비엔동물전문의료센터
BIEN ANIMAL MEDICAL CENTER

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: Monitoring

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Previous seminar

1. Pre-anesthetic period

- ☐ History and definition of anesthesia
- ☐ Pre-anesthetic period
- ☐ Patient evaluation
- ☐ Consent form
- ☐ Hydration
- ☐ NPO
- ☐ Medication discontinuation

2. Anesthetic period

- ☐ Anesthetic protocol
- ☐ Physical examination
- ☐ Pre-medication
- ☐ Induction
- ☐ Intubation
- ☐ Anesthetic machine
- ☑ Monitoring
- ☐ Recovery

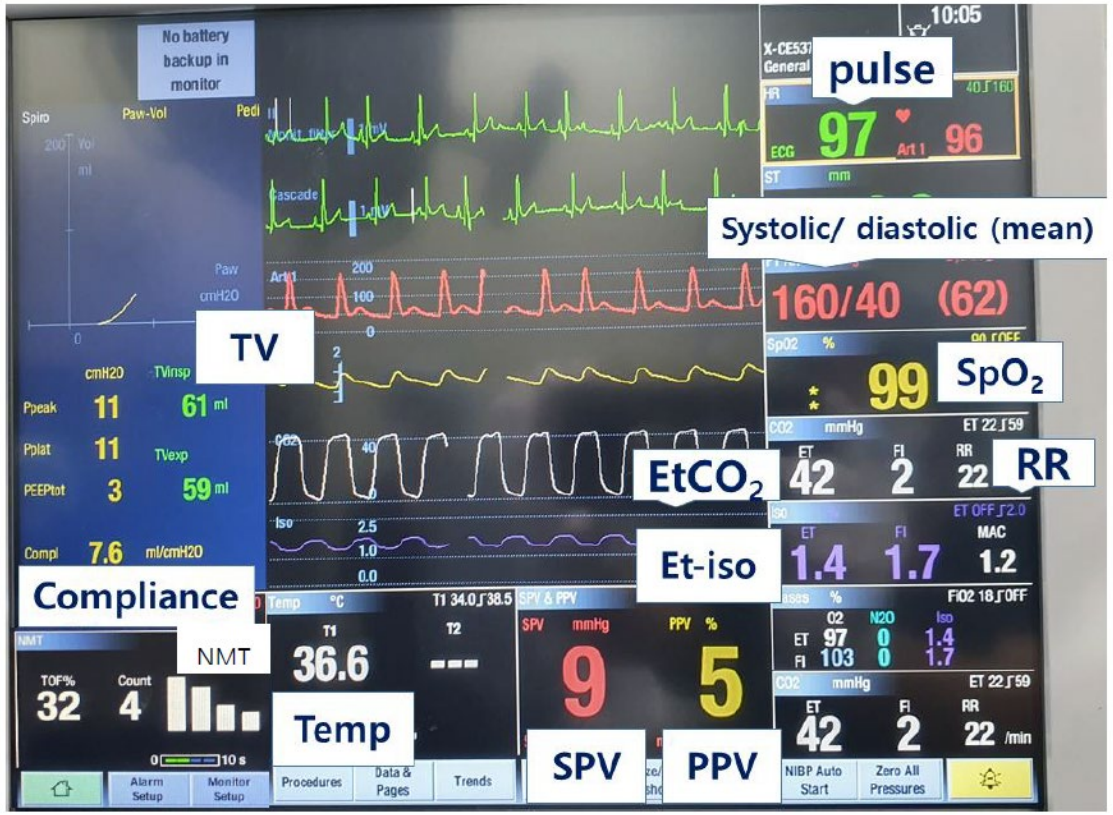
3. Post-anesthetic period

- ☐ Patient handover
- ☐ Brachycephalic dog
- ☐ Re-starting oral feeding

Monitoring

- What is monitoring? - 5 steps
- Monitoring ≒ predicting
  - Patient-related
  - Non-patient-related
- Criteria: absolute vs. relative
- Treatments: cause vs. symptomatic
  - Pulse rate (ECG, SpO_2)
  - Blood pressure
  - End tidal carbon dioxide level
  - Temperature
- Quiz

What is monitoring? – 5 steps



Criteria

① Know the normal range

② Recognize abnormal status

Treatments

③ Differentiate the cause

④ Determine the priority of interventions

⑤ Re-evaluation

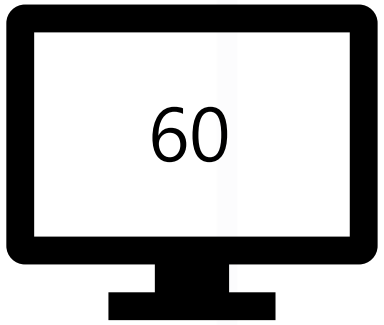
Monitoring ≒ Predicting

10 min before **Now** **10 min after**

60 → 60 → 60

Trend

80 → 60 → 40



Good?

Bad?

➔ Pulse rate, $EtCO_2$, blood pressure, etc.

Patient-related

Brain, heart, lung, liver, kidney, etc.

