

KETAMINE FOR THE CRITICALLY ILL PATIENT



SEAN EATON, FP-C, CCP-C, C-NPT

KETAMINE FOR THE CRITICALLY ILL PATIENT

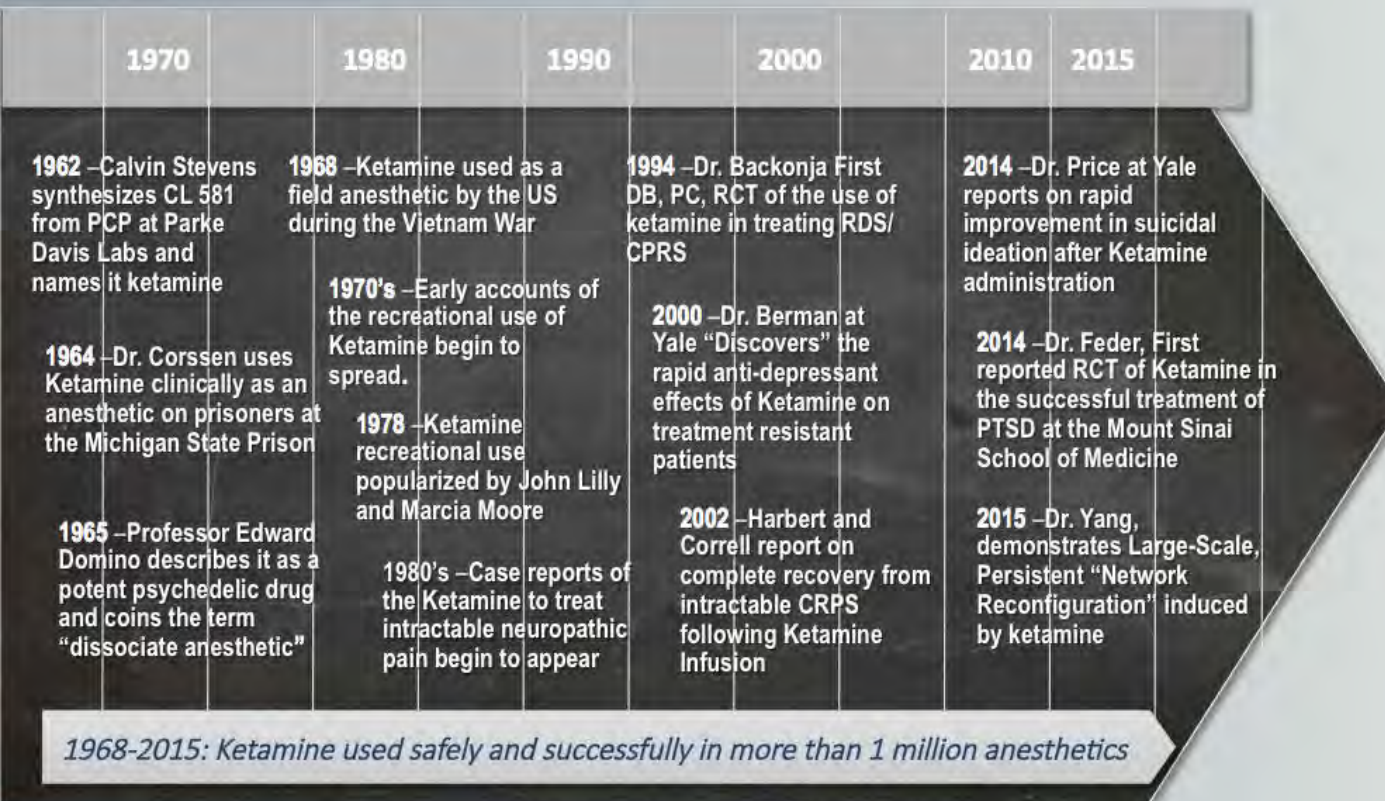
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KETAMINE FOR THE CRITICALLY ILL PATIENT

Ketamine Timeline



2013

ACEP APPROVES CLINICAL PRACTICE GUIDELINES FOR KETAMINE USE AS A SAFE AND EFFECTIVE DRUG FOR PROCEDURAL SEDATION AND ANALGESIA IN THE ED.

2017

ACEP ACCEPTS SUB-DISSOCIATIVE DOSE KETAMINE (SDK) AS SAFE AND EFFECTIVE FOR ANALGESIA IN THE ED.

2018

ENA ADOPTS ACEPS POLICY ON SDK FOR ANALGESIA

JANUARY 1, 2018

COLORADO REGULATION - CHAPTER 2 (RULE PERTAINING TO EMS PRACTICE...)

KETAMINE FOR USE BY P-CC ADDED TO STATE CRITICAL CARE FORMULARY.

DOES NOT REQUIRED WAIVER

IMAGE CREDIT: KETAMINEINSTITUTE.COM/KETAMINE-TIMELINE/



KETAMINE FOR THE CRITICALLY ILL PATIENT

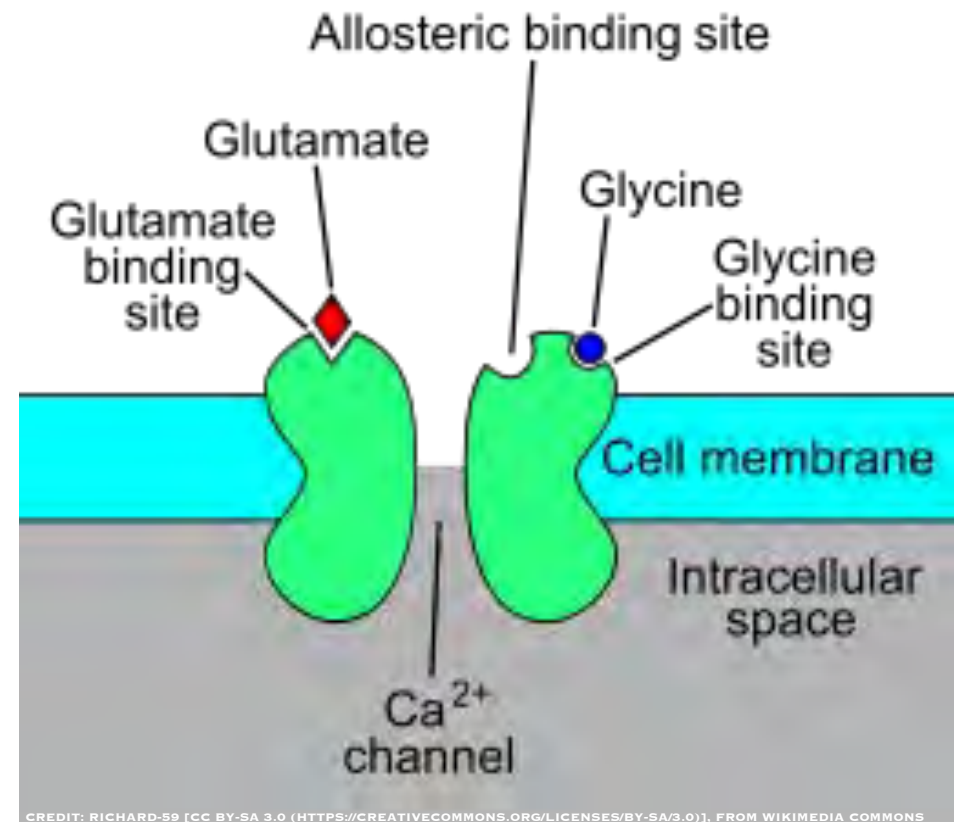
WHAT IS
KETAMINE?



