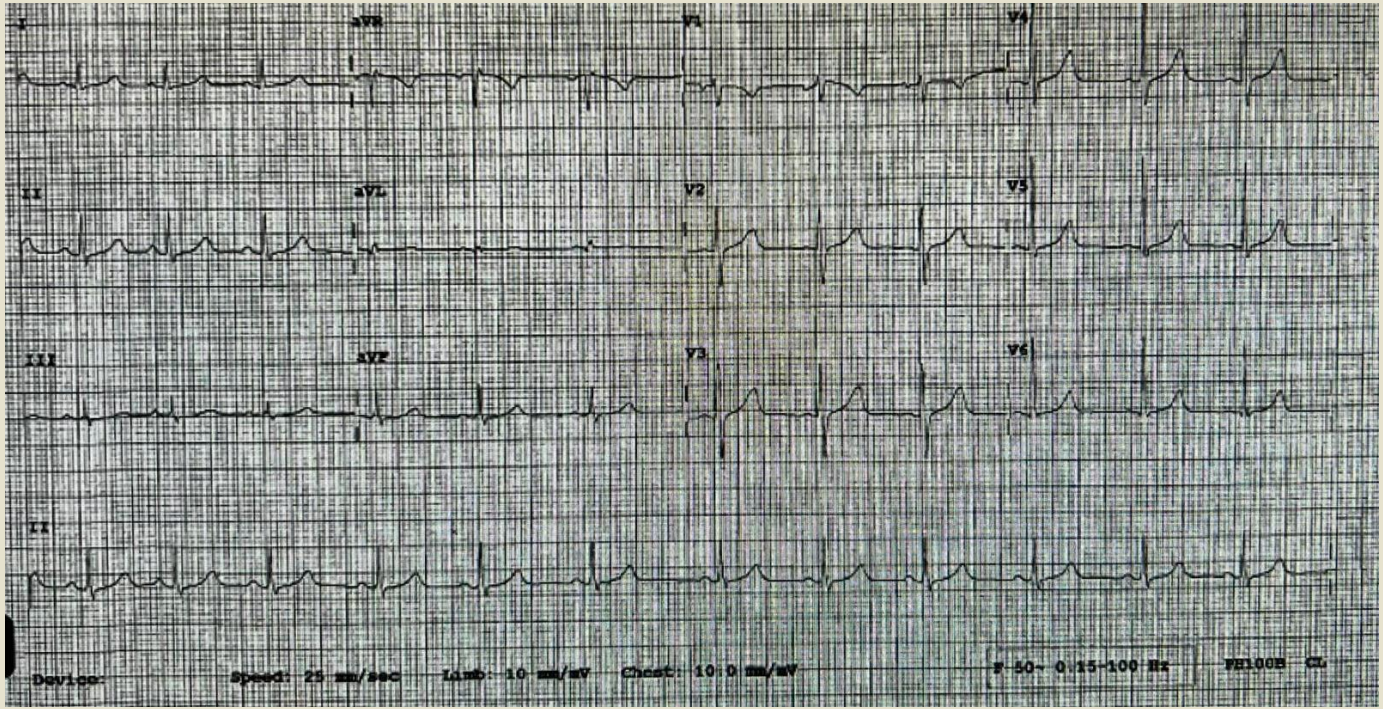
Electrocardiogram

- Normal sinus rhythm rate 75/min, no ST-T change



Electrocardiogram

- **Right ventricular hypertrophy**
  - Right axis deviation of +110 or more.
  - Dominant R wave in V1 (> 7mm tall or R/S ratio > 1).
  - Dominant S wave in V5 or V6 (> 7mm deep or R/S ratio < 1).
  - QRS duration < 120ms

- **Right ventricular strain pattern**
  - ST depression / T wave inversion in the right precordial (V1-4) and inferior (II, III, aVF) leads.

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R_1 Problem list and ASA classification ?

Problem lists

- Adolescent idiopathic scoliosis with 56° cobb angle

ASA classification

- ASA classification I

Preoperative evaluation

Preoperative evaluation

- **Patient factors**

  - Adolescent idiopathic scoliosis

  - Pediatrics (12 years old)

Adolescent idiopathic scoliosis

- Onset and etiology
- Anatomical and physiological change
- Severity of disease

Adolescent idiopathic scoliosis

- **Onset :** Lung continues to grow and develop from birth to 8 years
  (The development of significant thoracic scoliosis during this phase of rapid growth impairs lung development.)

- **Etiology :** Understanding of the etiology of the scoliosis is important
  - Associated anomaly
  - Some disease (e.g. muscular dystrophy or cerebral palsy) will influence anesthetic management.

- **Anatomical change :** Cervical or upper thoracic associated with Difficult airway

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Respiratory system

Scoliosis

- ↓ Low Lung volume
  - Hypoxemia
    - Pulmonary HT
    - Cor pulmonale
  - CO_2 retention
  - Poor sleep
- ↓ Chest wall distensibility and excursion
  - ↑ Work of breathing
  - Tachypnea
  - ↓ Poor growth
  - Exercise Tolerance
- ↓ Respiratory muscle force and movement
  - Respiratory failure

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Respiratory system

- **Assessment**

- Risk factors : Greater number of vertebrae involved, cobb angle, loss of thoracic kyphosis
  (Cobb > 60° : Significant decrease pulmonary function
  Cobb > 100° : Associated with impairment in gas exchange)

- History : Exercise tolerance, Dyspnea, Tachypnea
  ("Keep up with friends" in vigorous activities reflects good cardiopulmonary function)

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Respiratory system

- **Assessment**

  - Pulmonary function test : Consider if History of physical examination suggest decrease pulmonary function

  - Arterial blood gas : Consider if Vital capacity is significantly diminished

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Cardiovascular system

- Hypoxemia produces pulmonary vasoconstriction, an increase in pulmonary vascular resistance, and hence an increase in pulmonary arterial pressure leading to pulmonary hypertension

- Pulmonary hypertension may result in RV hypertrophy and eventually right ventricular failure.

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Cardiovascular system

- Assessment

  - Risk factors : Early onset of scoliosis, Untreated scoliosis

  - History/Examination : Sign of pulmonary hypertension or RV hypertrophy or RV failure (angina, dyspnea, tachypnea, heart sound, heaving, engorged neck vein, edema)

  - Echocardiogram : Consider if history or physical exam suggest pulmonary HT, RV failure

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Neurological system

- **Assessment**

  - Patients who have preexisting neurologic deficits are at increased risk for developing spinal cord injury during scoliosis surgery.

  - It is important to document preoperative neurologic function in order to avoid confusion about postoperative neurologic complications.

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Surgical factors

- **Scoliosis correction**
  - Intraoperative blood loss
  - Third space loss
- **Prone position**
  - Anatomical change
  - Physiological change
- **Neurological monitoring**
  - Wake up test
  - SSEP & MEP

Scoliosis correction

- **Intraoperative blood loss**

  - Risk factors : Number of fusion > 6 level, Cobb angle > 50°, Need of osteotomies, Prolong operation time

- **Third space loss**

  - Moderate third space loss (5-7 ml/kg/hr) : Replace with isotonic balanced salt solution