Trends

Anesthetic protocol, position, surgery type, endoscopy, CT&MRI

Non-patient-related

Monitoring ≒ Predicting

Patient-related

- ☐ Brain
  - ☐ Brain disorder: prolonged recovery
  - ☐ ICP ↑ : need higher MAP
- ☐ Heart
  - ☐ MMVD: regurgitation
  - ☐ DCM: contractility
  - ☐ HCM: impaired filling
- ☐ Lung
  - ☐ Upper airway: BOAS
  - ☐ Lower airway: trachea-lung
- ☐ Liver
  - ☐ PSS, liver failure
- ☐ Kidney
  - ☐ CKD, AKI

Non-patient-related

- ☐ Anesthesia protocol
- ☐ Position
- ☐ Surgery types
- ☐ Endoscopy
- ☐ CT & MRI

Criteria: absolute vs. relative

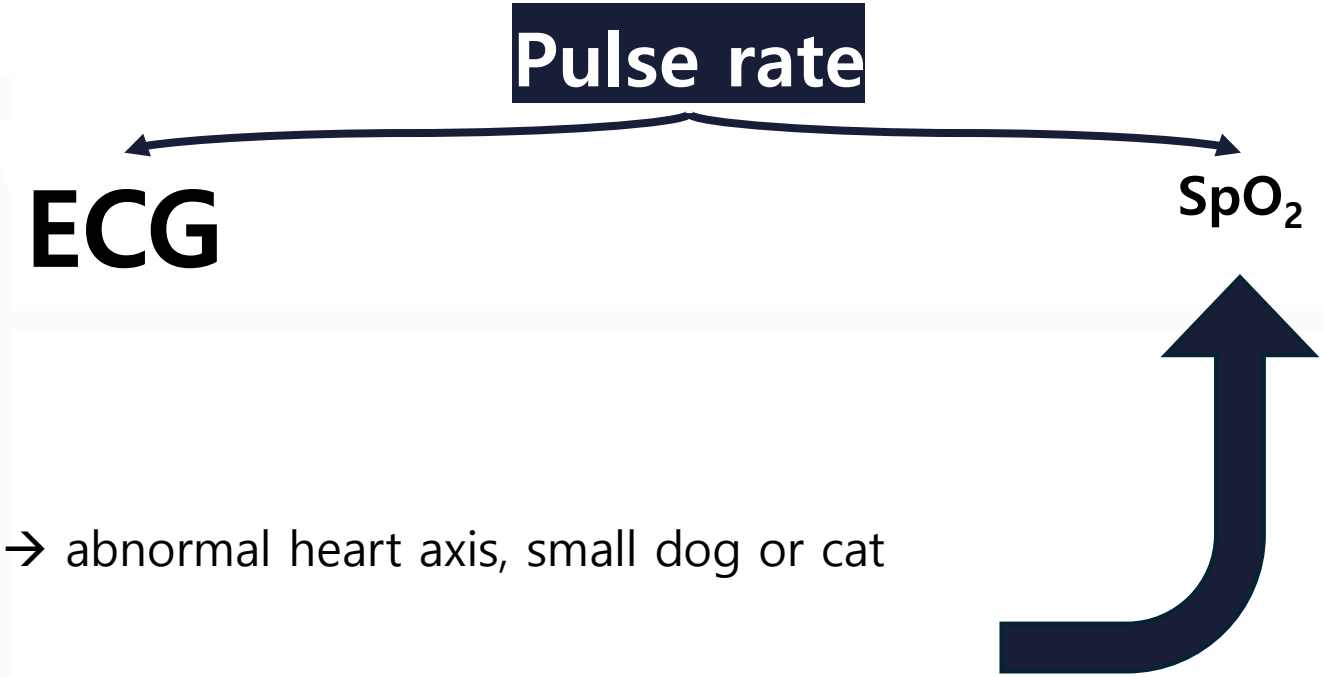
Absolute: reference range **Relative: individual patient**

	Dogs				Cats
Pulse	**Puppy**	**Small**	**Medium**	**Large**	
	70-220	90-180	80-160	70-140	140-220
BP	**SAP**	90-140 mmHg			80-140 mmHg
	MAP	60-100 mmHg			60-100 mmHg
	DAP	50-80 mmHg			55-75 mmHg
$EtCO_2$	35-45 mmHg				27-41 mmHg
Temp.	37.5-39℃				38-39.5℃
SpO_2	> 95%				