KETAMINE FOR THE CRITICALLY ILL PATIENT

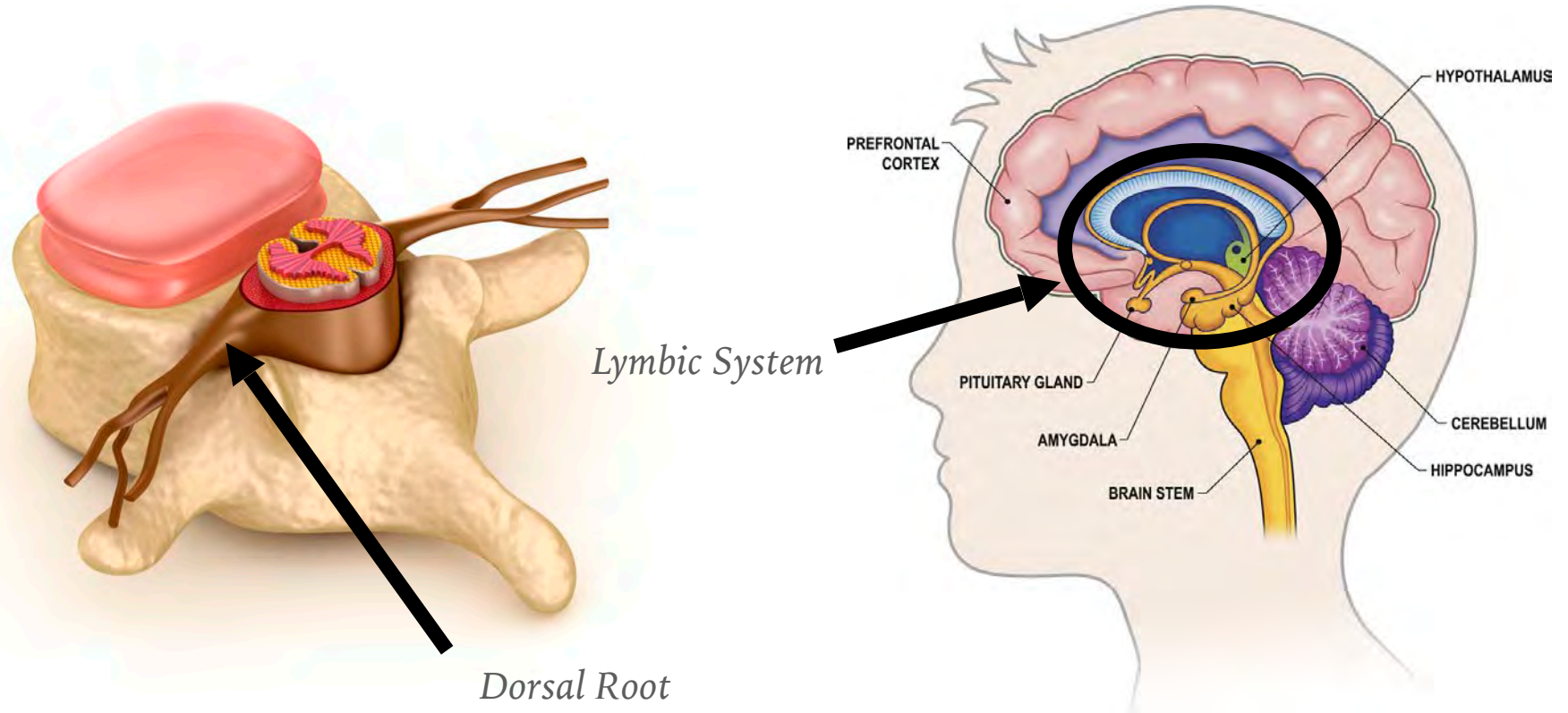
NONCOMPETITIVE NMDA RECEPTOR ANTAGONIST

Activated NMDAR

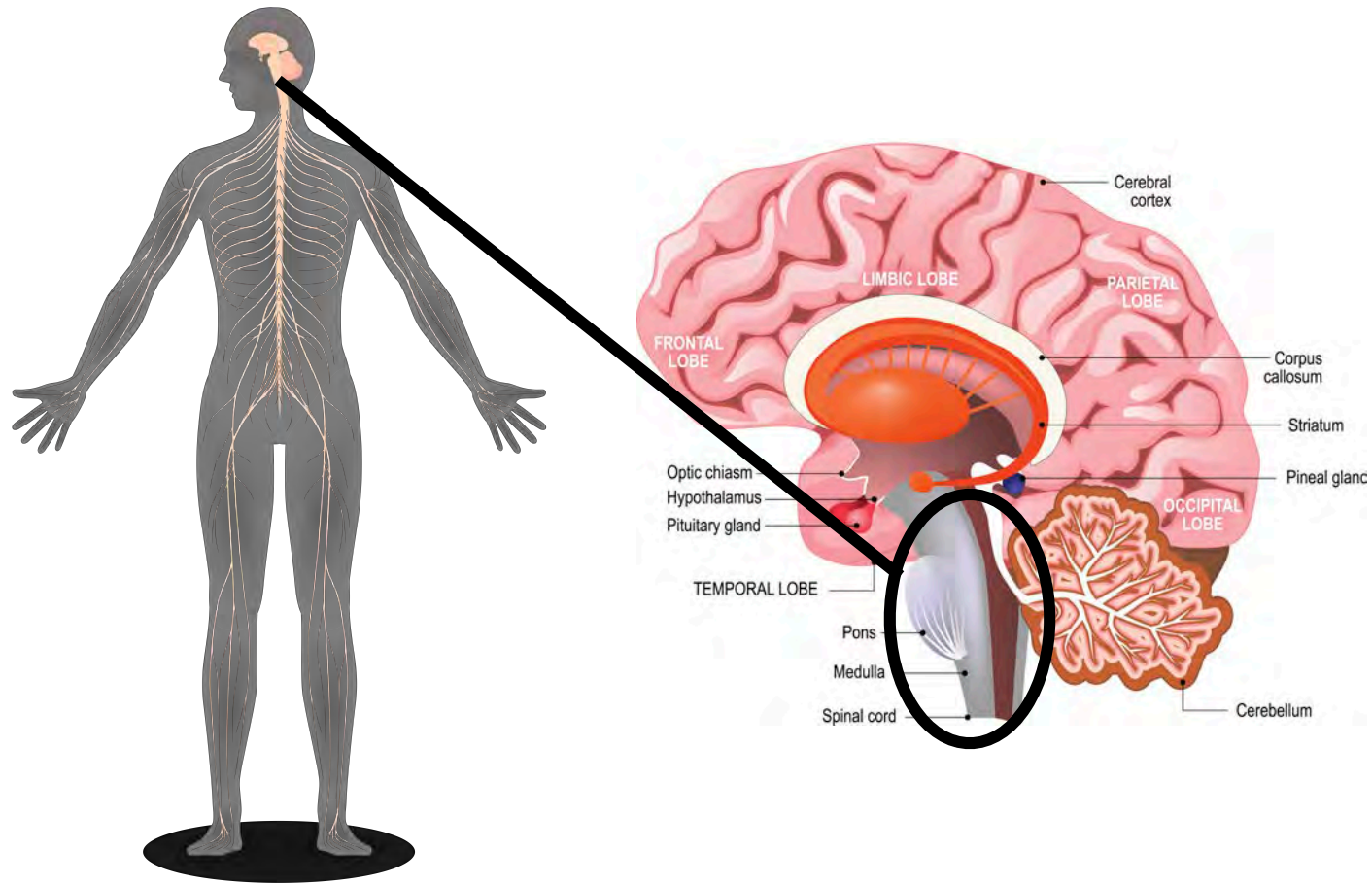


NMDAR = ION GATED RECEPTOR IN CNS

KETAMINE FOR THE CRITICALLY ILL PATIENT



KETAMINE FOR THE CRITICALLY ILL PATIENT



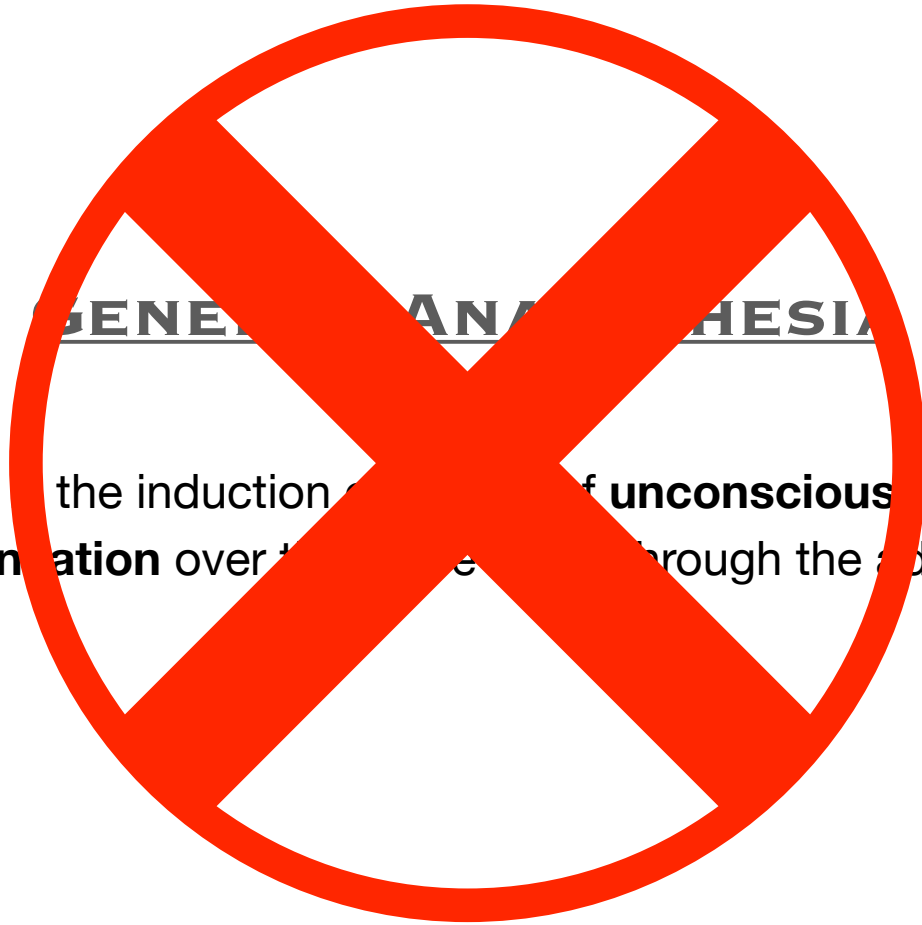
KETAMINE FOR THE CRITICALLY ILL PATIENT

AWAKE, BUT UNCONSCIOUS

KETAMINE FOR THE CRITICALLY ILL PATIENT

GENERAL ANESTHESIA

“General anesthesia is the induction of **unconsciousness** with the **absence of pain sensation** over the entire body through the administration of anesthetic drugs.”



KETAMINE FOR THE CRITICALLY ILL PATIENT

SEDATION

Minimal sedation is equivalent to **anxiolysis**, that is, a **drug-induced relief of apprehension** with **minimal effect on sensorium**.

Moderate sedation is a **depression of consciousness** in which the patient **can respond to external stimuli** (verbal or tactile). **Airway reflexes, spontaneous ventilation, and cardiovascular function are maintained**.

Deep sedation is a **depression of consciousness** in which the patient **cannot be aroused** but responds purposefully to repeated or painful stimuli. **The patient may not be able to maintain airway reflexes or spontaneous ventilation, but cardiovascular function is preserved**.

KETAMINE FOR THE CRITICALLY ILL PATIENT

DISSOCIATIVE SEDATION

“A TRANCELIKE CATALEPTIC STATE CHARACTERIZED BY PROFOUND ANALGESIA AND AMNESIA, WITH RETENTION OF PROTECTIVE AIRWAY REFLEXES, SPONTANEOUS RESPIRATIONS, AND CARDIOPULMONARY STABILITY.”

DEFINITION BY AMERICAN COLLEGE OF EMERGENCY PHYSICIANS - 2011

KETAMINE FOR THE CRITICALLY ILL PATIENT



KETAMINE FOR THE CRITICALLY ILL PATIENT

THE GOOD

ANALGESIC

SEDATIVE

ANESTHETIC

SYMPATHOMIMETIC

BRONCHIAL DILATOR

PRESERVES RESPIRATORY DRIVE AND PROTECTIVE REFLEXES

ANTI-EPILEPTIC

ANTI-DEPRESSANT / PTSD

MIGRAINES

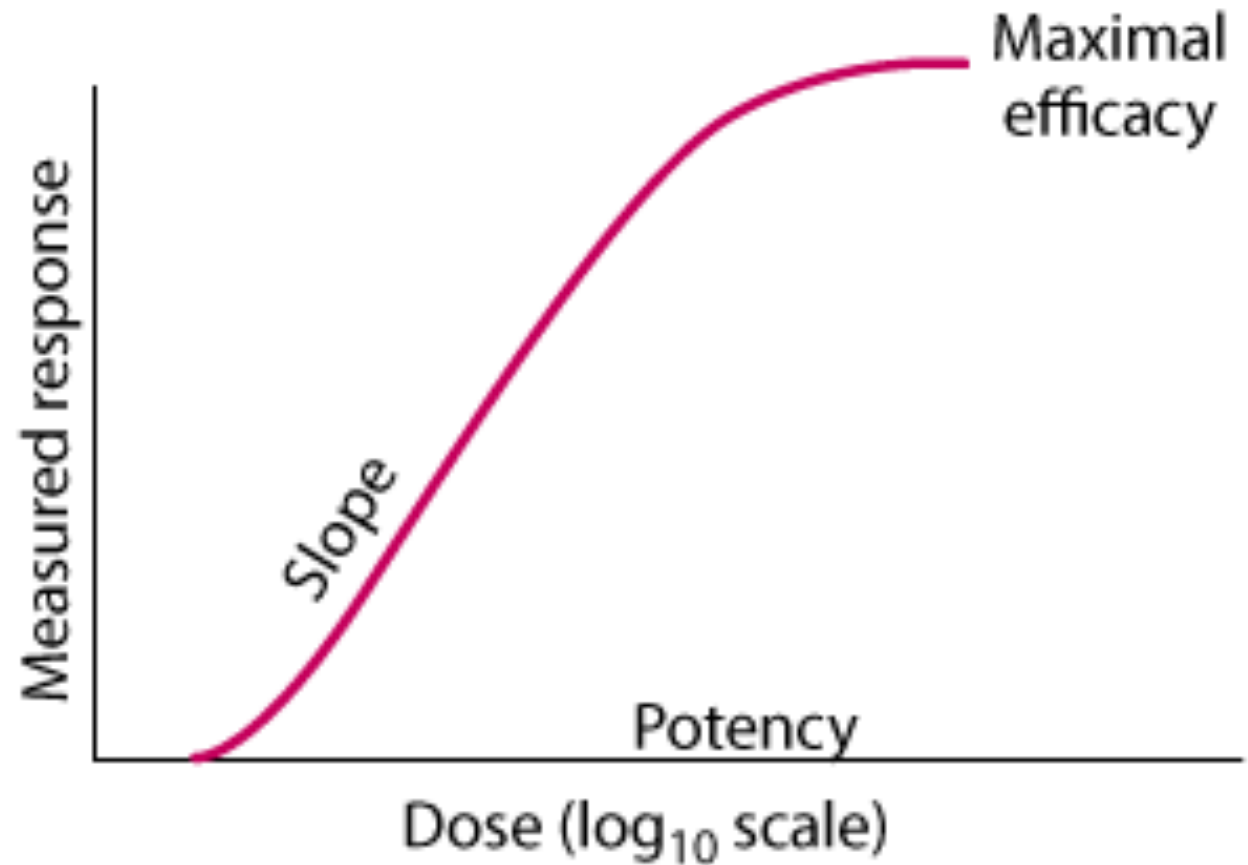
KETAMINE FOR THE CRITICALLY ILL PATIENT

DELIVER IS EVERYTHING



KETAMINE FOR THE CRITICALLY ILL PATIENT

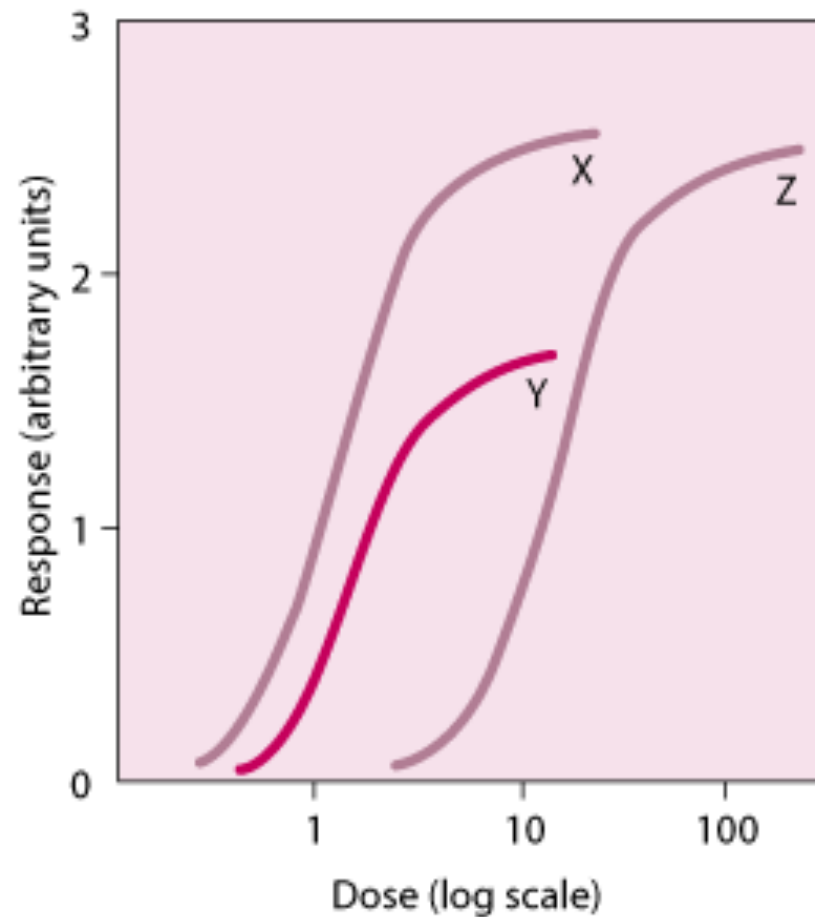
DOSE RESPONSE CURVE



From the Merck Manual Professional Version (Known as the Merck Manual in the US and Canada and the MSD Manual in the rest of the world), edited by Robert Porter. Copyright 2019 by Merck Sharp & Dohme Corp., a subsidiary of Merck & Co., Inc, Kenilworth, NJ. Available at <http://www.merckmanuals.com/professional>. Accessed 1/28/2019.