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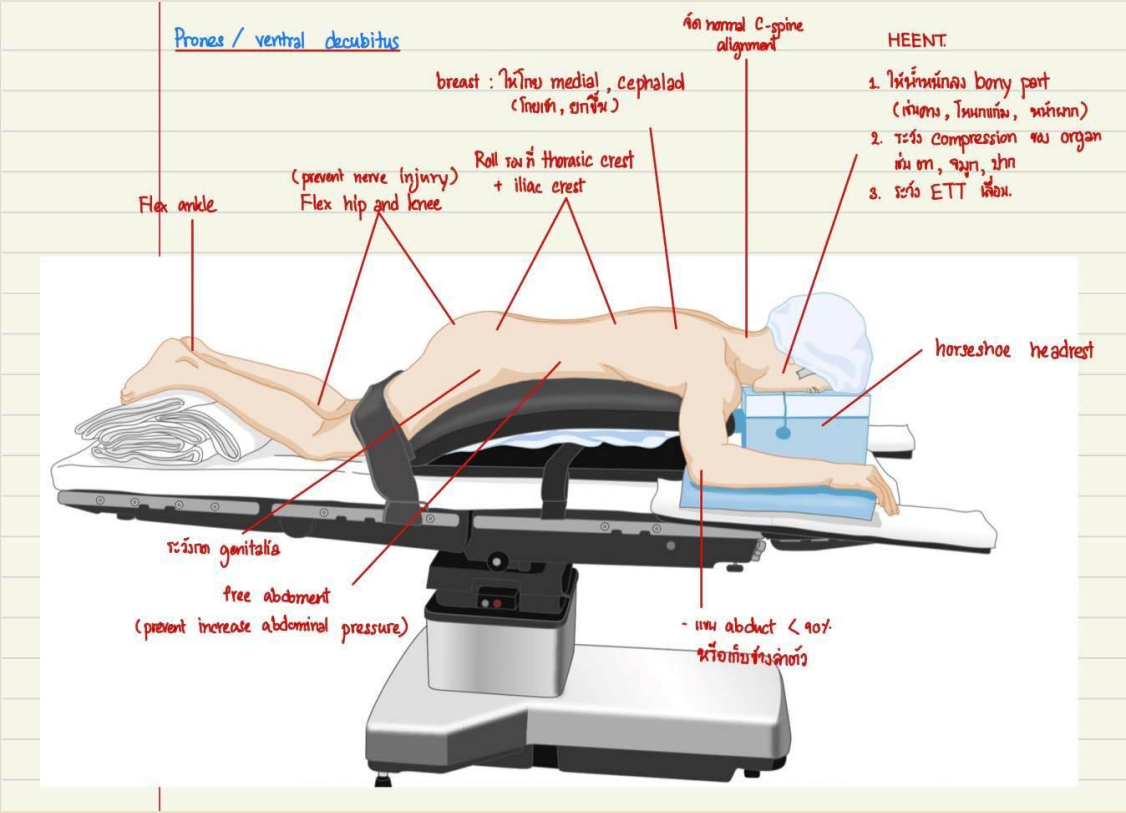
Prone position



Prone position

- Provide adequate support for head and face, Beware of ETT dislodgement
- Avoid flexion, extension, or lateral rotation of C-spine
- Avoid thoracic compression to facilitate ventilation and reduce excessive airway pressure

Gropper, M. (Ed.). (2020). *Miller's Anesthesia* (9th Edition). Elsevier.

Prone position

- Avoid abdominal compression, allowing for free movement of abdomen and reducing venacaval compression
- Maintain normal positioning of the extremities to avoid compression or stretching of peripheral nerves
- Provide liberal padding, avoiding pressure sores

Gropper, M. (Ed.). (2020). *Miller's Anesthesia* (9th Edition). Elsevier.

Neurological monitoring

- Wake up test
- Somatosensory Evoked Potential (SSEP)
- Motor evoked potentials (MEPs)

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Wake up test

- The wake-up test is used to assess the integrity of the spinal motor pathways.
- Lightening the depth of anesthesia sufficiently to allow the patient to follow commands.
- First instructed to squeeze the anesthesiologist's hand, and then asked to move his or her feet and toes.
- When the patient moves his or her feet, anesthesia is quickly deepened with small doses of propofol (0.5 mg per kg). Additional short-acting benzodiazepines may be given.

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Wake up test

- **Complication**

  - Extubation in the prone position

  - Recall of intraoperative events

  - Myocardial ischemia

  - Self-injury, and dislodgment of instrumentation or intravenous access.

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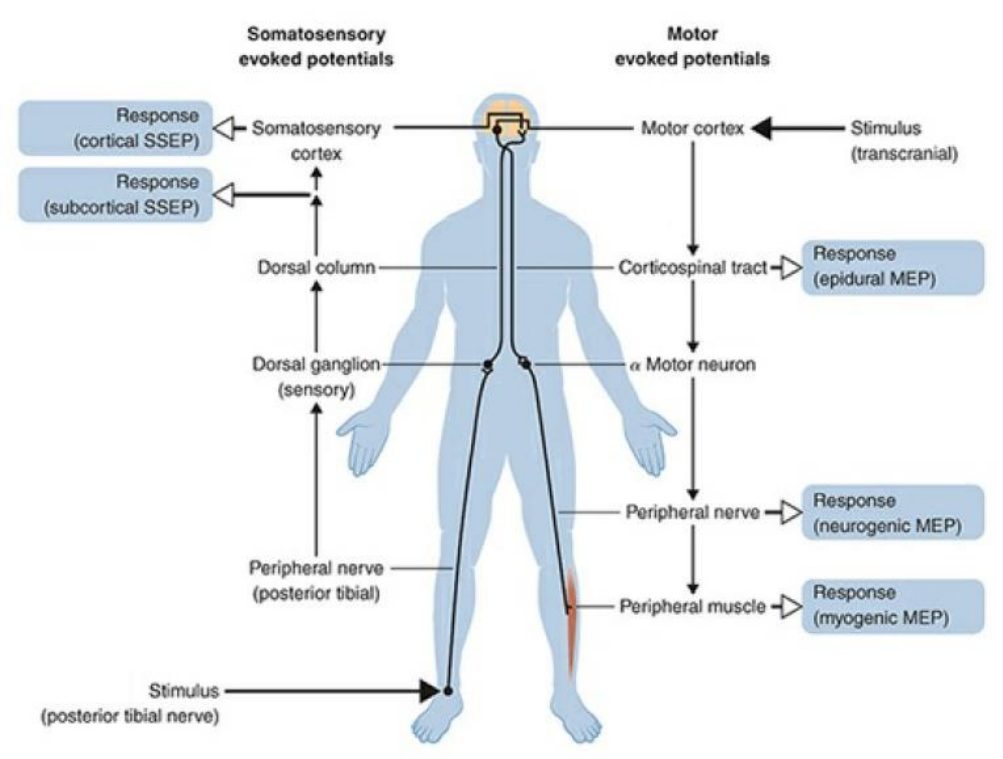
SSEP & MEPs



Cottrell, J. (2017). *Cottrell and Patel's Neuroanesthesia* (6th Edition). Elsevier.

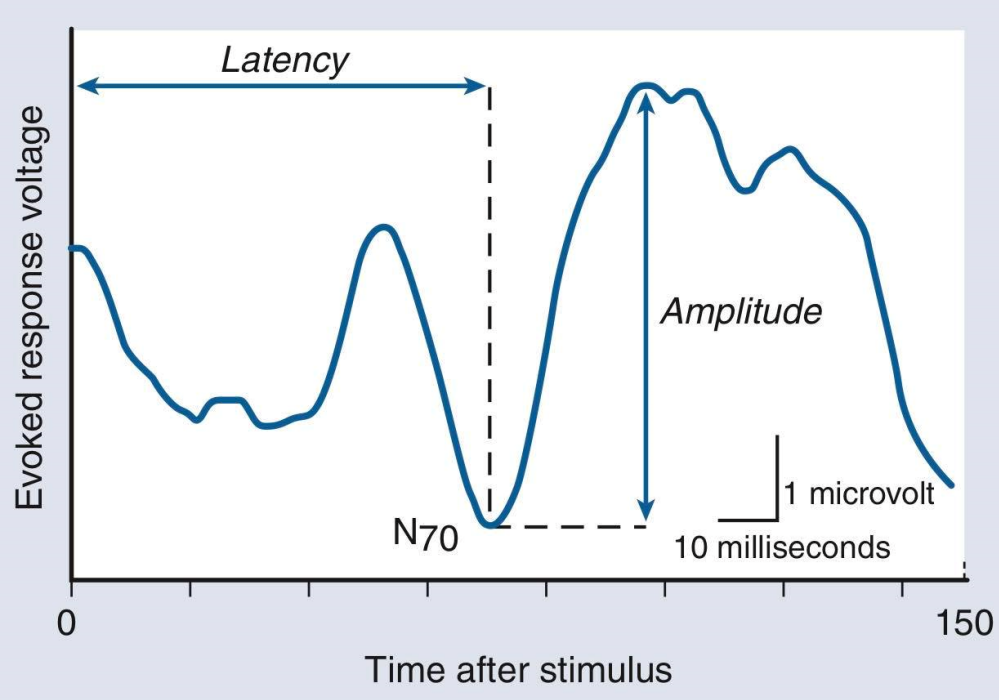
SSEP & MEPs

- As general principle :

  - Amplitude reduction of 50%

  - Latency increase of 10%

  is consider significant and raises concern.