But! should compare with the **physical examination or previous data**

Treatments: cause vs. symptomatic

Treatments: cause vs. symptomatic



Artifact

Asystole
- Too small QRS wave → abnormal heart axis, small dog or cat

Double counting
- Too tall P or T wave → abnormal heart axis, disease

Treatments: cause vs. symptomatic

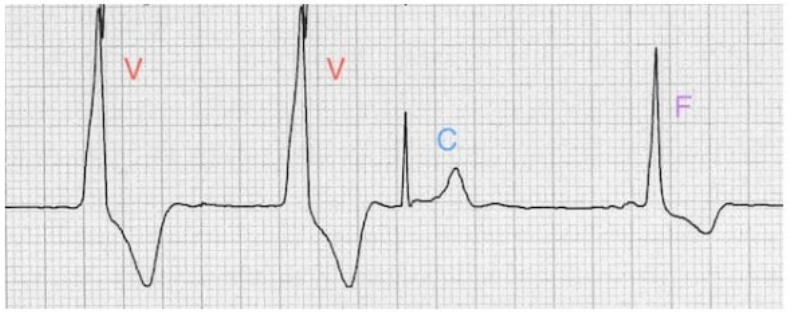
Pulse rate

ECG — **SpO_2**

Tachycardia

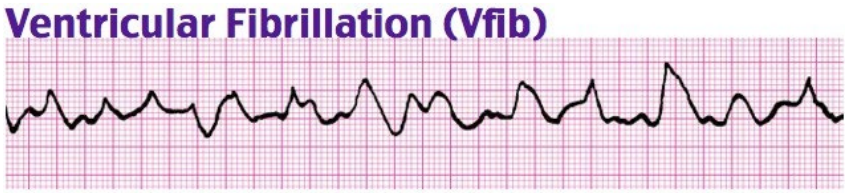
Tachycardia
- Pain, hypovolemia, vasodilation ➔ Analgesics, sympathomimetics

Accelerated idioventricular rhythm (AIVR)
- Ischemia (hemoperitoneum; ruptured spleen or liver, chronic anemia)
- < 160-180 bpm, benign



AIVR showing ventricular complexes (V), capture beat (C), fusion beat (F)

Fibrillation
- A-fib, V-fib
- > 160-180 bpm, malignant
- De-fibrillation



- Completely **disorganized**
- Immediate cessation of cardiac output, **no associated pulse**
- No discernible P waves, QRS complexes, or T waves
- **Incompatible** with life

Treatments: cause vs. symptomatic

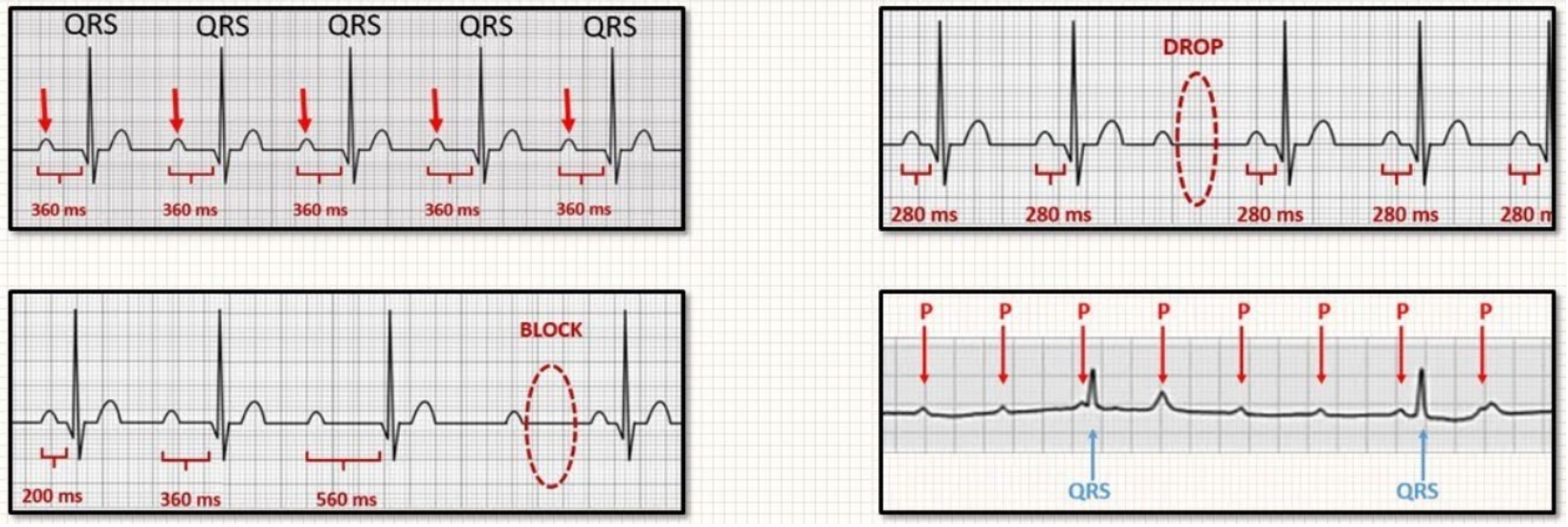
Pulse rate

ECG — **SpO_2**

Arrhythmia

Respiratory
- Respiratory cycle (inspiration: expiration)