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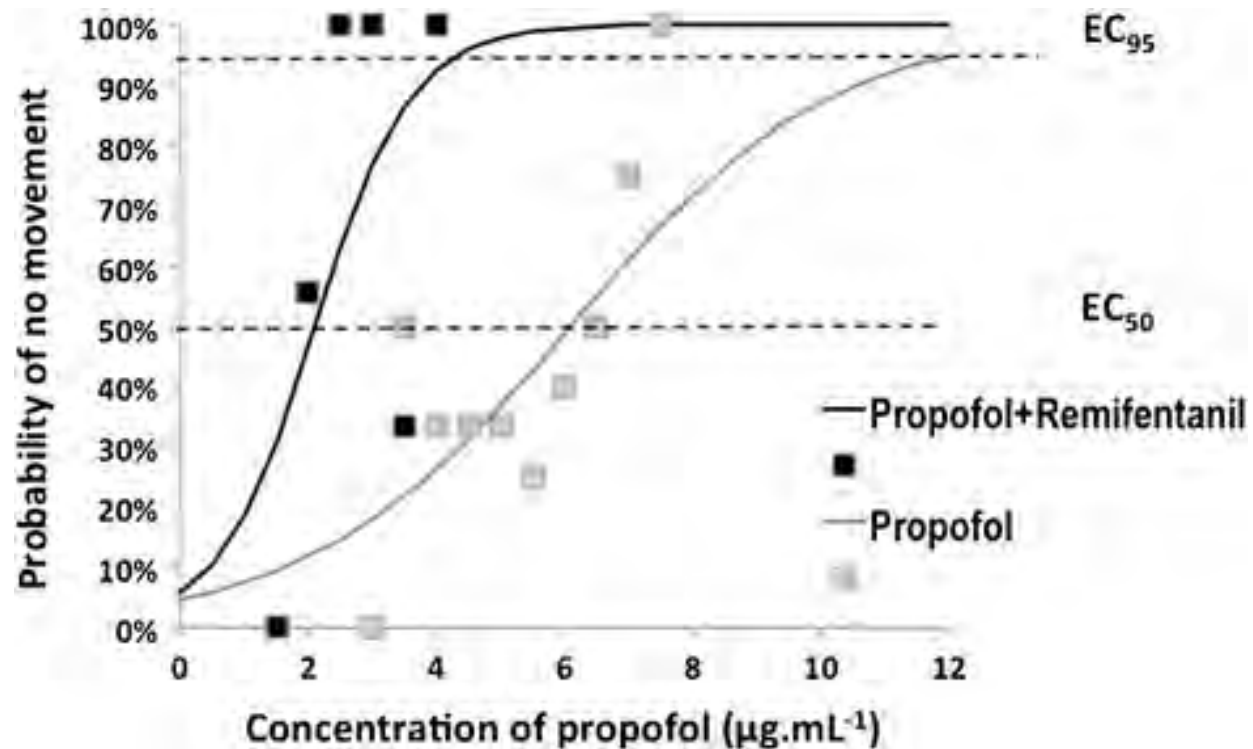
COMPARISON OF DOSE RESPONSE CURVE



From the Merck Manual Professional Version (Known as the Merck Manual in the US and Canada and the MSD Manual in the rest of the world), edited by Robert Porter. Copyright 2019 by Merck Sharp & Dohme Corp., a subsidiary of Merck & Co., Inc, Kenilworth, NJ. Available at <http://www.merckmanuals.com/professional>. Accessed 1/28/2019.

KETAMINE FOR THE CRITICALLY ILL PATIENT

DOSE RESPONSE CURVE - PROPOFOL



Effect-site concentration of propofol required for LMA-Supreme™ insertion with and without remifentanyl: A randomized controlled trial - Scientific Figure on ResearchGate. Available from: https://www.researchgate.net/figure/Dose-response-curves-plotted-from-logistic-analysis-of-individual-propofol-concentrations_fig3_282651371 [accessed 31 Jan, 2019]

KETAMINE FOR THE CRITICALLY ILL PATIENT

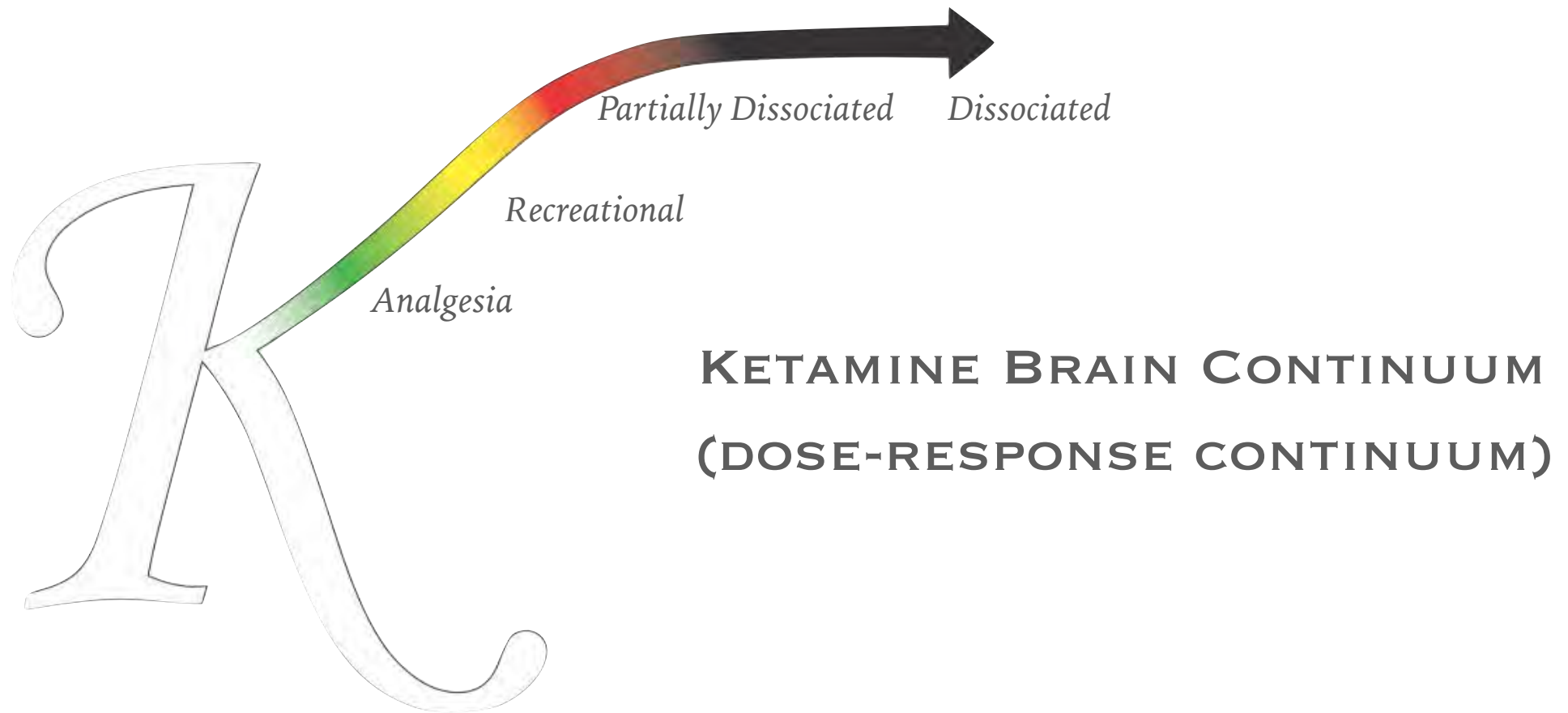
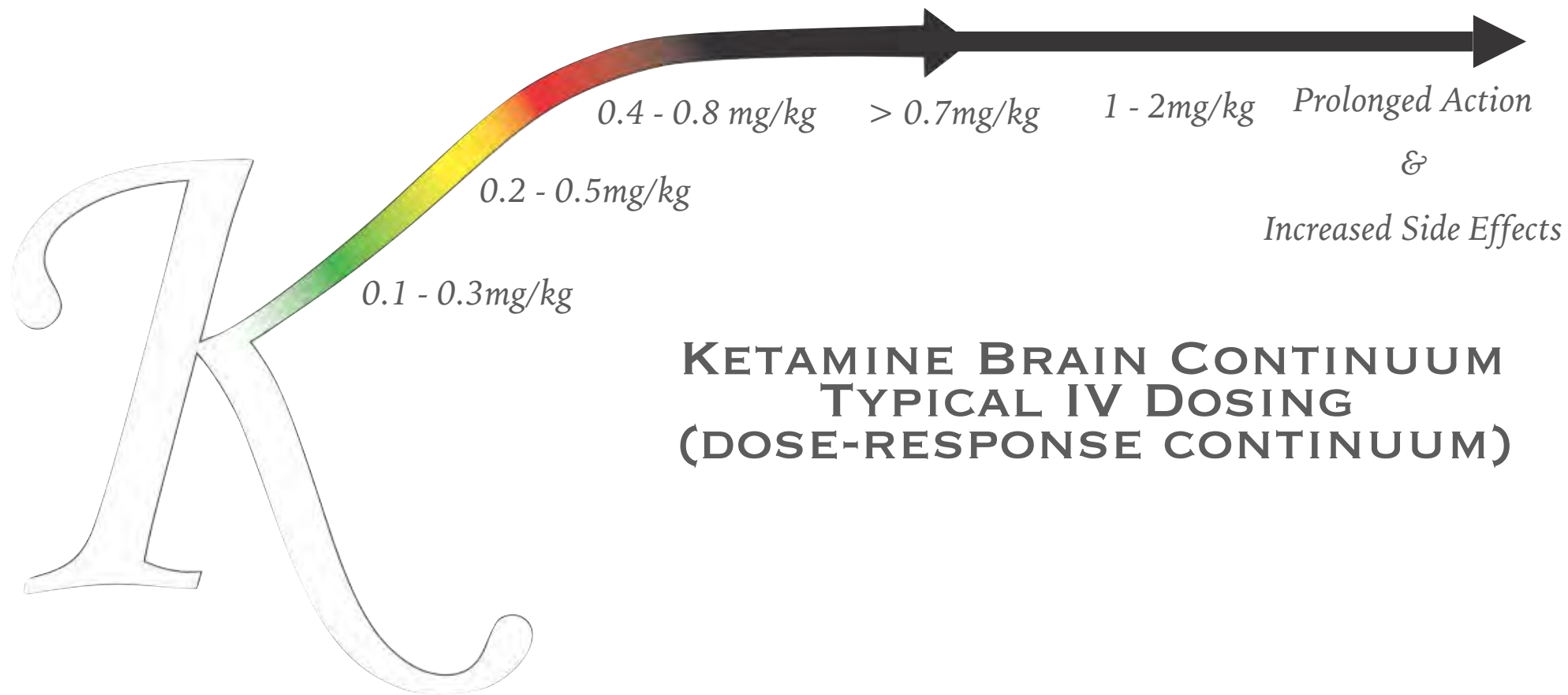
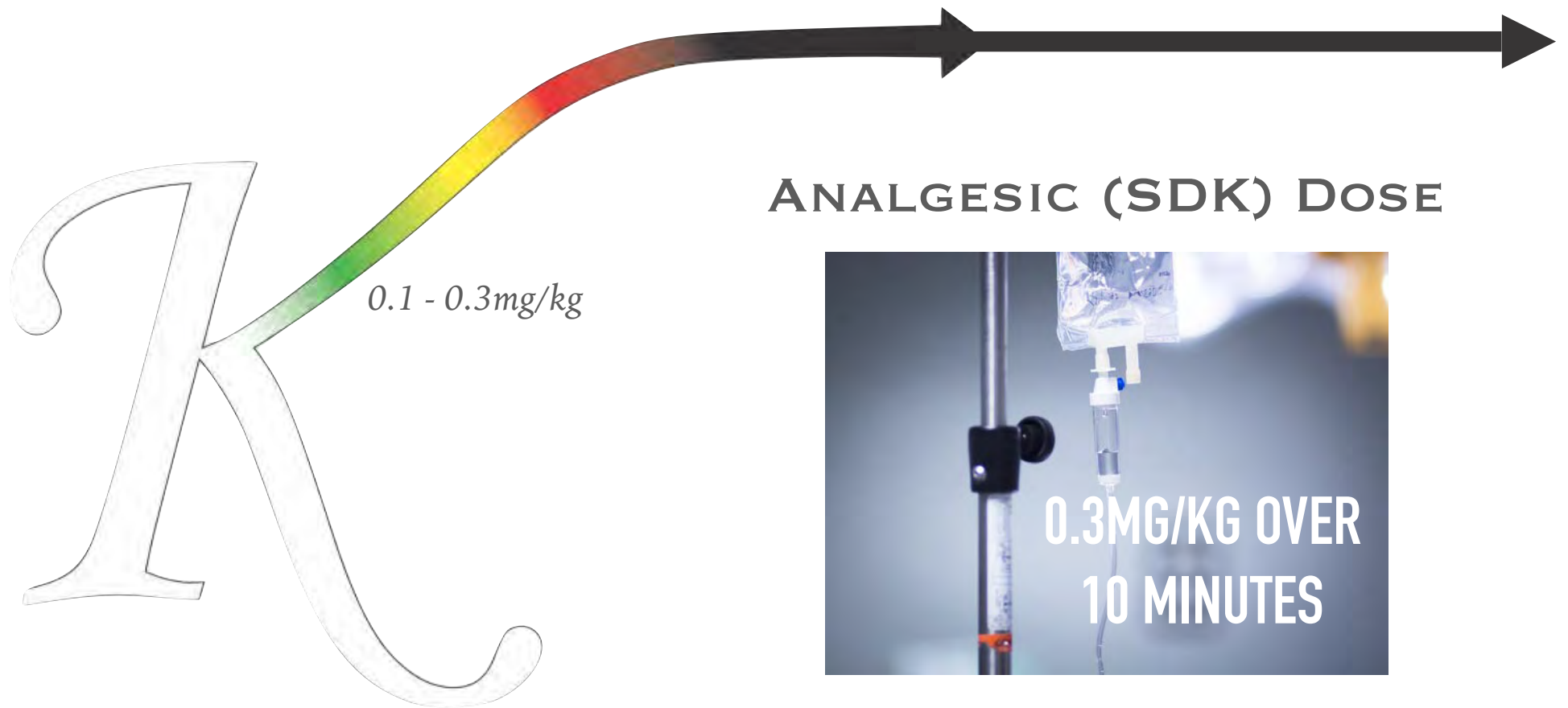