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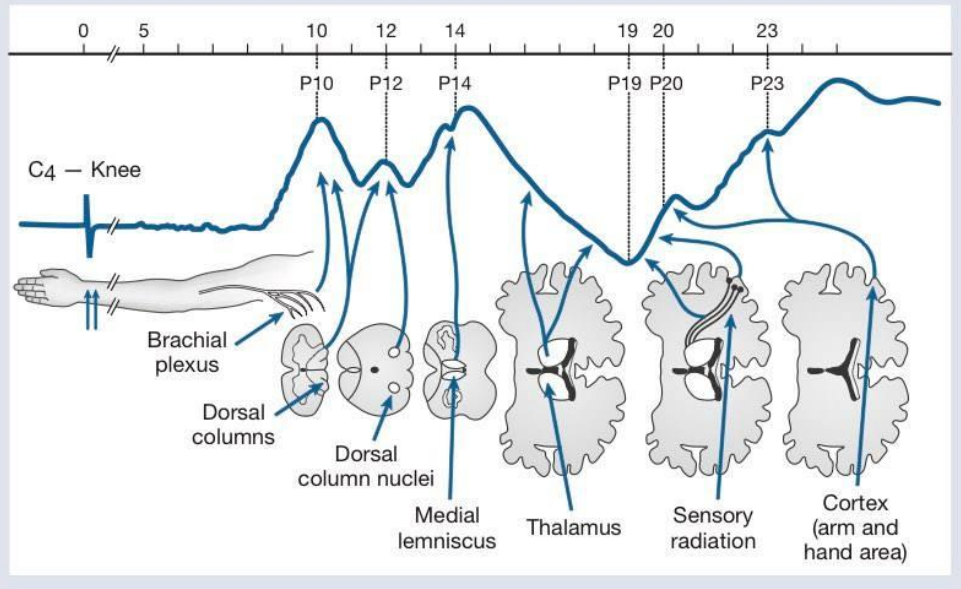
Somatosensory Evoked Potential (SSEP)



- SSEP is produced by stimulation of a peripheral sensory nerve with the response measured along the sensory pathway.

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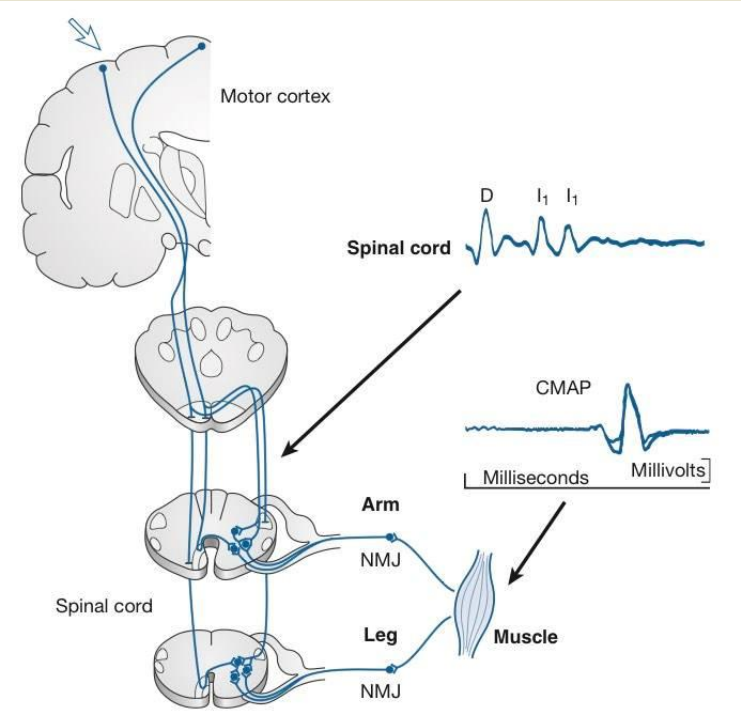
Motor evoked potentials (MEPs)



- MEP is produced by transcranial multi-pulse electrical stimulation of the motor cortex using scalp electrode.

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Case assessment

- **Patient factors** : Scoliosis

  - Onset of 10 year old, idiopathic etiology, cobb angle of 56 degree
  - Good cardiopulmonary function
  - No neurological deficit

- **Surgical factors** :

  - Intraoperative blood loss : discuss with surgeon for deliberate hypotension
  - Position : Prone position
  - Neuromuscular monitoring : SSEP & MEPs

Anesthetic consideration

Anesthetic consideration

- Intraoperative blood loss :
  - Blood conservation strategies

- Provide and anesthetic that suitable for spinal cord monitoring while providing analgesia and amnesia

- Monitor and prevention complication of spine surgery
  - Postoperative visual loss
  - Venous air embolism

- Early extubation and good postoperative pain control

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Blood conservation strategies

- Minimize intraabdominal pressure : ↑ abdominal pressure is transmitted to the vertebral venous plexus, increasing venous bleeding.

- Deliberate hypotension : Moderate controlled hypotension (MAP 50 to 65 mmHg)
  - Caution in older adult, CVD, risk for ischemic complication, POVL

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Blood conservation strategies

- Antifibrinolytic drug :

  - Tranexamic acid : Initiation dose 10-20 mg/kg or 1-2 gm, maintenance dose 1 mg/kg/hr.

  - Avoid in Thromboembolism events, renal impairment, cerebrovascular accident, pregnancy

  - It is important to administer the full loading dose before surgical incision for maximum benefit.

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Blood conservation strategies

- Isovolemic hemodilution :

  - Hematocrit is lowered 20% to 25% by removing blood aseptically and storing it in anticoagulated bags.

  - Replacing the blood with 3 times the volume of a balanced saline solution or an equal volume of colloid.

  - Intraoperatively, the previously collected blood is replaced as needed.

  - Requires careful monitoring of intravascular volume status and hemoglobin level.

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Blood conservation strategies

- Cell salvaging technique :

  - 50% to 60% of the red blood cells lost can be recovered, concentrated, washed, and returned to the patient using commercially available autotransfusion devices.

  - Lacking in platelets and plasma

  - Contraindication : Bacterial contamination of wound, Malignancy, Sickle cell disease

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Intraoperative neurophysiologic monitoring

- **Somatosensory Evoked Potential (SSEPs)**

  - Volatile anesthetics produce a dose dependent increase latency & decrease amplitude.

  - Inhalation are prominent on cortical responses , with marked depression on amplitude with 0.5-1 MAC

  - IV anesthetic agents have minimal effects on cortical SSEPs, except etomidate and ketamine

  - Dexmedetomidine and opioid appear to have minimal effect on SSEPs

  - Muscle relaxants do not effect SSEPs

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Intraoperative neurophysiologic monitoring

- **Motor evoked potentials (MEPs)**

  - MEPs are extremely sensitive to inhibitory effects of volatile anesthetic.