AV-block



Anticholinergics

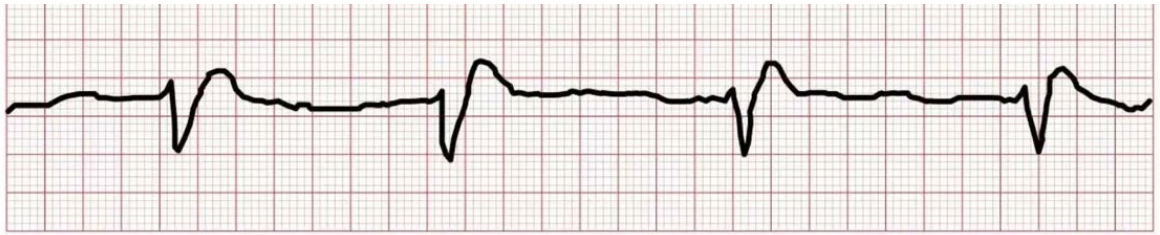
Treatments: cause vs. symptomatic

Pulse rate

ECG — **SpO_2**

Arrhythmia

Pulseless electrical activity
- No actual pulse ➔ CPCR



PULSELESS ELECTRICAL ACTIVITY (PEA)			
RHYTHM	**RATE**	**QRS**	**P-WAVES/ PR INTERVAL**
Regular or irregular	*Any (Fast or slow)*	*Narrow or wide*	*May be visible, normal, including sinus in origin*

Treatments: cause vs. symptomatic

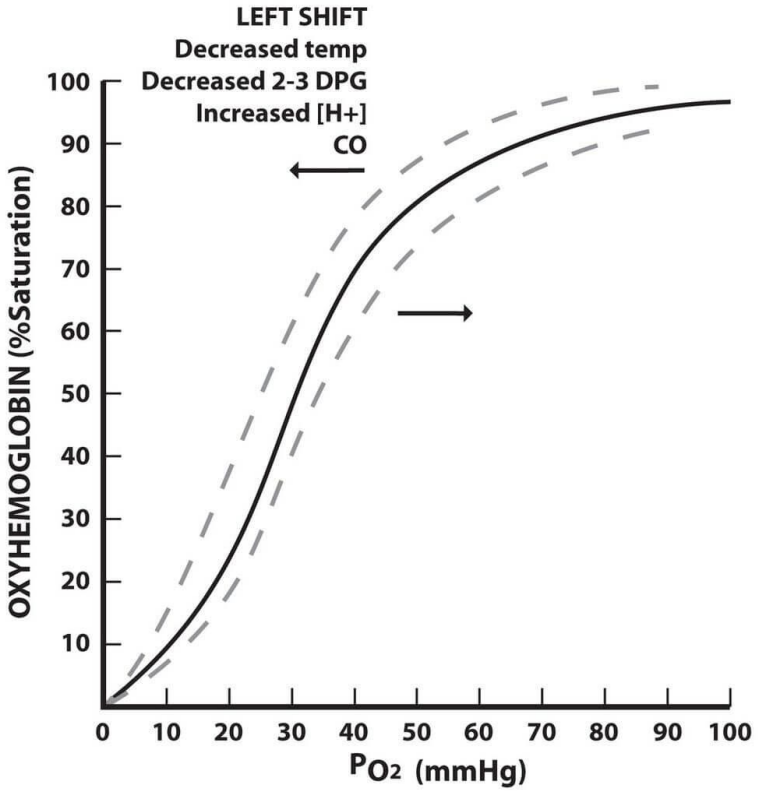
Pulse rate

ECG

SpO_2 >95%

Artifact

- ☐ **Cyanosis?**
- ☐ Damaged probe
- ☐ Poor perfusion
- ☐ Movement
- ☐ Color
- ☐ Inherited forms of hemoglobin
- ☐ Carbon monoxide poisoning



Treatments: cause vs. symptomatic

Blood pressure

BP = CO x SVR

↓

HR x SV

↓

Pre/after-load x Contractility

Table 8-1 **Causes of Hypotension and Recommended Treatment**

Cause	Sample Diseases	Treatments
Reduction in Preload		
Hypovolemia	Hemorrhage Severe dehydration Edema/cavitary effusions	Address underlying problem. Provide fluid resuscitation.
Obstructive	Gastric dilation-volvulus Mesenteric volvulus Caval/portal venous occlusion Pericardial effusion Severe pleural space disease Pulmonary thromboembolism	Relieve the obstruction if possible, with surgery, pericardiocentesis, or thoracentesis; administration of thrombolytics; or thrombectomy as needed. Provide fluid resuscitation.
Reduction in Cardiac Function		
Primary	Cardiomyopathy Valvular disease Tachyarrhythmia or bradyarrhythmia	Administer positive inotrope. Administer antiarrhythmics. Provide supportive measures for congestive heart failure
Secondary	Systemic inflammatory response syndrome/sepsis Electrolyte abnormalities Severe hypoxia Severe acidosis or alkalosis	Address the underlying cause. Administer positive inotrope.
Reduction in Systemic Vascular Resistance		
	SIRS/sepsis Electrolyte abnormalities Severe hypoxia Severe acidosis or alkalosis Drug or toxins	Address the underlying cause. Provide fluid resuscitation. Administer vasopressors.