IMAGE CREDIT: REUBEN STRAYER - EMUPDATES.COM (USED WITH PERMISSION) (MODIFIED)

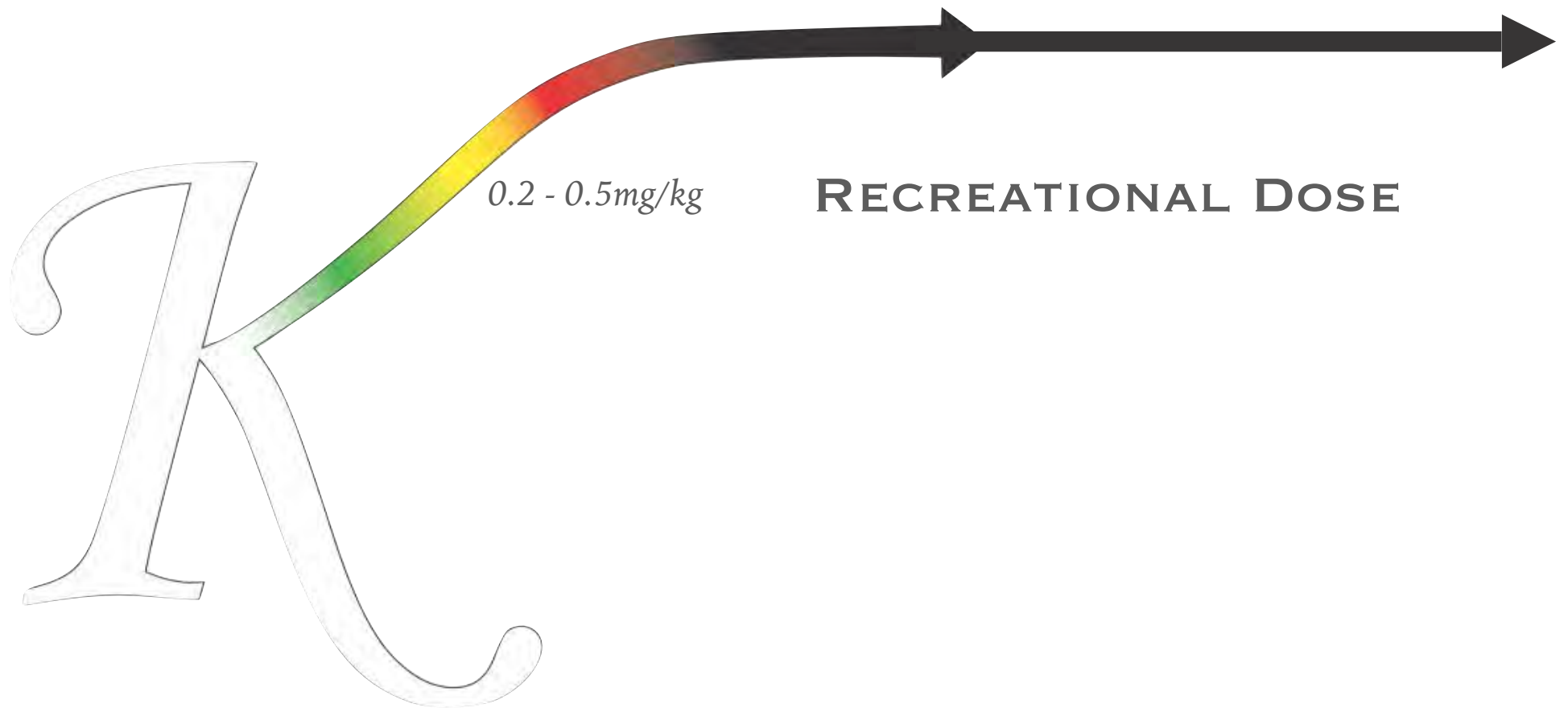
KETAMINE FOR THE CRITICALLY ILL PATIENT



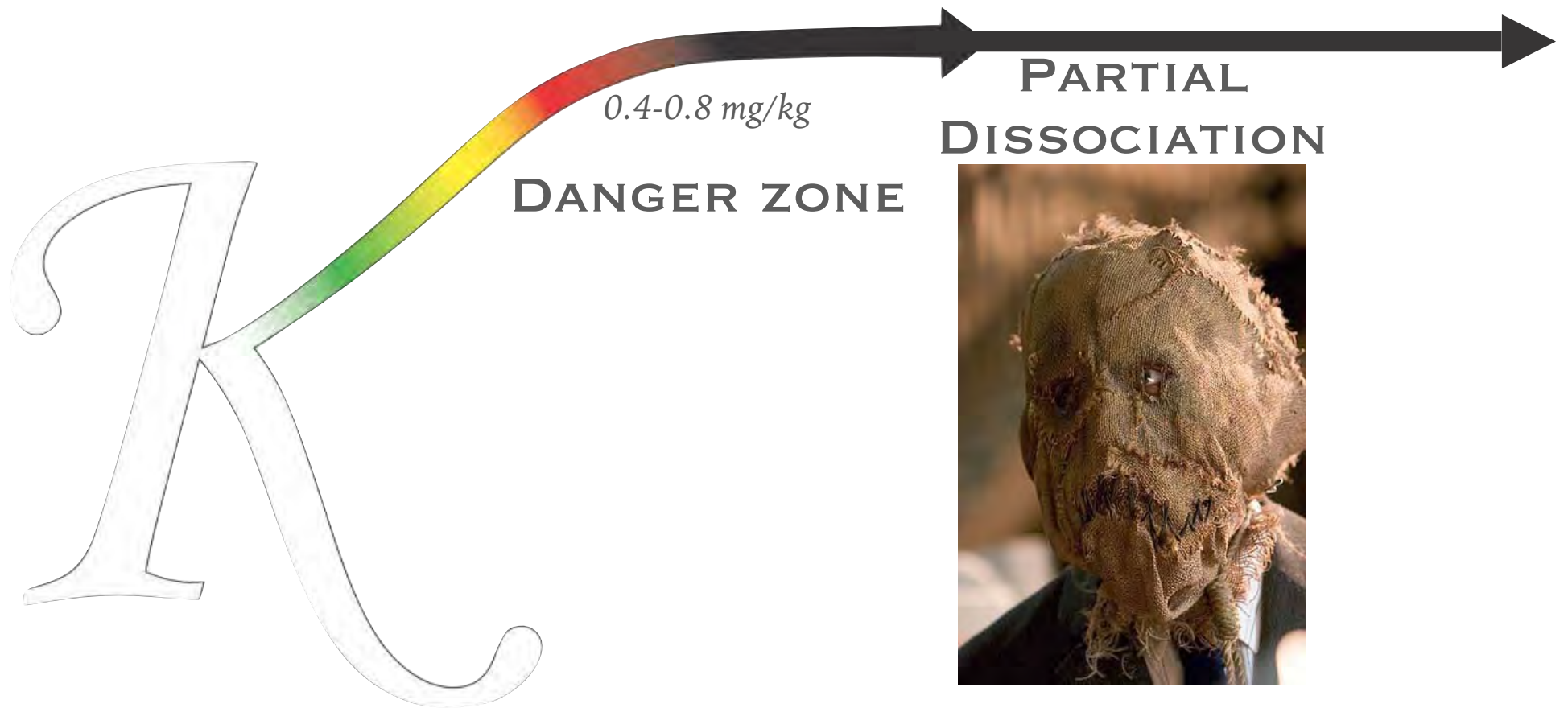
KETAMINE FOR THE CRITICALLY ILL PATIENT



KETAMINE FOR THE CRITICALLY ILL PATIENT



KETAMINE FOR THE CRITICALLY ILL PATIENT



KETAMINE FOR THE CRITICALLY ILL PATIENT





INTRAMUSCULAR
3-5 MG/KG



INTRANASAL
0.5 - 9 MG/KG

REF. ACEP NOW - [HTTPS://WWW.ACEPNOW.COM/ARTICLE/WHEN-TO-USE-INTRANASAL-MEDICATIONS-IN-CHILDREN/](https://www.acepnow.com/article/when-to-use-intranasal-medications-in-children/) (ACCESSED JAN. 25, 2019).







KETAMINE FOR THE CRITICALLY ILL PATIENT



KETAMINE FOR THE CRITICALLY ILL PATIENT



THE BAD

LARYNGEAL SPASMS

HYPER-SALIVATION

APNEA

INCREASES MYOCARDIAL O₂ DEMAND

DECREASED SYMPATHETIC TONE



LARYNGEAL SPASMS

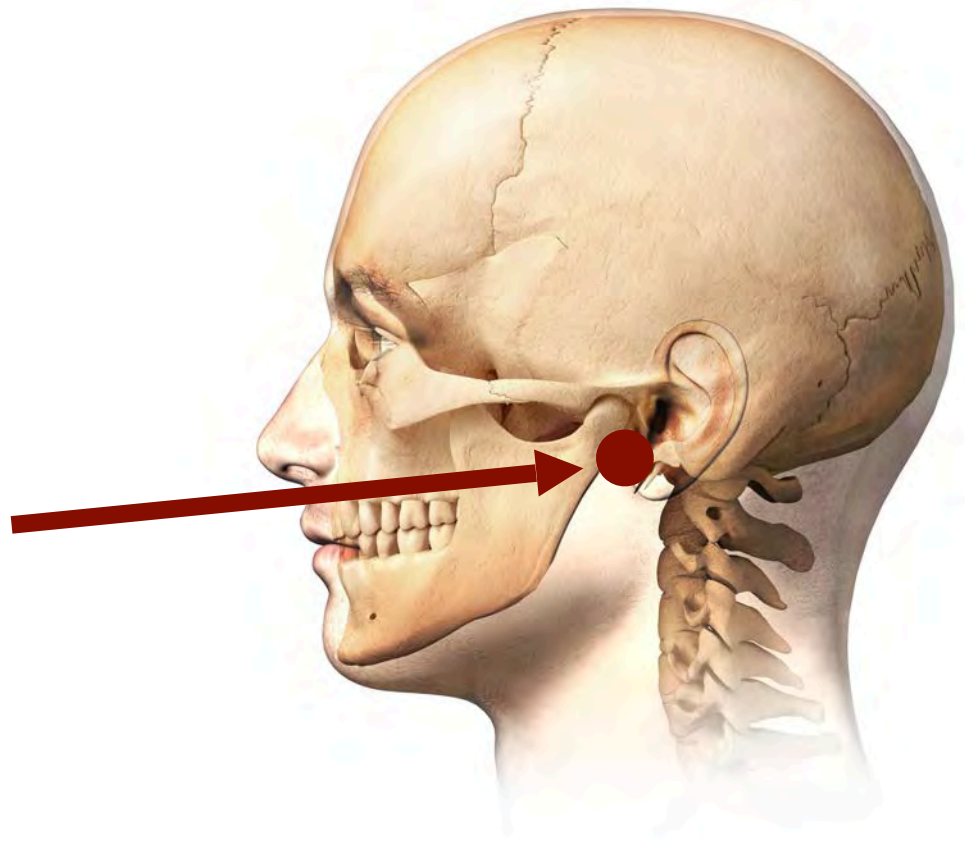
KETAMINE FOR THE CRITICALLY ILL PATIENT

LARYNGEAL SPASMS

PPV / CPAP

“LARSON’S POINT”

RSI



[HTTPS://WWW.ALIEM.COM/2010/12/TRICK-OF-TRADE-LARYNGOSPASM-NOTCH/](https://www.aliem.com/2010/12/trick-of-trade-laryngospasm-notch/)