  - 0.25-0.5 MAC can suppress

  - Muscle relaxants suppress EMG activity and obliterate MEPs

  - Opioid cause only mild depression of MEPs

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Intraoperative neurophysiologic monitoring

- **Physiological effect on EPs**

  - Hypoxia
  - Hypocarbia
  - Hypo/hyperthermia
  - Hypotension
  - Anemia

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Intraoperative neurophysiologic monitoring

- **Acute evoked potential signal change**

  - Rule out surgical and equipment-related factor; communicate with surgeon and neuromonitoring team

  - Reposition the patient (maintain neutral alignment of spinal column)

  - Correct hypotension, metabolic abnormality, severe anemia, hypo-hyperthermia

  - Raise MAP > 85 mmHg to increase spinal cord perfusion

  - Turn off inhalation agent and switch to TIVA

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Complication of spine surgery

- Venous air embolism (VAE) :

  - Symptoms : Unexplained hypotension, ↓End tidal CO_2 , ↑End tidal nitrogen concentration

  - Treatment : - Flooding the surgical field with saline
    - Controlling sites of air entry
    - Repositioning the patient with the surgical site below the right atrium
    - Aspiration of air form central venous catheter
    - Use 100% O_2 supplement, cessation of NO_2
    - IV fluid and inotropic agent

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Complication of spine surgery

- Postoperative visual loss

  - Rare but serious complication associated spine injury

  - Major cause : optic neuropathy, retinal artery occlusion

  - Associated with complex instrumented fusion, significant sustained intraoperative hypotension, anemia, excessive blood loss, prolonged surgery

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Preoperative preparation

Preoperative preparation

- **General preparation** :

- Inform consent, assent
- NPO
- Warm isotonic crystalloid
- Force air warmer
- Anesthetic machine
- Intubation equipment
- IV Anesthetic drugs

Preoperative preparation

- **Specific preparation** :

- G/M PRC 4 u
- Large bore IV
- Arterial line
- Prone equipment
- SSEPs, MEPs
- BIS monitoring
- Syringe pump
- Postop PICU

Intraoperative management

Intraoperative management

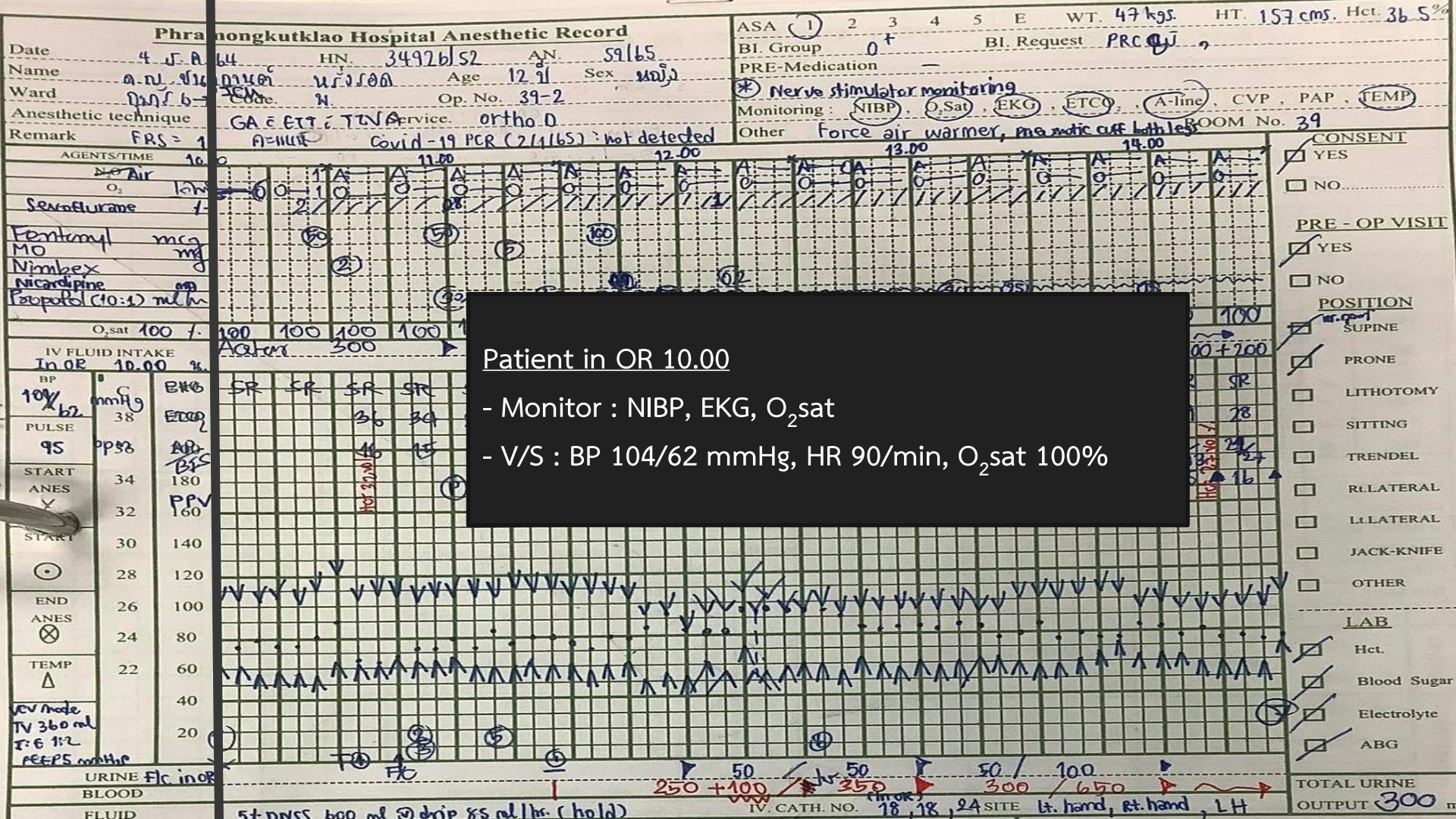
- Choice of anesthesia : GA with ETT with Controlled ventilation
- Maintenance : Inhalation (0.4 MAC) + Propofol infusion
- Position : Prone position