BP: blood pressure
CO: cardiac output
SVR: systemic vascular resistance
HR: heart rate
SV: stroke volume

Treatments: cause vs. symptomatic

Blood pressure

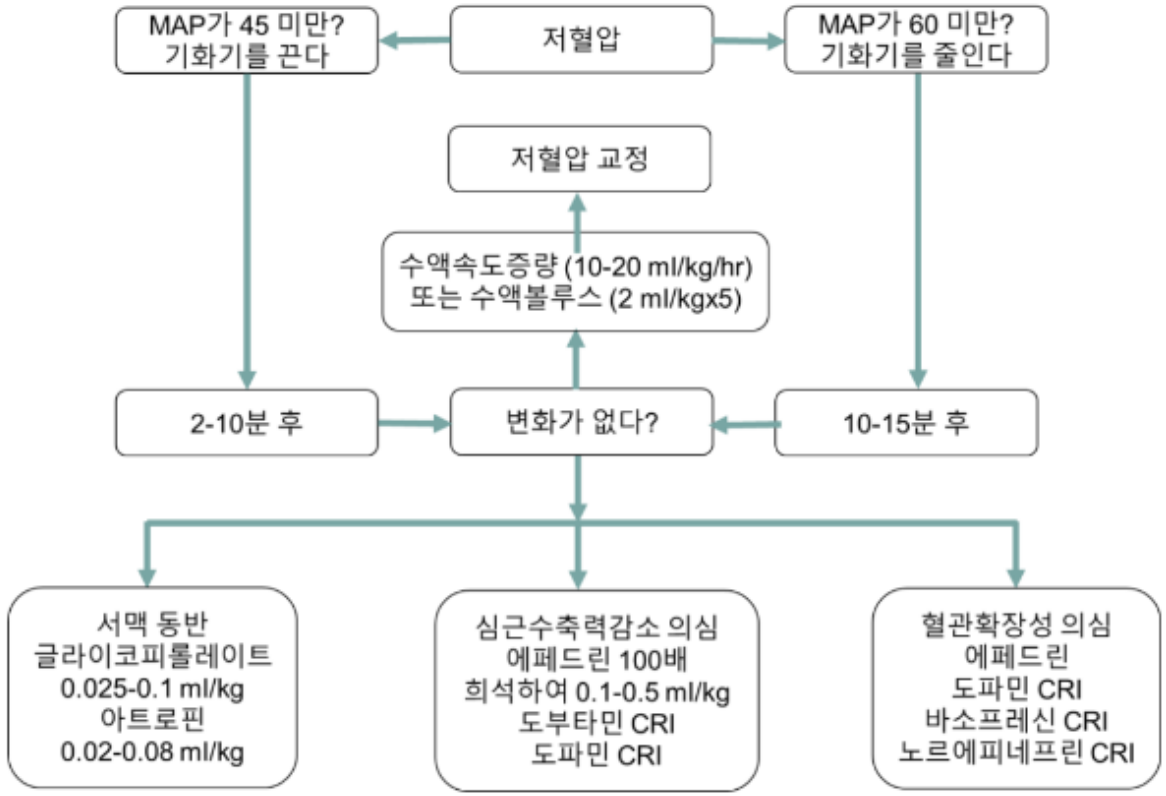
BP = CO x SVR

↓

HR x SV

↓

Pre/after-load x Contractility



Guess what is cause?

- ☐ SVR
- ☐ HR
- ☐ Contractility
- ☐ Pre/after-load

BP: blood pressure
CO: cardiac output
SVR: systemic vascular resistance
HR: heart rate
SV: stroke volume

Treatments: cause vs. symptomatic

$EtCO_2$

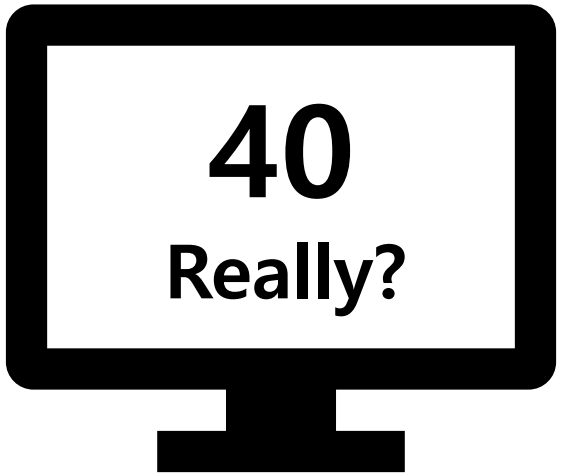
$EtCO_2$	Dogs	Cats
	35-45 mmHg	27-41 mmHg