KETAMINE FOR THE CRITICALLY ILL PATIENT



HYPER-SALAVATION

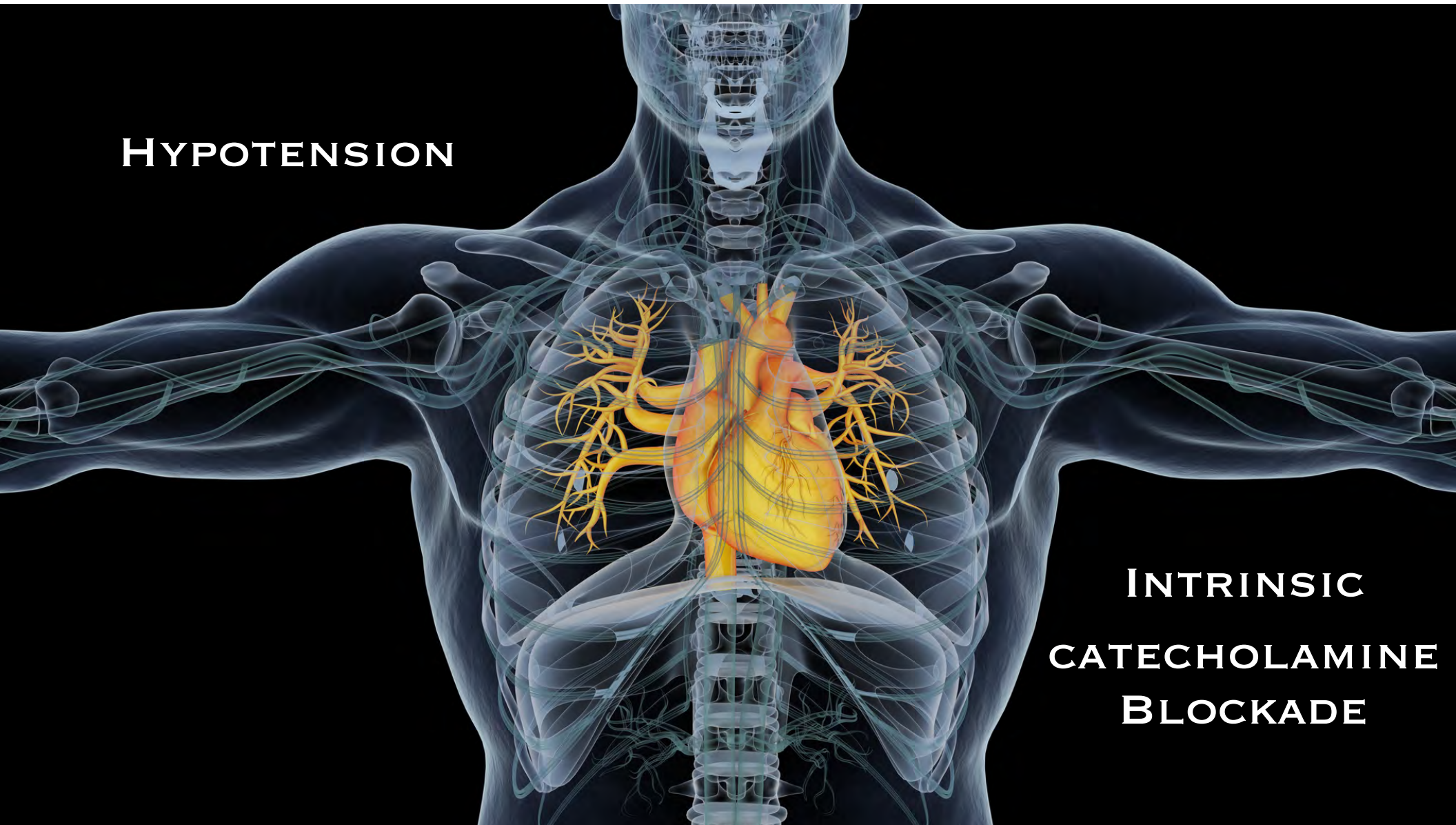


APNEA

INCREASED CARDIAC ISCHEMIA



HYPOTENSION



**INTRINSIC
CATECHOLAMINE
BLOCKADE**



RESUSCITATE BEFORE YOU INTUBATE

KETAMINE FOR THE CRITICALLY ILL PATIENT



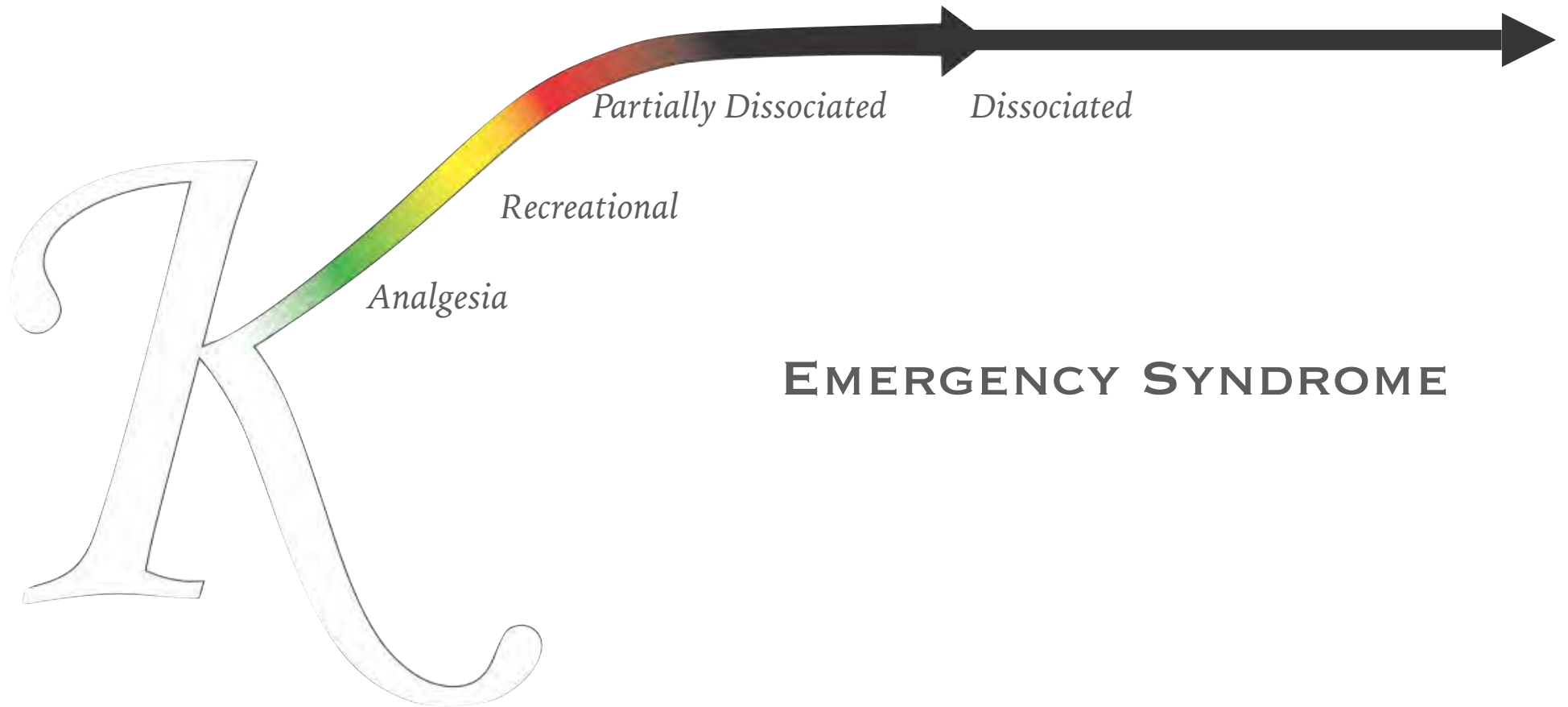
THE UGLY

EMERGENCY SYNDROME

PARTIAL DISSOCIATION

AWAKE PARALYSIS

KETAMINE FOR THE CRITICALLY ILL PATIENT



EMERGENCY SYNDROME



KETAMINE FOR THE CRITICALLY ILL PATIENT

ENCOURAGE HAPPY
THOUGHTS DURING
INDUCTION

CALM REASSURANCE

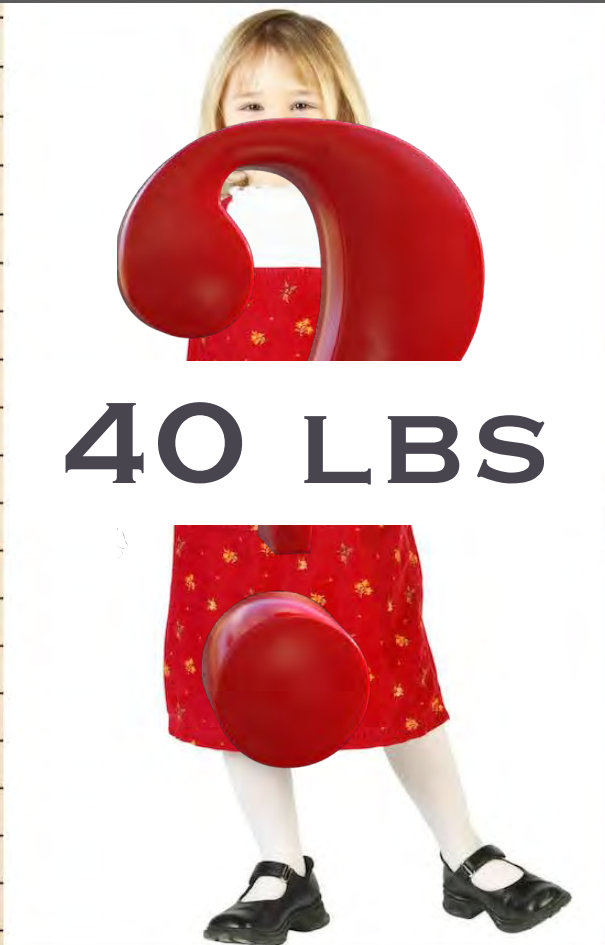
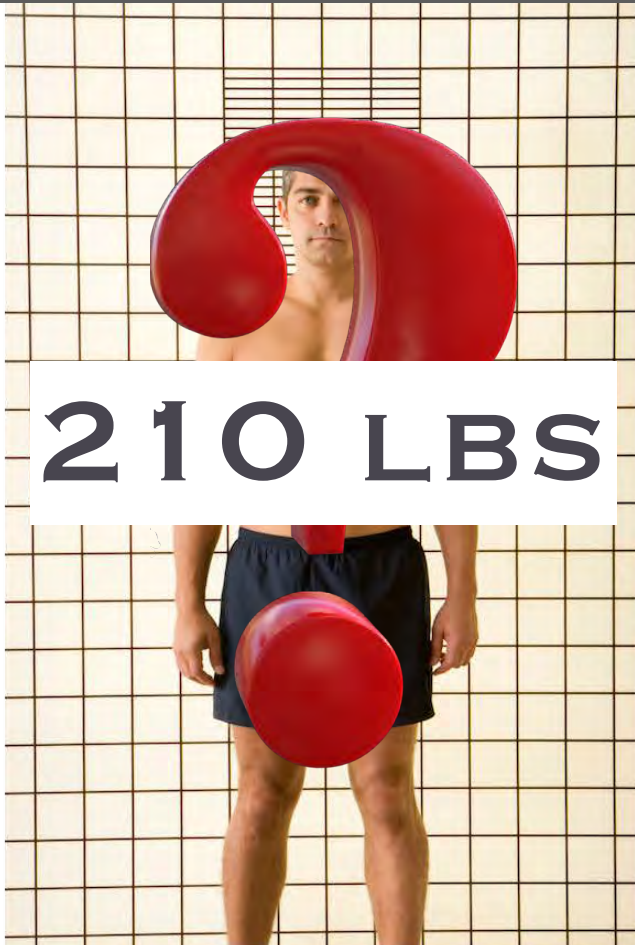
REDUCE STIMULI