Intraoperative management

- Monitor : NIBP, EKG, O_2sat, Temp, $ETCO_2$, BIS, Urine output

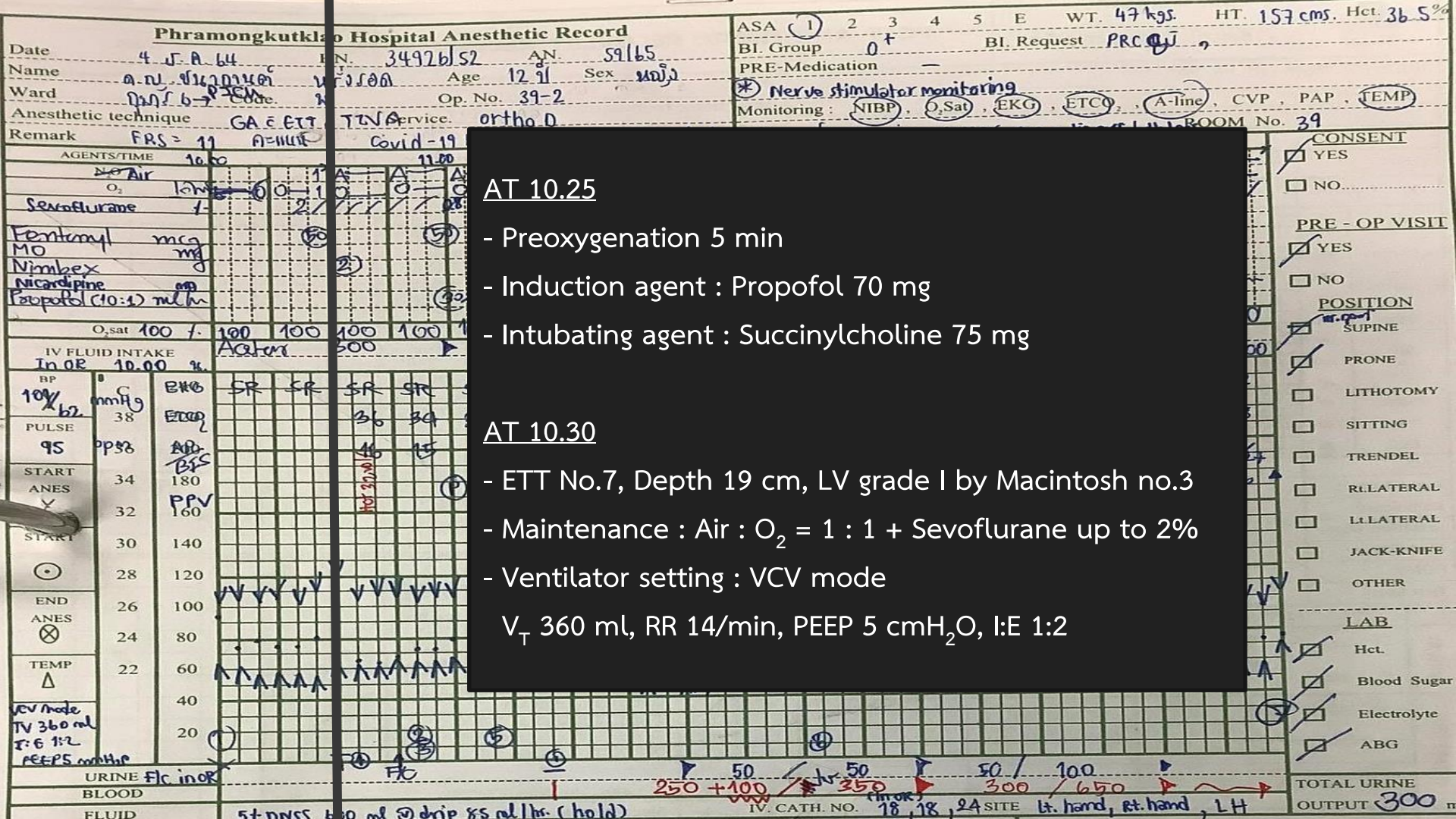
- Invasive monitoring : A-line, SSEPs, MEPs

- Blood conservation strategies : Deliberate hypotension (Keep MAP 60-65 mmHg)
  Antifibrinolytic drug (Tranexamic acid)