$$MV \propto \frac{1}{EtCO_2}$$

$$= VT \times RR$$

$$\downarrow$$

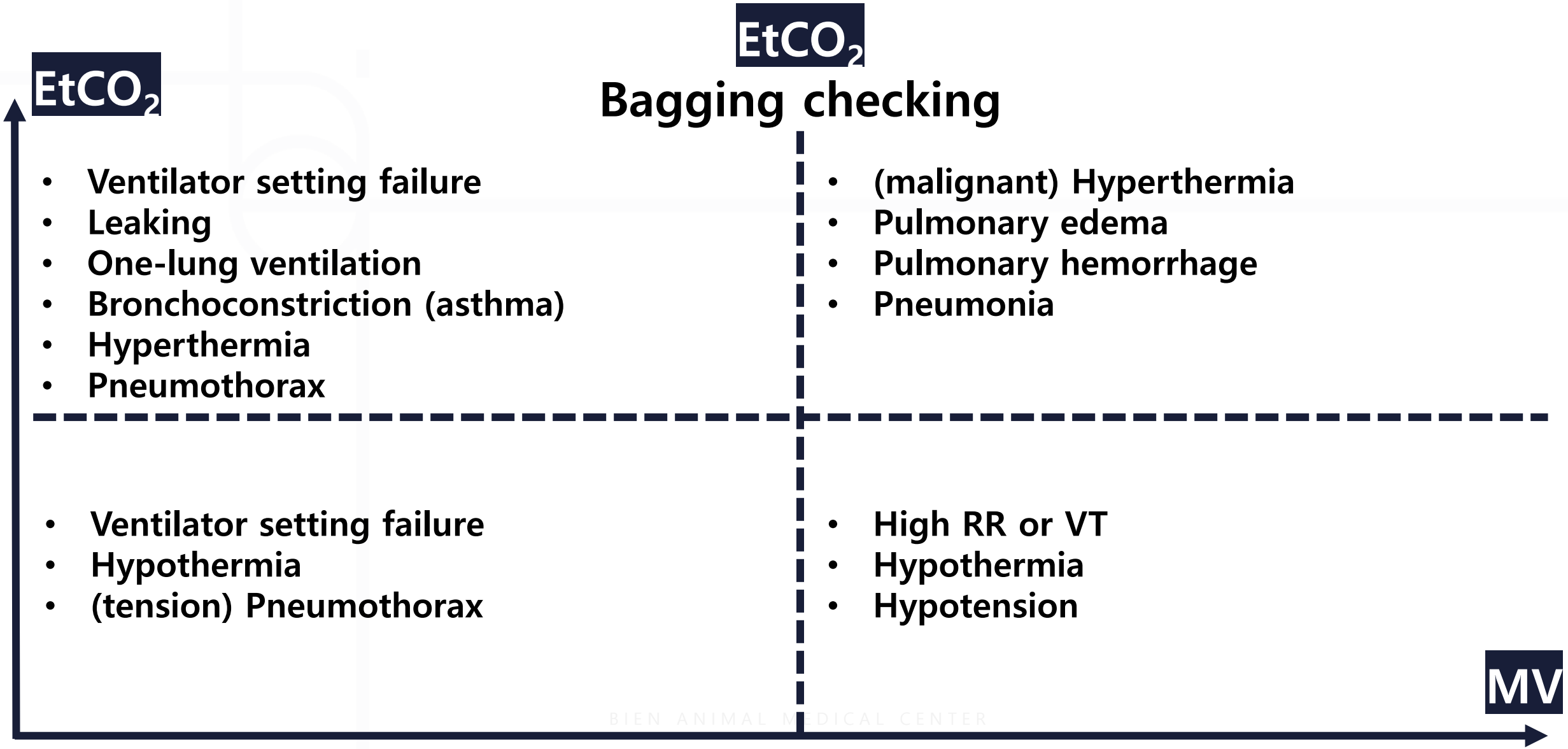
$$P_{insp} \text{ or } T_{insp}$$



Bagging checking

MV: minute ventilation
VT: tidal volume
RR: respiratory rate
P_{insp}: peak inspiratory pressure
T_{insp}: time of inspiration

Treatments: cause vs. symptomatic



Treatments: cause vs. symptomatic

$EtCO_2$

Normal

Hypoventilation

Hyperventilation

Cardiac oscill.

Spon. breathing

Leak/asthma

Soda lime

Treatments: cause vs. symptomatic

Temperature

Temperature	Dogs	Cats
	37.5-39℃	38-39.5℃

Hypothermia
< 36℃: Anesthetic requirement ↑ ➔ prolonged recovery
< 34℃: Coagulopathy, seizure
< 32.8℃: Cardiovascular depression

Hyperthermia
> 40℃: Coagulopathy, oxygen requirement ↑
> 42℃: Cell death

Quiz

- 6살 비글견 수컷 Rt. TPLO 수술
- 마취 전 수화 후, 탈수 < 5%, Alfaxalone 2 mg/kg IV, Isoflurane 2%
- 신체검사 시, HR 130, BP 130/85/60, Temp. 37.9℃, RR 18
- 마취 중, HR 90, BP 90/55/45, Temp. 37.1 ℃, RR 20, $EtCO_2$ 38
- 2° AV block

가장 우선적으로 시행할 것은?