KETAMINE FOR THE CRITICALLY ILL PATIENT

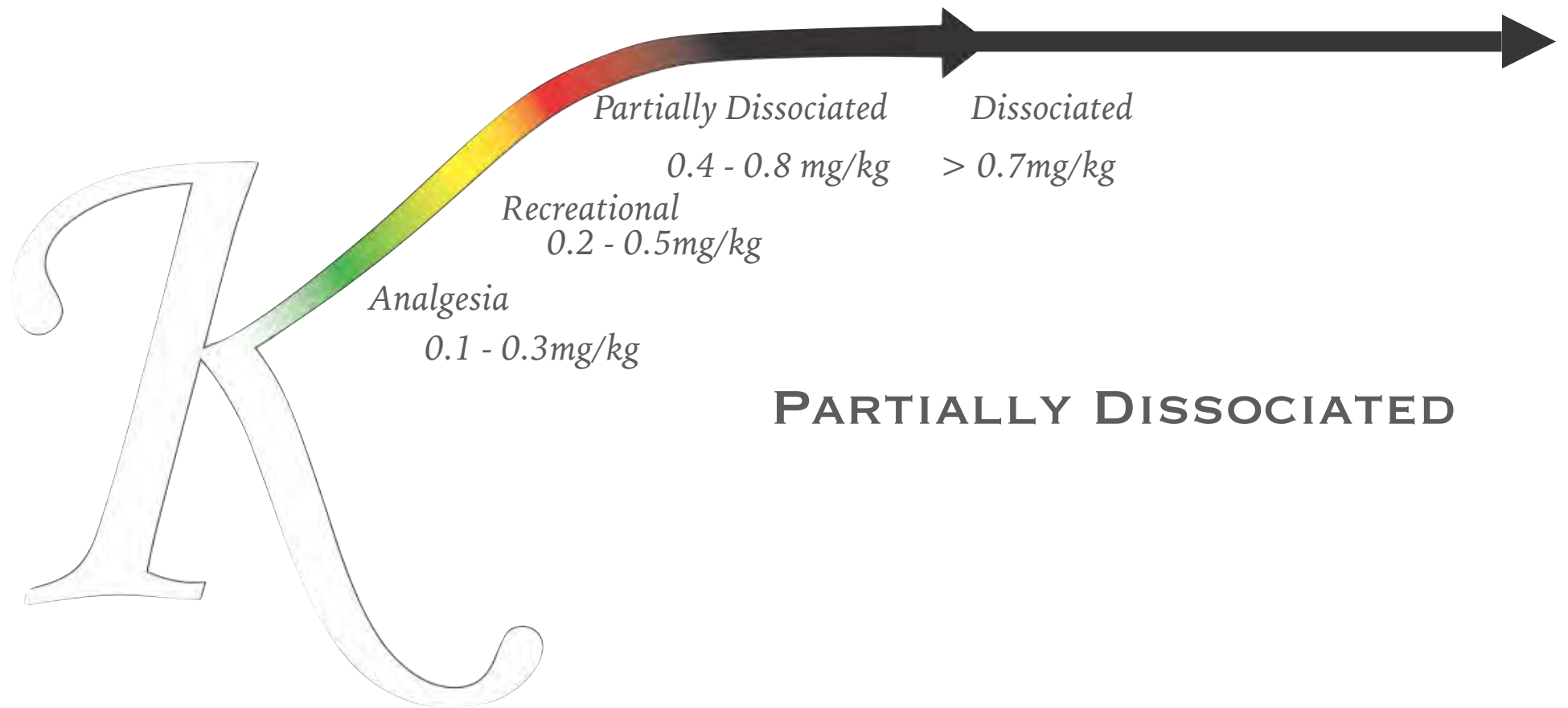


BENZODIAZEPINES

KETAMINE FOR THE CRITICALLY ILL PATIENT

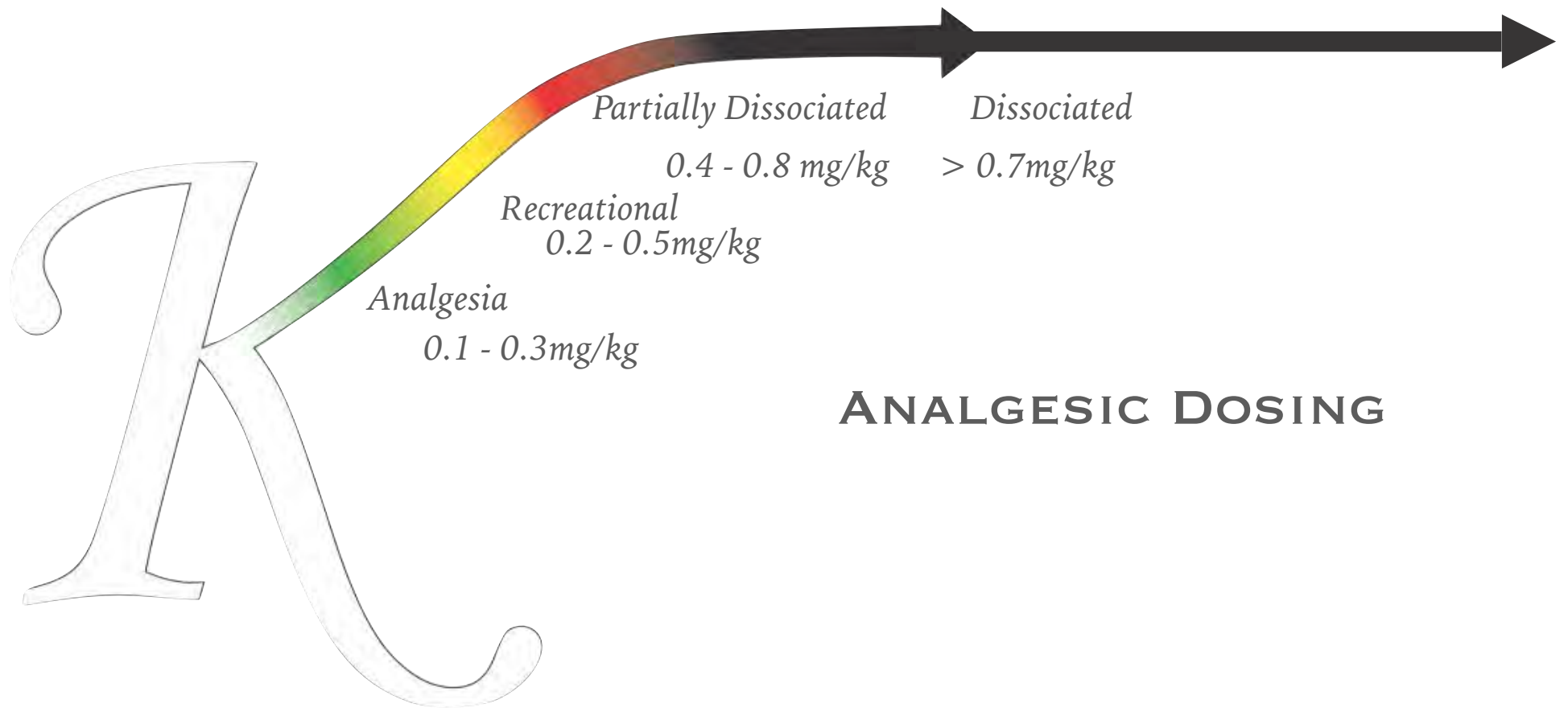


KETAMINE FOR THE CRITICALLY ILL PATIENT





KETAMINE FOR THE CRITICALLY ILL PATIENT



KETAMINE FOR THE CRITICALLY ILL PATIENT



**1 in 10 patients experience Awake
Paralysis post intubation**

TASAKA, C. L., DUBY, J. J., PANDYA, K., WILSON, M. D., & A HARDIN, K. (2016). INADEQUATE SEDATION DURING THERAPEUTIC PARALYSIS: USE OF BISPECTRAL INDEX IN CRITICALLY ILL PATIENTS. DRUGS - REAL WORLD OUTCOMES, 3(2), 201-208. DOI:10.1007/S40801-016-0076-3

KETAMINE FOR THE CRITICALLY ILL PATIENT

“INTUBATION USING ROCURONIUM INCREASES A PATIENT'S RISK OF WAKEFUL PARALYSIS.”

IMPACT OF PARALYTIC AGENT ON POSTINTUBATION SEDATION, BILLUPS, KELSEY ET AL. AIR MEDICAL JOURNAL, VOLUME 38, ISSUE 1, 39 - 44

KETAMINE FOR THE CRITICALLY ILL PATIENT

DURATION

3-20 MIN



KETAMINE FOR THE CRITICALLY ILL PATIENT

DURATION

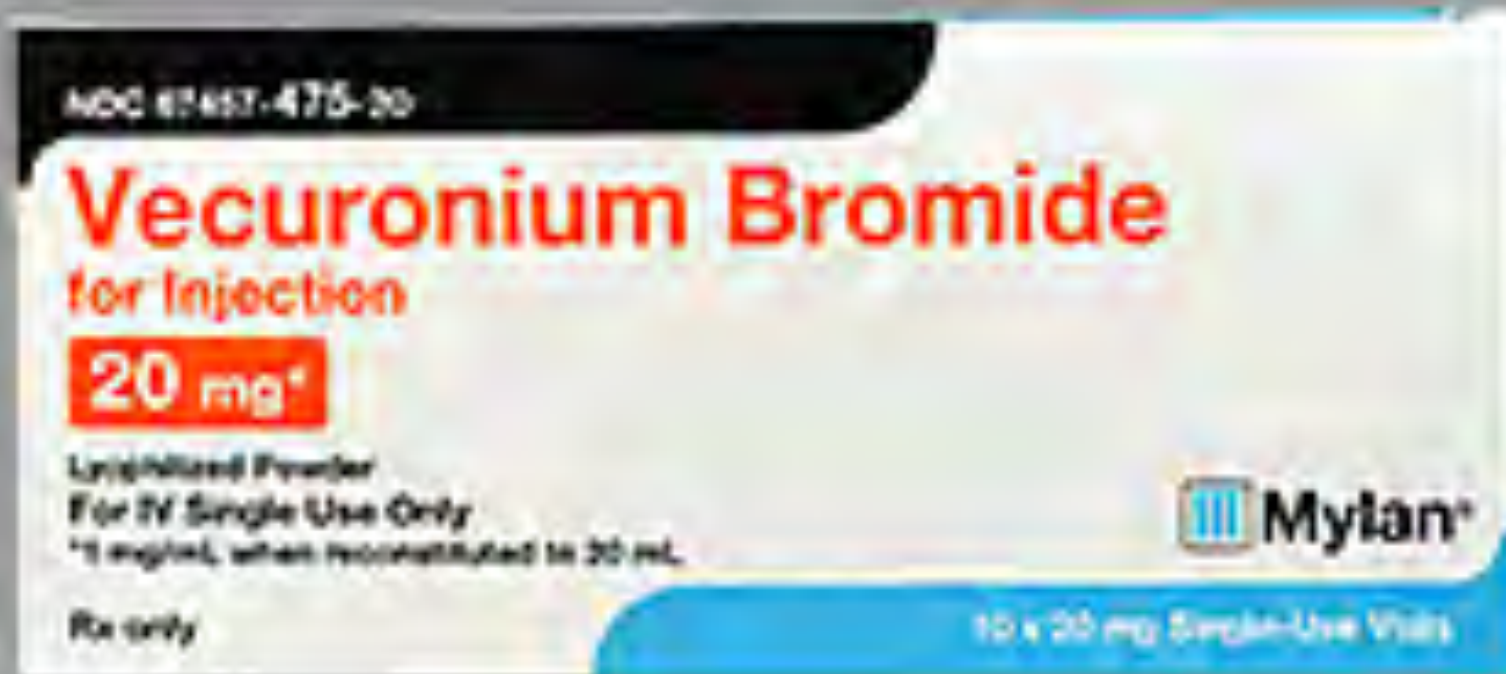
35-45



KETAMINE FOR THE CRITICALLY ILL PATIENT

DURATION

40-60 MIN



KETAMINE FOR THE CRITICALLY ILL PATIENT



**KETAMINE FOR CONTINUED
SEDATION DURING TRANSPORT
(0.5 - 1 MG/KG/HR)**



How Do We Apply This?





A close-up photograph of a patient lying down, receiving mechanical ventilation. A clear plastic endotracheal tube is inserted into the patient's airway, connected to a blue and white ventilator circuit. The patient's face is partially visible, and they appear to be unconscious. The background is a blurred clinical setting.

**Pre Oxygenation: Optimize
preintubation oxygenation.**



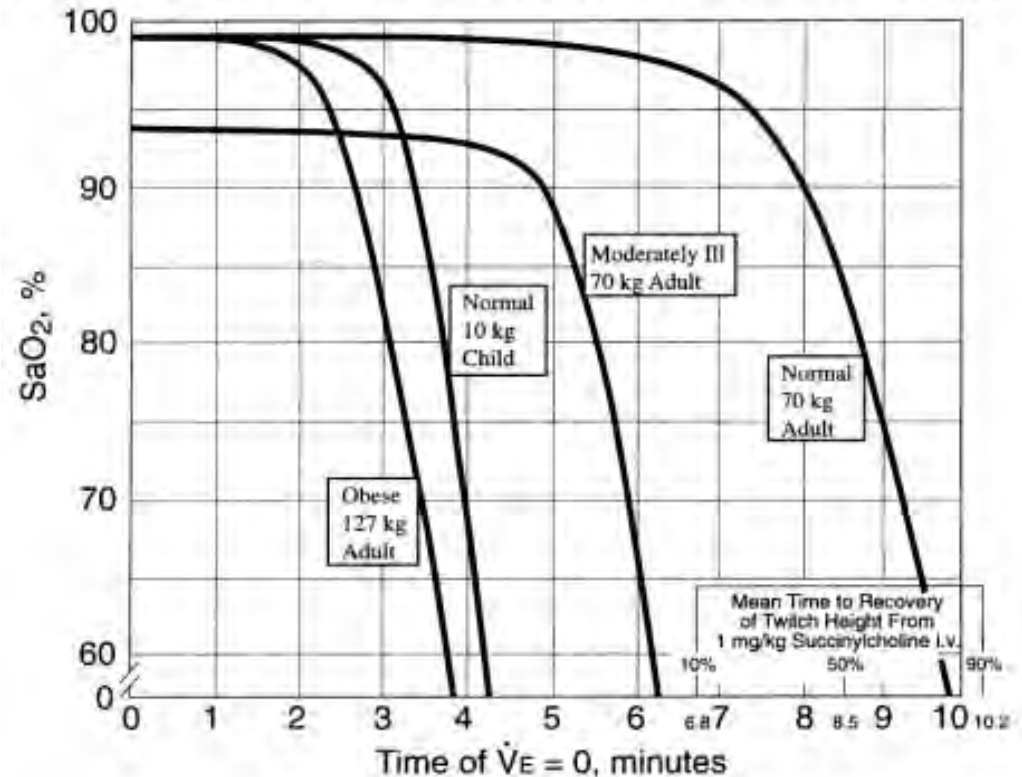
All patients with SpO₂ < 95% prior to RSI