Patient in OR 10.00

- Monitor : NIBP, EKG, O_2sat
- V/S : BP 104/62 mmHg, HR 90/min, O_2sat 100%



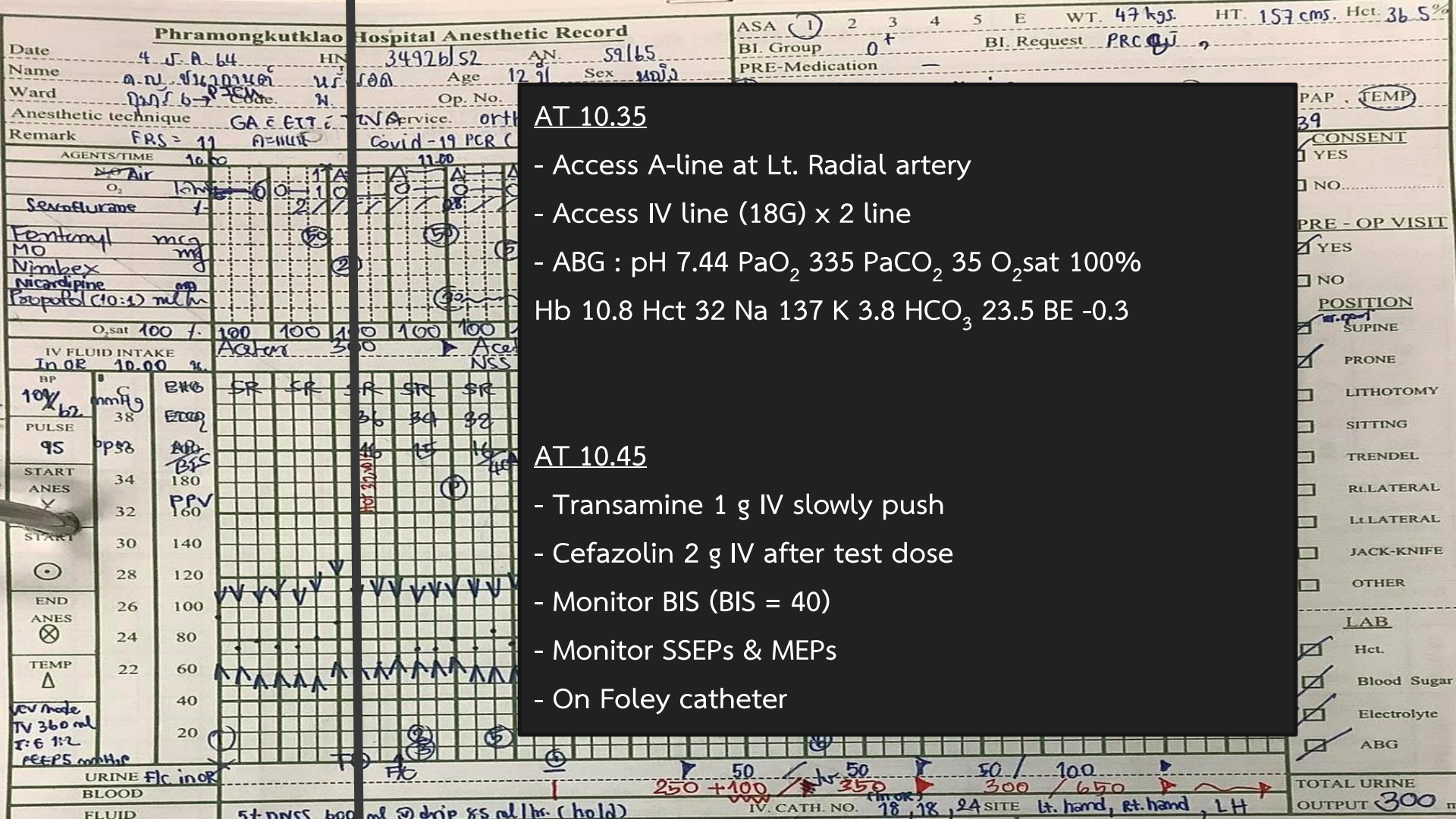
AT 10.25

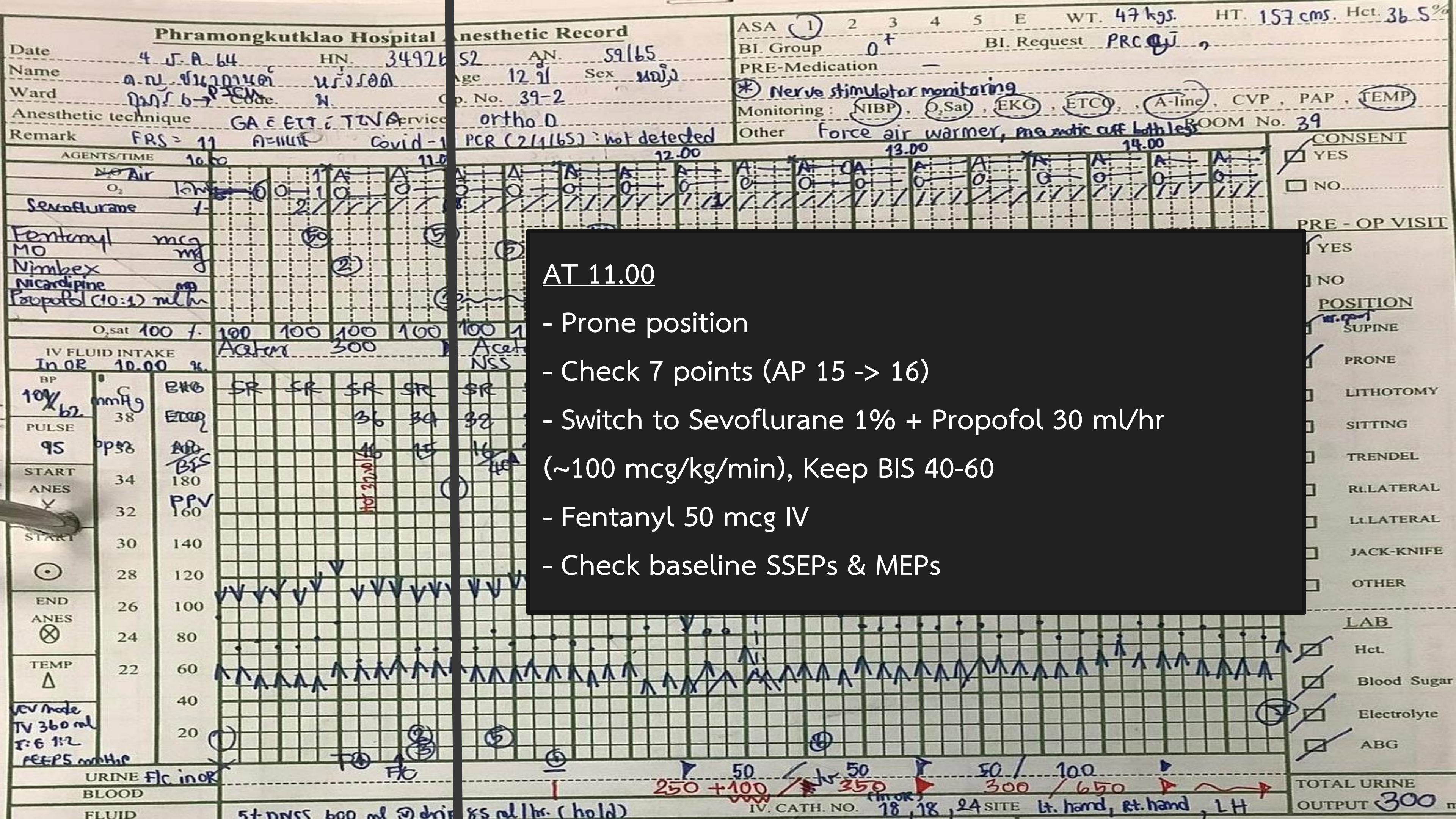
- Preoxygenation 5 min
- Induction agent : Propofol 70 mg
- Intubating agent : Succinylcholine 75 mg

AT 10.30

- ETT No.7, Depth 19 cm, LV grade I by Macintosh no.3
- Maintenance : Air : O_2 = 1 : 1 + Sevoflurane up to 2%
- Ventilator setting : VCV mode

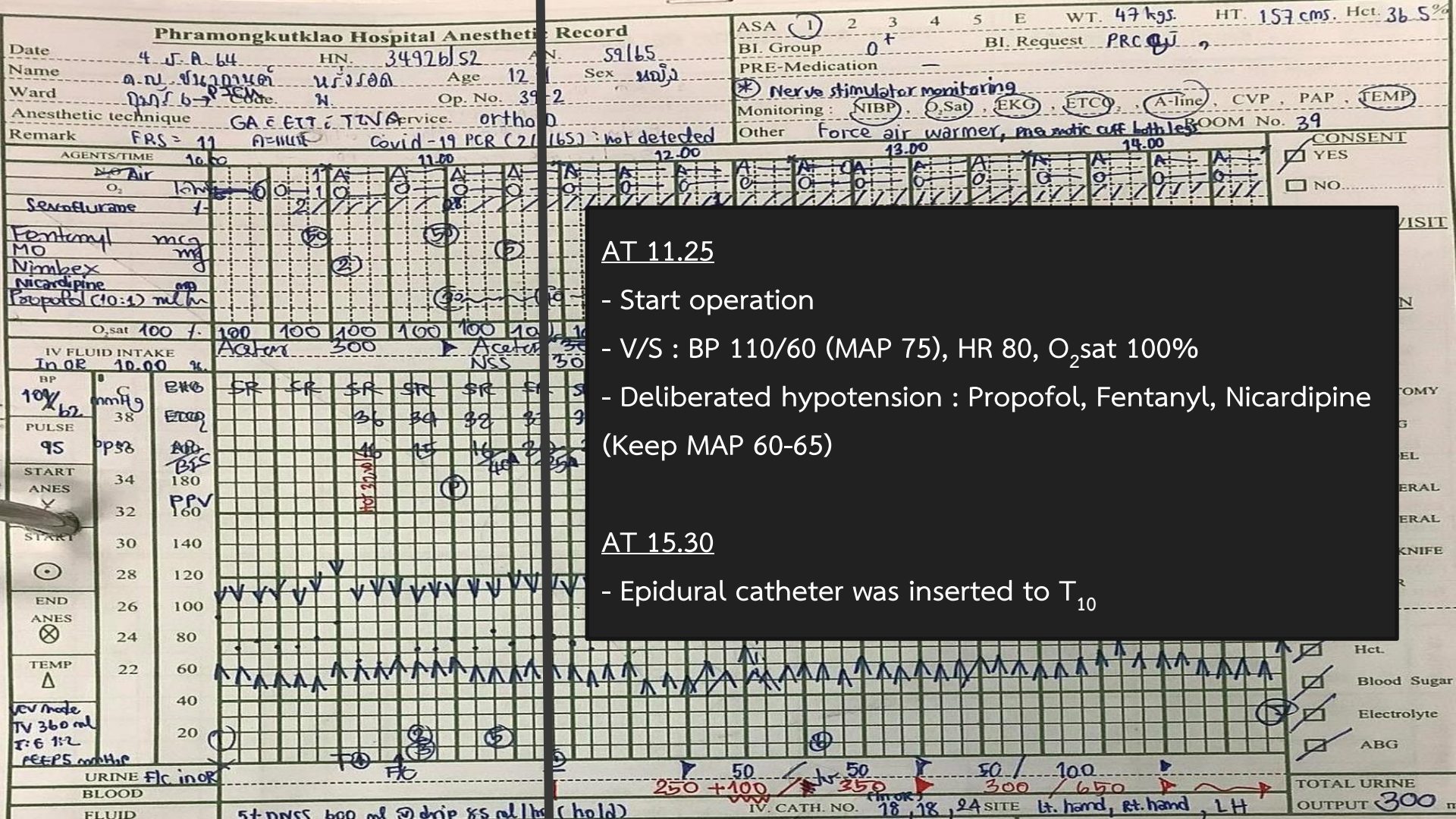
  V_T 360 ml, RR 14/min, PEEP 5 cmH_2O, I:E 1:2