1. 기화기 줄이기
2. 수액 투여
3. 글라이코 투여
4. 에페드린 투여
5. 노르에피네프린 CRI 투여

Quiz

- 10살 웰시 코기, 암컷 담낭절제술
- CRP ↑, Alb ↓
- 마취 전 수화 후, 탈수 5%, Alfaxalone 2 mg/kg IV, Isoflurane 1.8%
- 신체검사 시, HR 180, BP 110/65/40, Temp. 39.7℃, RR 40
- 마취 중, HR 190, BP 70/45/35, Temp. 39.2 ℃, RR 24, $EtCO_2$ 42
- 저혈압 개선 위해 기화기를 1.0% 까지 줄였는데 환자는 깨고 BP 90/57/40 (아직 담낭 주변 둔성분리중)

가장 우선적으로 시행할 것은?

1. 수액 투여
2. 기화기 증가시키기
3. 에페드린 투여
4. 노르에피네프린 CRI 투여
5. 수술 빨리 끝내기

Quiz

- 11살 불독, 흉요추 MRI (IVDD susp.), BCS 8/9, 16 kg
- Propofol 6 mg/kg IV, Isoflurane 1.5%
- 마취 중, HR 110, BP 120/70/55, Temp. 38.5 ℃, RR 15, $EtCO_2$ 57, VT 80 mL

가장 우선적으로 시행할 것은?

1. 흡기시 압력 증가시키기
2. 기화기 줄이기
3. 에페드린 투여
4. 더 큰 사이즈 ET tube 삽관
5. 호흡수 줄이기

Quiz

- 3살 닥스훈트, 발치 및 치석제거, 8 kg
- Alfaxalone 2 mg/kg IV, Isoflurane 1.7%
- 마취 중, HR 120, BP 140/80/65, Temp. 37.1 ℃, RR 20, $EtCO_2$ 31, VT 35 mL

가장 우선적으로 시행할 것은?

1. 흡기시 압력 증가시키기
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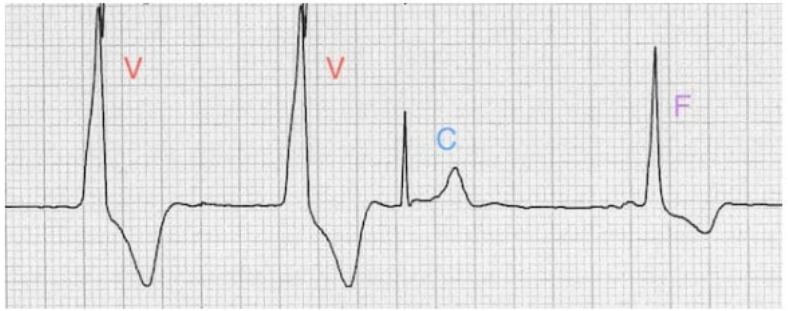
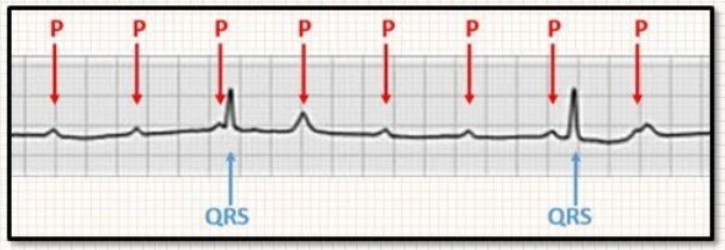
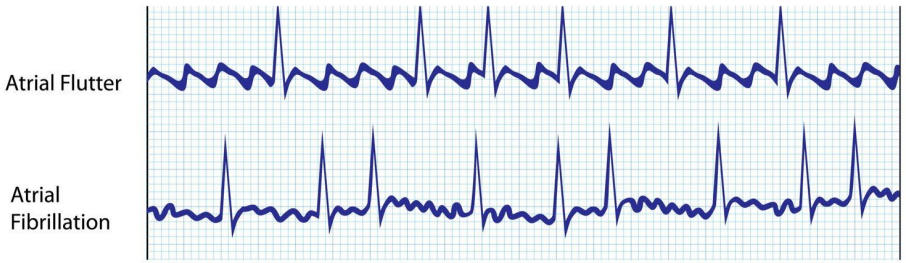


AIVR showing ventricular complexes (V), capture beat (C), fusion beat (F)





PULSELESS ELECTRICAL ACTIVITY (PEA)

RHYTHM	RATE	QRS	P-WAVES/ PR INTERVAL
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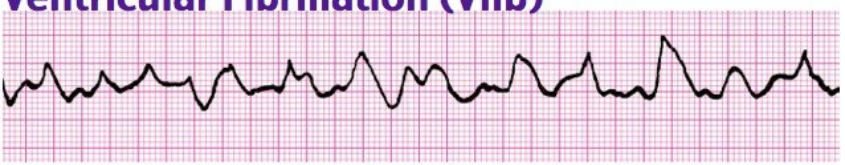
Ventricular Fibrillation (Vfib)



- Completely **disorganized**
- Immediate cessation of cardiac output, **no associated pulse**
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$EtCO_2$

Normal

Hypoventilation

Hyperventilation

Cardiac oscill.