KETAMINE FOR THE CRITICALLY ILL PATIENT

Reduce chances of critical desaturation event

- W/O PreOx, healthy patient desats 45-60 sec.
- Sick = 10-15 sec

TIME TO HEMOGLOBIN DESATURATION WITH INITIAL $F_{A}O_2 = 0.87$

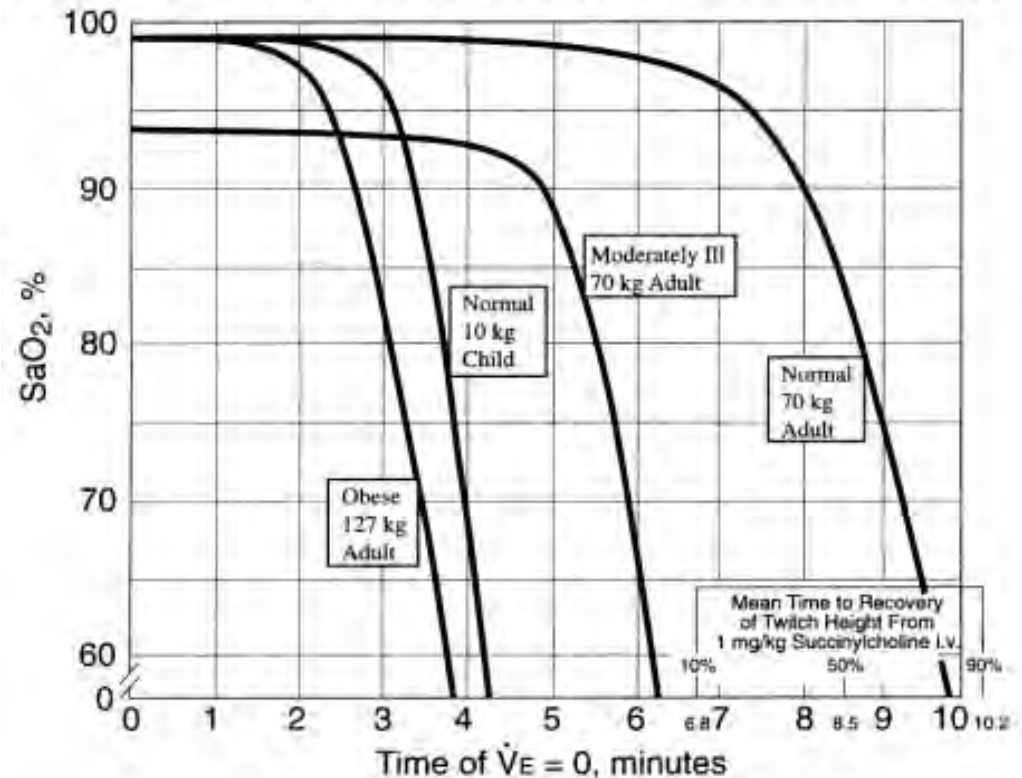


KETAMINE FOR THE CRITICALLY ILL PATIENT

Goals

- Complete Arterial / Tissue / Venous (SvO₂) O₂ Saturation
- Complete Nitrogen Washout

TIME TO HEMOGLOBIN DESATURATION WITH INITIAL $F_{A}O_2 = 0.87$





Sit pt up at least 30 degrees.

NC @ 15 Imp

NRB @ 15 Imp or BVM w/
PEEP at 15 cmH₂O or CPAP

3 minutes VT breathing

Let pt breath. Do Not Bag

PPV if ventilations inadequate



Why both NC
and NRB/BVM?

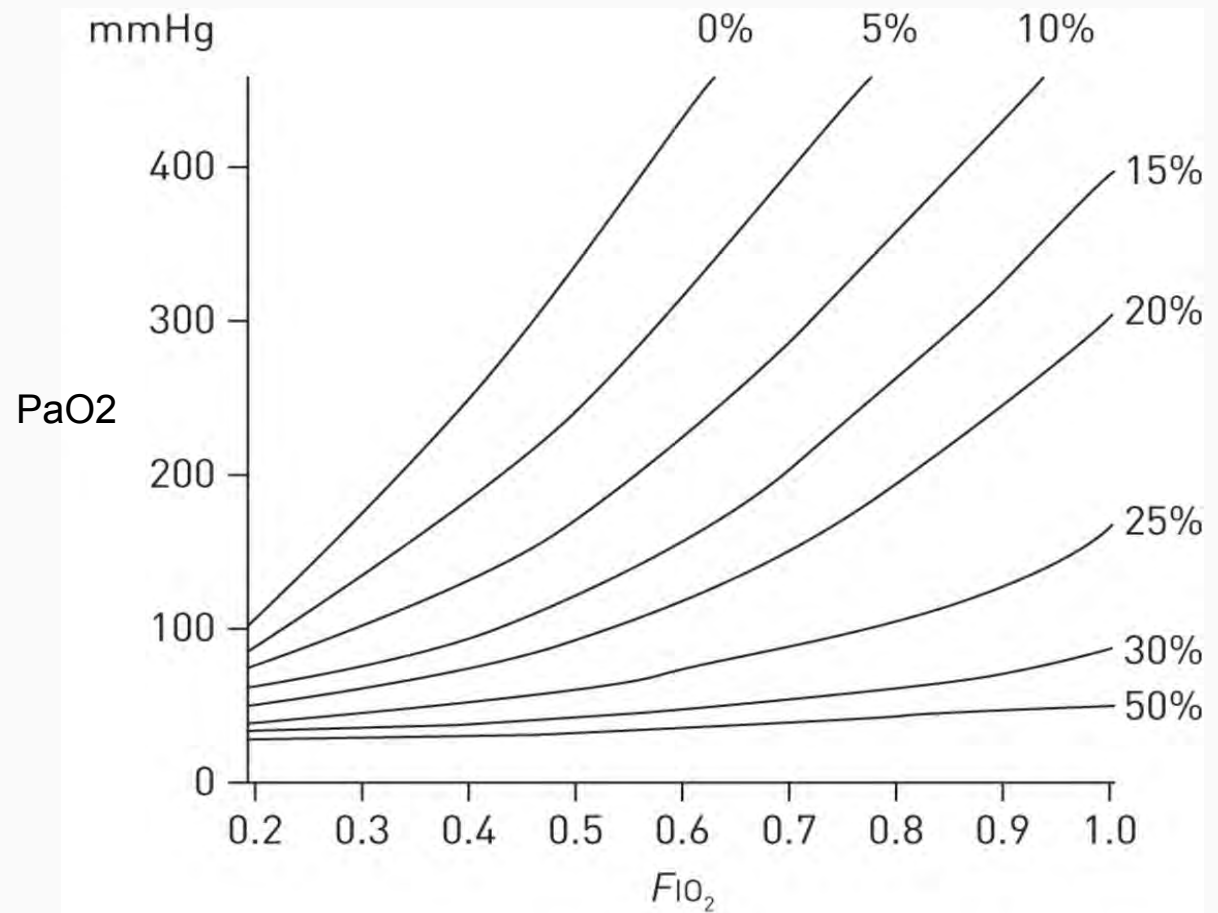
Traditional NRB's and
BVM's don't supply
100% FiO₂ alone.

When and Why add PEEP?

If patient remains hypoxic after NRB and NC.

PEEP increase MAP which drives oxygenation pressures.

PEEP required to correct for Shunt Physiology.




Iso-Shunt Diagram



How is the related to this lecture?







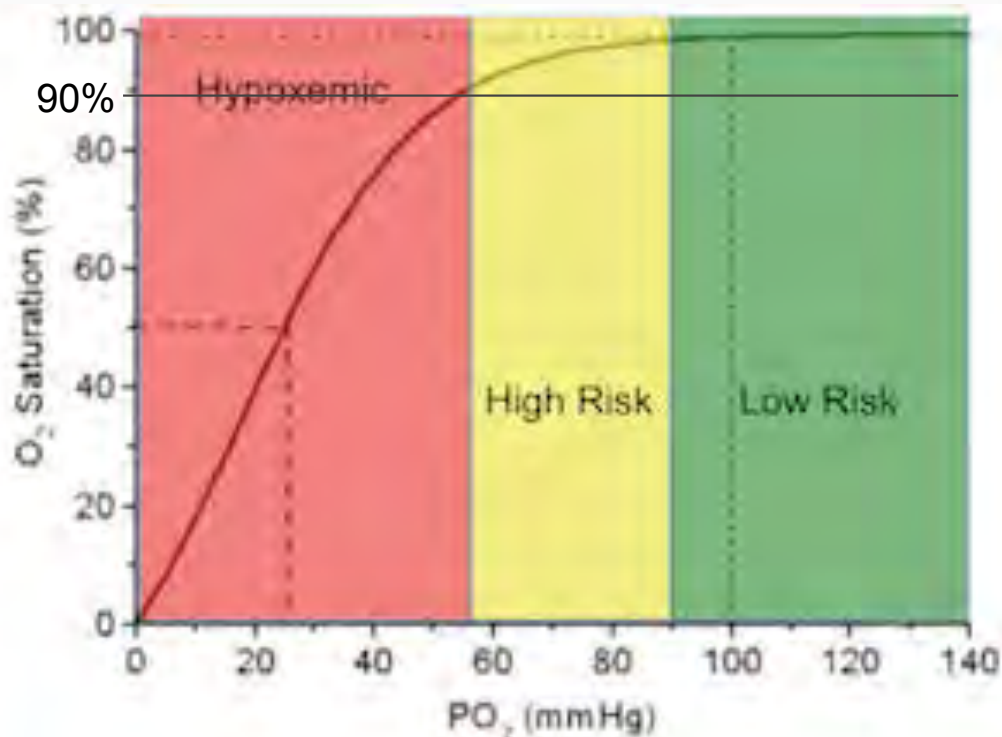
Delayed Sequence Intubation: Procedural Sedation for PreOxygenation



To facilitate
preoxygenation in the
setting of agitation
preventing standard preox.

Typically from Hypoxia or
Hypercarbia

Why?



UNCOOPERATIVE PATIENTS, WHETHER FROM HYPOXIA, HYPERCAPNIA, OR ACUTE ILLNESS POSE A PARTICULAR CHALLENGE DURING ATTEMPTS AT PREOXYGENATION.

ATTEMPTING TO INTUBATE A HYPOXIC PATIENT INCREASE THE RISK OF CRITICAL DESATURATION.

How?



Ketamine

1.5 - 2 mg/kg slow IVP

KETAMINE FOR THE CRITICALLY ILL PATIENT



KETAMINE:

DOSE: 2 MG/KG

ONSET: RAPID, <60 SECONDS

DURATION: 5-20 MINUTES

**PRESERVES RESPIRATIONS AND
PROTECTIVE REFLEXES**

**ONCE O2 SATS REACH >95%, START 3
MINUTES NITROGEN WASHOUT, THEN
PROCEED WITH NMBA AND
INTUBATION.**

KETAMINE FOR THE CRITICALLY ILL PATIENT

Pro's

Improved patient safety by allowing adequate preoxygenation.

Reduced risk of gastric inflation, vomiting, and aspiration by minimizing PPV.

More controlled intubating environment

Con's

Requires additional time

Risk of drug reaction

Risk of under dosing and inducing a partially dissociated state.

Hypersalivation and laryngeal spasm with high doses.

Brief apnea with rapid administration





KETAMINE FOR THE CRITICALLY ILL PATIENT



SCENARIO

THIS TIME OF YEAR

CALL RECEIVED 1020

“FALLEN CLIMBER BROKEN
LEG”

90 MIN HIKE FROM BEST
ACCESS POINT



**WHAT COMPLICATIONS
CAN YOU EXPECT?**

**WHAT EQUIPMENT WILL
YOU TAKE?**

KETAMINE FOR THE CRITICALLY ILL PATIENT

INJURIES

OPEN FX RIGHT ANKLE

DP PULSES ABSENT

FRACTURE RIGHT TIB/FIB



KETAMINE FOR THE CRITICALLY ILL PATIENT



PRIORITIES?

KETAMINE FOR THE CRITICALLY ILL PATIENT

REDUCE THE ANKLE FRACTURE
(IMPROVE DISTAL PERFUSION)

STABILIZED INJURIES

MANAGE PAIN DURING
EXTRICATION

KETAMINE FOR THE CRITICALLY ILL PATIENT

DISSOCIATIVE DOSE

2 MG/KG

TO REDUCE ANKLE,
STABILIZE EXTREMITIES,
AND PACKAGE FOR EGRESS



KETAMINE FOR THE CRITICALLY ILL PATIENT



ANALGESIC DOSE

**0.3MG/KG INFUSION OVER 10-15
MIN**

**NO ADVANCED MONITORING
REQUIRED**

RE-DOSE PRN

AMERICAN COLLEGE OF EMERGENCY PHYSICIANS. "OPTIMIZING THE TREATMENT OF ACUTE PAIN IN THE EMERGENCY DEPARTMENT." POLICY STATEMENT. APPROVED APRIL 2017.