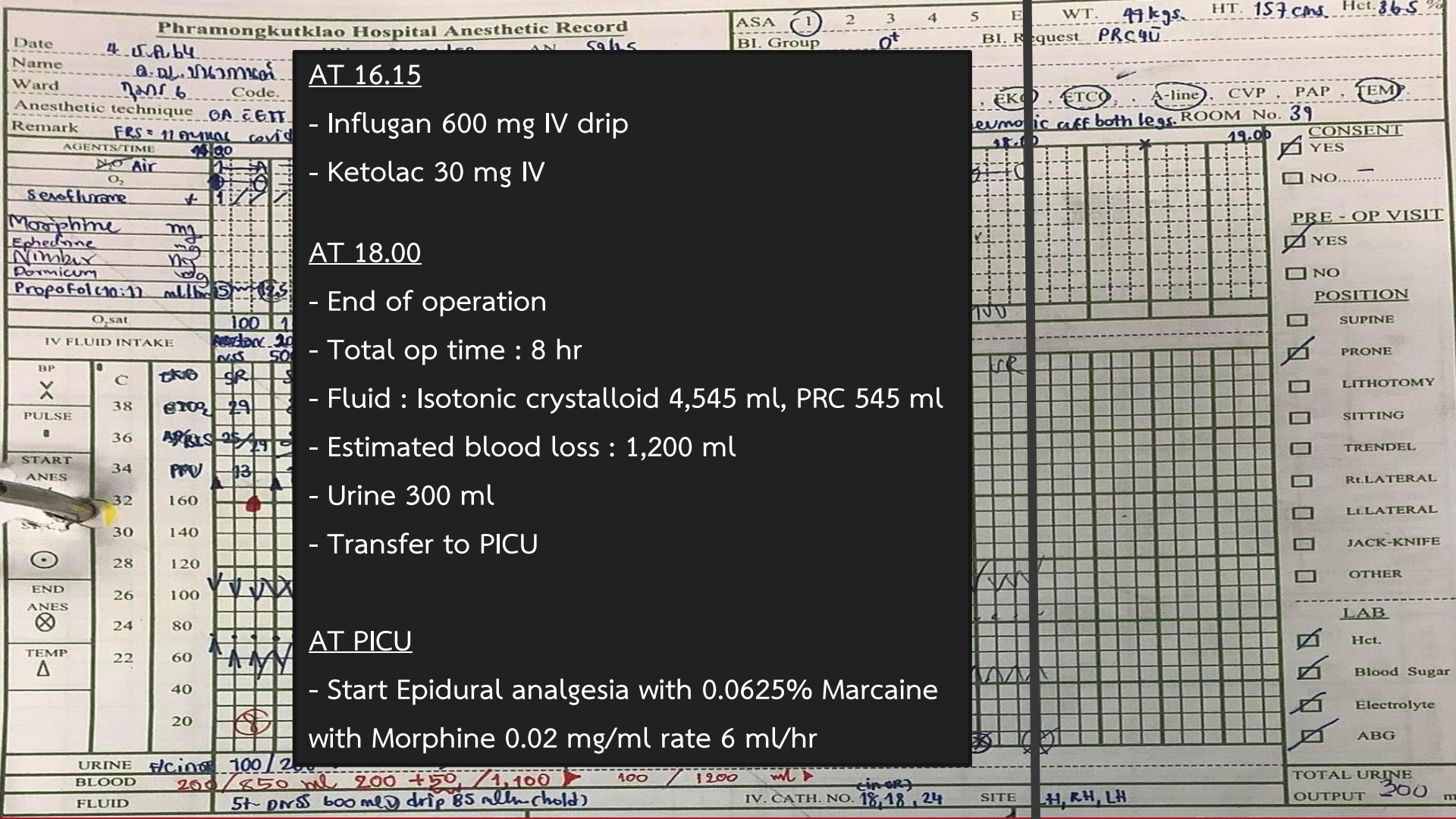

Phramongkutklao Hospital Anesthetic Record
AT 10.35
- Access A-line at Lt. Radial artery
- Access IV line (18G) x 2 line
- ABG : pH 7.44 PaO_2 335 $PaCO_2$ 35 O_2sat 100%
Hb 10.8 Hct 32 Na 137 K 3.8 HCO_3 23.5 BE -0.3
AT 10.45
- Transamine 1 g IV slowly push
- Cefazolin 2 g IV after test dose
- Monitor BIS (BIS = 40)
- Monitor SSEPs & MEPs
- On Foley catheter



<u>AT 11.00</u>

- Prone position
- Check 7 points (AP 15 -> 16)
- Switch to Sevoflurane 1% + Propofol 30 ml/hr (~100 mcg/kg/min), Keep BIS 40-60
- Fentanyl 50 mcg IV
- Check baseline SSEPs & MEPs


Phramongkutklao Hospital Anesthetic Record
Date 4 ม.ค. 64
HN. 3492652
AN. 59165
Name
Age 12
Sex
Ward
Code. N.
Op. No. 39-2
Anesthetic technique GA c ETT c TIVA
Service. ortho
Remark FRS = 11 A=111
Covid-19 PCR (21165) : not detected
ASA 1 2 3 4 5 E
WT. 47 kgs.
HT. 157 cms.
Hct. 36.5%
BI. Group O+
BI. Request PRC 1U
PRE-Medication
Nerve stimulator monitoring
Monitoring : NIBP, O2Sat, EKG, ETCO2, A-line, CVP, PAP, TEMP
Other Force air warmer, pneumatic cuff both legs
ROOM No. 39
CONSENT
YES
NO
AGENTS/TIME
Air
O2
Sevoflurane
Fentanyl
MO
Nimbex
Nicardipine
Propofol (10:1)
O2sat
IV FLUID INTAKE
In OR 10.00
Acetar 300
Acetar
NSS
BP
PULSE
START ANES
START
END ANES
TEMP
URINE F/C in OR
BLOOD
FLUID
5% DNSS 500 ml @ drip 85 ml/hr (hold)
IV. CATH. NO. 18, 18, 24 SITE Lt. hand, Rt. hand, LH
TOTAL URINE OUTPUT 300
Hct.
Blood Sugar
Electrolyte
ABG
AT 11.25
- Start operation
- V/S : BP 110/60 (MAP 75), HR 80, O2sat 100%
- Deliberated hypotension : Propofol, Fentanyl, Nicardipine (Keep MAP 60-65)
AT 15.30
- Epidural catheter was inserted to T10


Phramongkutklao Hospital Anesthetic Record
AT 16.15
- Influgan 600 mg IV drip
- Ketolac 30 mg IV
AT 18.00
- End of operation
- Total op time : 8 hr
- Fluid : Isotonic crystalloid 4,545 ml, PRC 545 ml
- Estimated blood loss : 1,200 ml
- Urine 300 ml
- Transfer to PICU
AT PICU
- Start Epidural analgesia with 0.0625% Marcaine with Morphine 0.02 mg/ml rate 6 ml/hr

Postoperative period

Postoperative day 1

- S : ผู้ป่วยตื่นดี off ETT เมื่อวานมีเวลา 19.30 ไม่เหนื่อย มีไข้ ปวดแผลมาก PS at rest = 7, PS at movement = 8, การมองเห็นปกติ ไม่มีอาการชา/อ่อนแรง ไม่มีอาการเจ็บคอ แผลมีเลือดไหลซึม

- O : BT 37.7 ^{o}C, RR 18/min, BP 106/63 mmHg, HR 80/min, O_2sat 100%, I/O : 835/250 (24.00-08.00)
  Test analgesic level : -, Test dose with 2% Lidocaine without adrenaline 3 ml = Negative
  Motor : V/V all extremities, Sensory intact

- A + P : S/P Scoliosis correction PDS T_4-L_4 post-op d1 ; Severe postoperative pain (Fail epidural)
  Acute fever d1 : Ddx Inflammation process, wound infection, lung atelectasis
  - Step diet, promote ambulation
  - Off Epidural catheter, On PCA Morphine : Bolus 1 mg, Lockout 8 min, Limit 4 hr : 20 mg
  - Ultracet 1 tab po q 12 hr
  - Ondansetron 4 mg IV prn for N/V q 6 hr

Postoperative day 2

- S : ผู้ป่วยตื่นดี มีไข้ ปวดแผลลดลง PS at rest = 3, PS at movement = 5, การมองเห็นปกติ ไม่มีอาการชา/อ่อนแรง ไม่มีอาการเจ็บคอ มีอาการท้องอืด ผายลมน้อย แผลซึมลดลง เริ่มลุกเดินได้ ไม่ปัสสาวะแสบขัด ไม่มีอาการไอ น้ำมูก