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	Dogs				Cats
Pulse	**Puppy**	**Small**	**Medium**	**Large**	
	70-220	90-180	80-160	70-140	140-220
BP	**SAP**	90-140 mmHg			80-140 mmHg
	MAP	60-100 mmHg			60-100 mmHg
	DAP	50-80 mmHg			55-75 mmHg
$EtCO_2$	35-45 mmHg				27-41 mmHg
Temp.	37.5-39℃				38-39.5℃
SpO_2	> 95%				

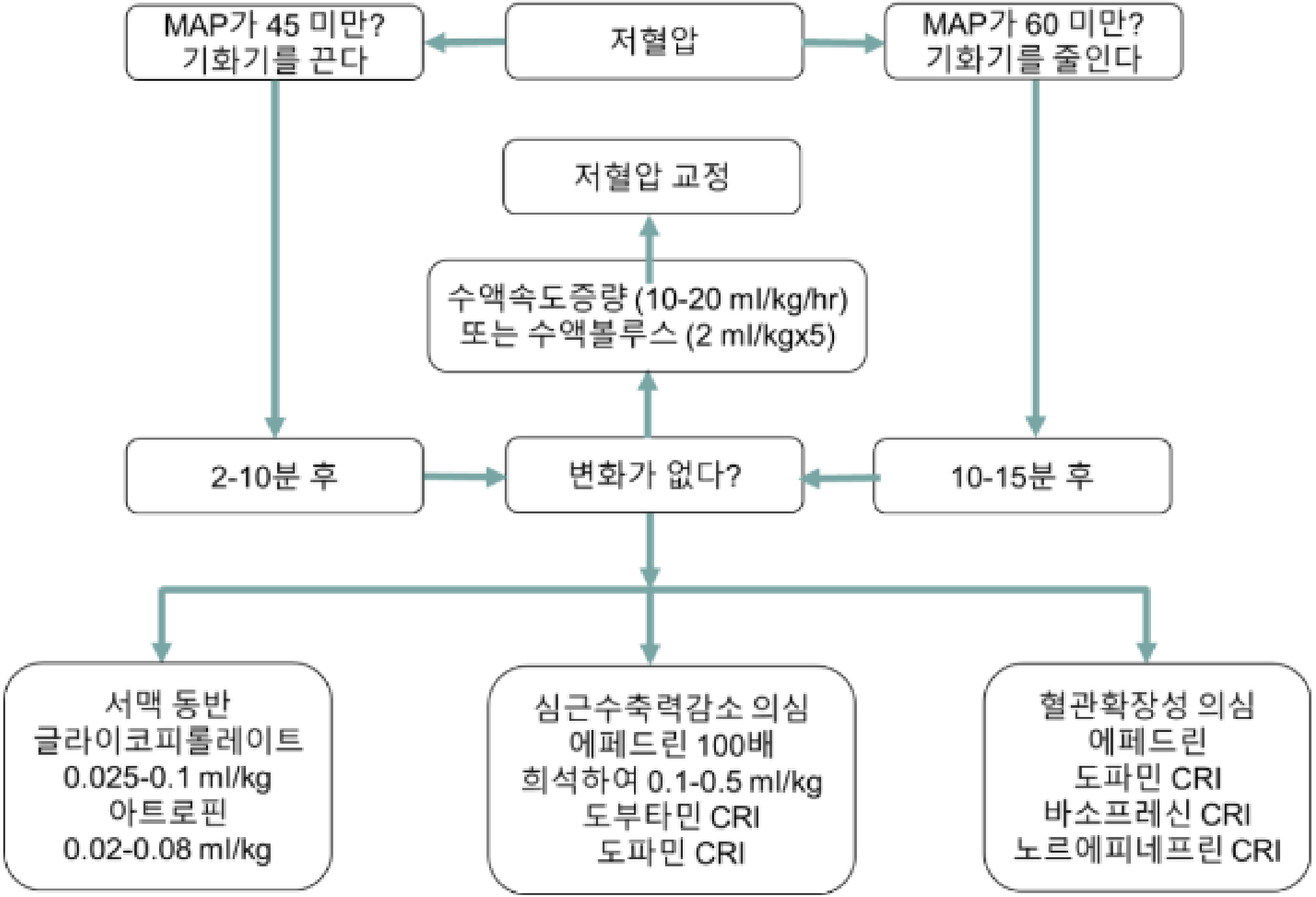
저혈압
MAP가 45 미만?
기화기를 끈다
MAP가 60 미만?
기화기를 줄인다
저혈압 교정
수액속도증량 (10-20 ml/kg/hr)
또는 수액볼루스 (2 ml/kgx5)
2-10분 후
변화가 없다?
10-15분 후
서맥 동반
글라이코피롤레이트
0.025-0.1 ml/kg
아트로핀
0.02-0.08 ml/kg
심근수축력감소 의심
에페드린 100배
희석하여 0.1-0.5 ml/kg
도부타민 CRI
도파민 CRI
혈관확장성 의심
에페드린
도파민 CRI
바소프레신 CRI
노르에피네프린 CRI

Table 8-1 Causes of Hypotension and Recommended Treatment

Cause	Sample Diseases	Treatments
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