- O : BT 38 ^{o}C, RR 18/min, BP 105/60 mmHg, HR 72/min, O_2sat 100%
  Motor : V/V all extremities, Sensory intact
  Abd : Mild distension, soft, not tender, no rebound tenderness
  Lung : Clear equal breath sound both lung, no adventitious sound

- A + P : S/P Scoliosis correction PDS T_4-L_4 post-op d2 ; Post-op bowel ileus (Ddx immobilization, opioid)
  Acute fever d2 : Ddx Wound infection, UTI
  - On PCA Morphine : Bolus 1 mg, Lockout 8 min, Limit 4 hr : 20 mg
  - Ultracet 1 tab po q 12 hr, Acetaminophen (500) 1 tab po q 6 hr
  - Ibuprofen (400) 1 tab po prn for pain q 8 hr
  - Promote ambulation

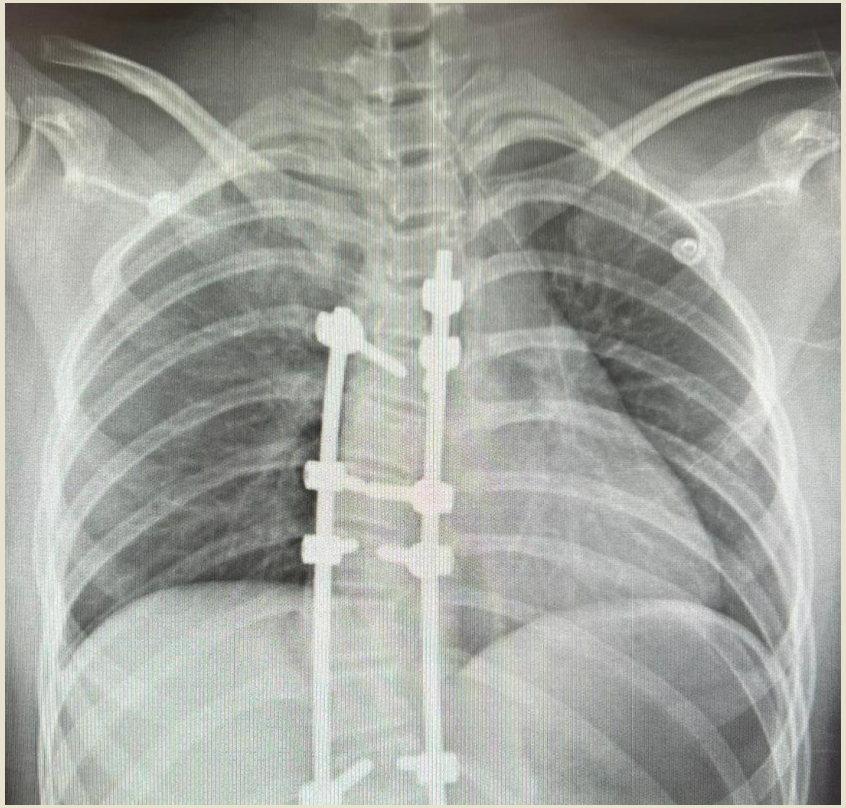
Postoperative day 3

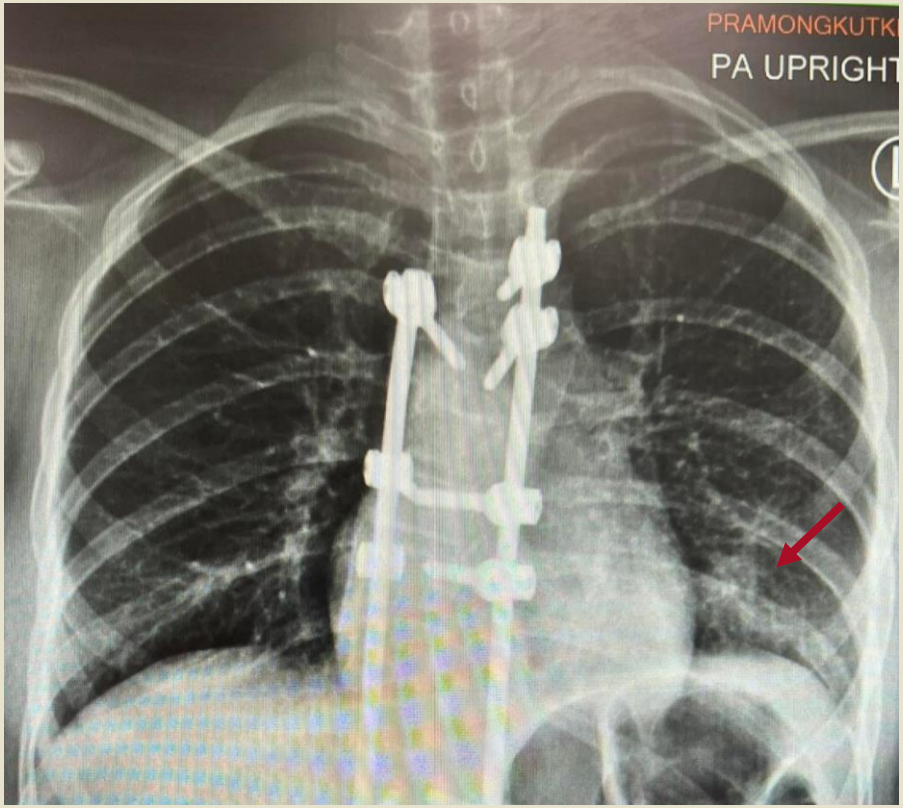
- S : ผู้ป่วยตื่นดี มีไข้ปวดแผลลดลง PS at rest = 3, PS at movement = 3, การมองเห็นปกติ ไม่มีอาการชา/อ่อนแรง ไม่มีอาการเจ็บคอ มีอาการท้องอืดลดลง ผายลมได้ แผลซึมลดลง ไม่มีอาการไอ น้ำมูก

- O : BT 38.5 ^{o}C, RR 18/min, BP 99/65 mmHg, HR 68/min, O_2sat 100%
  Motor : V/V all extremities, Sensory intact
  Lung : Clear equal breath sound both lung, no adventitious sound

- A + P: S/P Scoliosis correction PDS T_4-L_4 post-op d3 ; Post-op bowel ileus (Ddx immobilization, opioid)
  Acute fever d3 : Ddx Pneumonia, Wound infection
  - Off PCA Morphine, Morphine 3 mg IV prn for pain q 4 hr
  - Ultracet 1 tab po q 12 hr, Acetaminophen (500) 1 tab po q 6 hr
  - Ibuprofen (400) 1 tab po prn for pain q 8 hr
  - Cefepime 2 g IV q 8 hr

Postoperative day 3





Postoperative day 10

- S : ผู้ป่วยตื่นดี ไม่ปวดแผลแล้ว ไข้ลดลง ไม่ไอน้ำมูก การมองเห็นปกติ ไม่มีอาการชา/อ่อนแรง ไม่มีอาการเจ็บคอ ไม่มีอาการท้องอืด แผลไม่ซึม

- O : BT 37.4 ^{o}C, RR 18/min, BP 104/75 mmHg, HR /min, O_2sat 100%
  Motor : V/V all extremities, Sensory intact
  Lung : Clear equal breath sound both lung, no adventitious sound

- A + P: S/P Scoliosis correction PDS T_4-L_4 post-op d1 ; Post-op bowel ileus (Ddx immobilization, opioid)
  Acute Pneumonia on cefepime d7
  - Acetaminophen (500) 1 tab po prn for fever q 4-6 hr
  - Ibuprofen (400) 1 tab po prn for pain q 8 hr
  - Cefepime 2 g IV q 8 hr

Reference

- Yao, F. (2021). *Yao & Artusio's Anesthesiology : Problem-Oriented Patient Management* (9th edition). Wolters Kluwer.

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- Gropper, M. (Ed.). (2020). *Miller's Anesthesia* (9th Edition). Elsevier.

Thank you