KETAMINE FOR THE CRITICALLY ILL PATIENT

BENEFITS

MINIMAL GEAR REQUIRED

LESS DRUG TO CARRY

OPIATE SPARING



DIANE
44 YEARS OLD
MOTHER OF 3



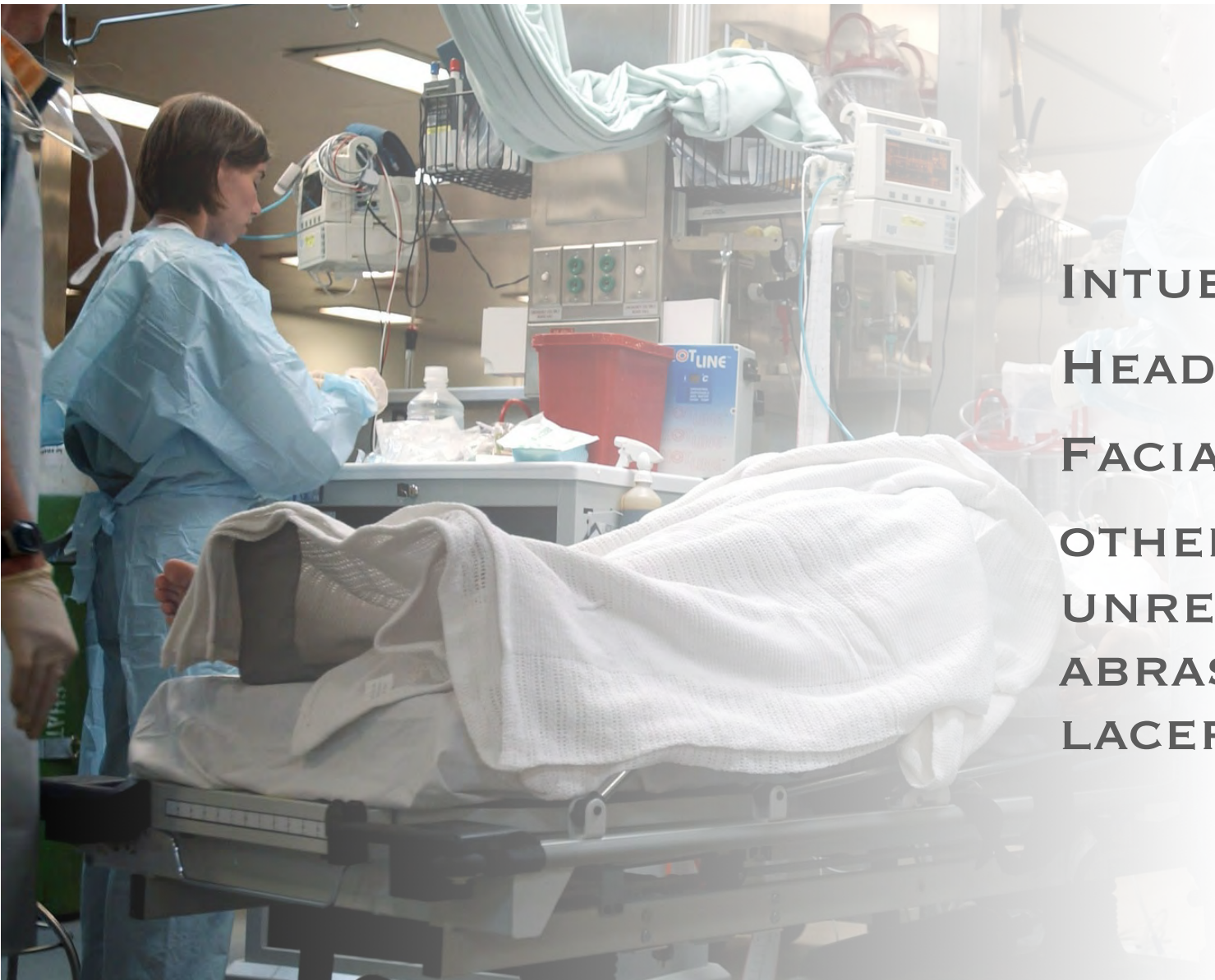




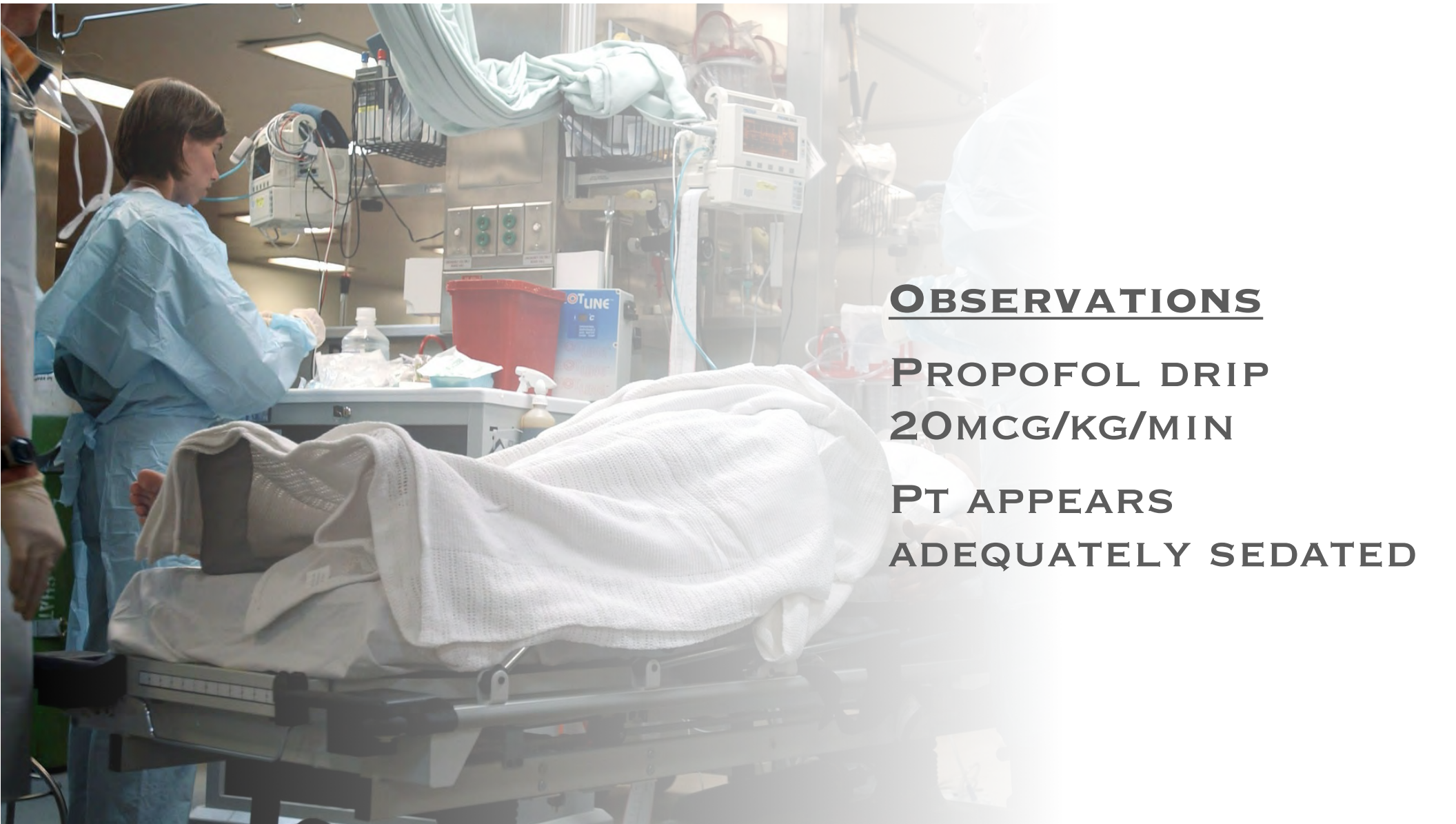
**CT SHOWED
LARGE EPIDURAL
BLEED W/
MIDLINE SHIFT**



DECISION MADE TO TRANSFER



**INTUBATED ON VENT
HEAD CONTUSION
FACIAL FRACTURES
OTHER
UNREMARKABLE
ABRASIONS /
LACERATIONS**



OBSERVATIONS

**PROPOFOL DRIP
20MCG/KG/MIN**

**PT APPEARS
ADEQUATELY SEDATED**



Vital

Breath sounds clean
bilaterally

Good chest rise

Pupils 3mm / Sluggish

BP 114/64

HR 98

RR Assisted 20



THOUGHTS?

TRANSPORT

PT BECOMES MORE RESTLESS

BUCKING ET TUBE

NEGATIVE DOPE

HR 140's

FENTANYL GIVEN W/O EFFECT

PROPOFOL STILL AT 20MCG/KG/MIN

HERE'S WHAT WAS
DONE.

PROPOFOL INCREASED



BLOOD PRESSURE
DROPPED TO 56
SYSTOLIC



**PROPOFOL TITRATED
DOWN**

**FLUIDS AND
PRESSORS STARTED**

**PATIENT ARRIVED AT
RECEIVING WITH BP
IN THE 90'S AND
UNDER SEDATED**



**DIANE ENDED UP
TRACHED AND VENTED**

**DISCHARGED TO LONG
TERM REHAB WITH
SEVERE
NEUROLOGICAL
IMPAIRMENT**



**STRESS OF TRANSPORT
INCREASES METABOLISM
AND REDUCES
EFFECTIVENESS OF
SEDATION**



KETAMINE FOR THE CRITICALLY ILL PATIENT

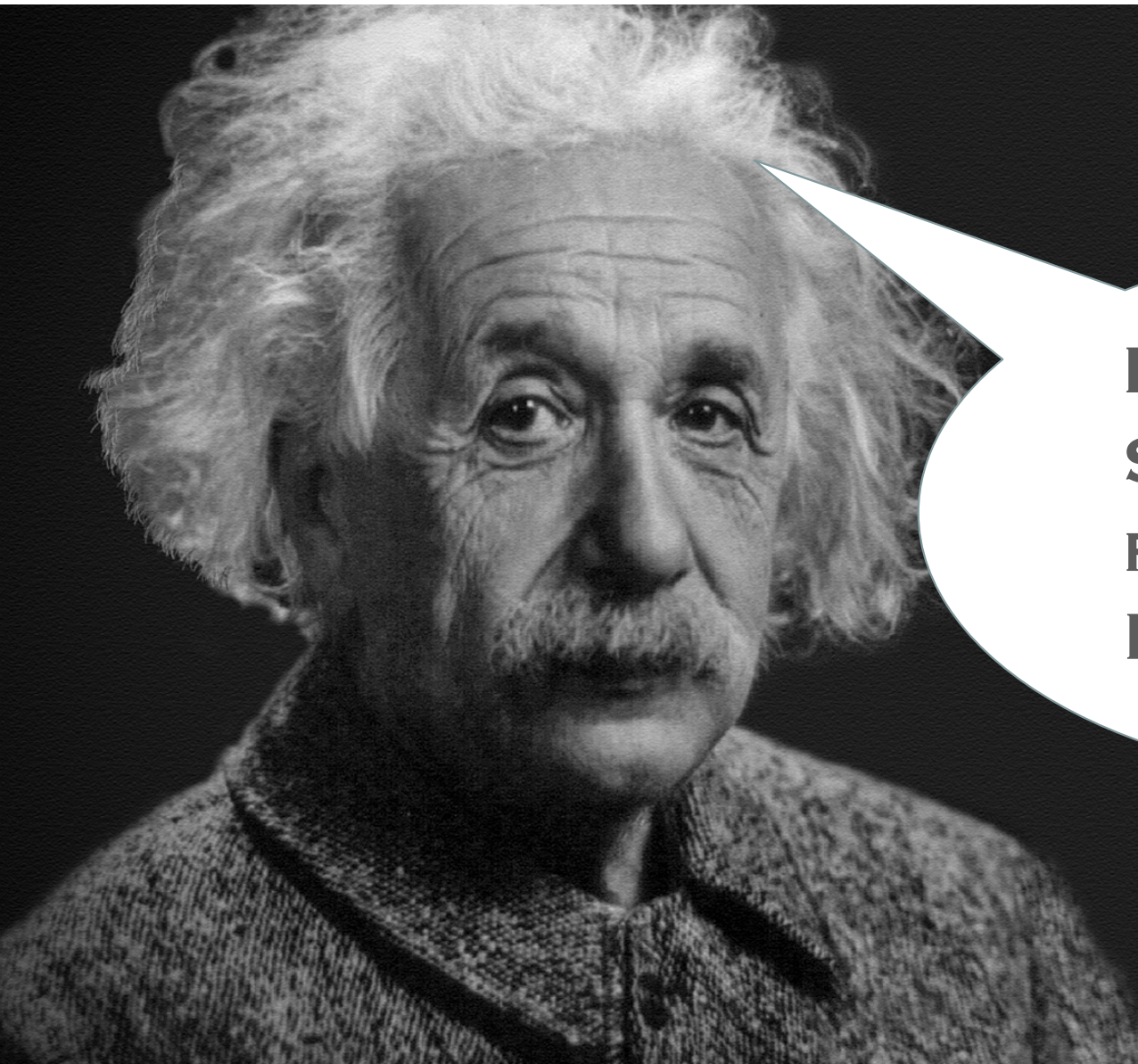
ALTERNATIVE OPTIONS

KETAMINE INFUSION

0.5-1.5 MG/KG/HR



GROETZINGER, LM. ET AL., KETAMINE INFUSION FOR ADJUNCT SEDATION IN MECHANICALLY VENTILATED ADULT, PHARMACOTHERAPY, 2018 FEB; 38(2): 1810-188



**DID HE JUST
SAY KETAMINE
FOR A HEAD
INJURY?**

KETAMINE FOR THE CRITICALLY ILL PATIENT

**EXCELLENT ANALGESIA
AND SEDATION PROFILE**

**HEMODYNAMICALLY
STABLE**

IMPROVES CBF

**NO SIGNIFICANT EFFECT
ON ICP**



KETAMINE FOR THE CRITICALLY ILL PATIENT

LEFT = ICP / CPP AND
MAP FOR ALL PATIENTS IN
STUDY

RIGHT = ICP / CPP / MAP
FOR PTS WITH ↑ ICP
BEFORE PROCEDURE

Ketamine for intracranial hypertension

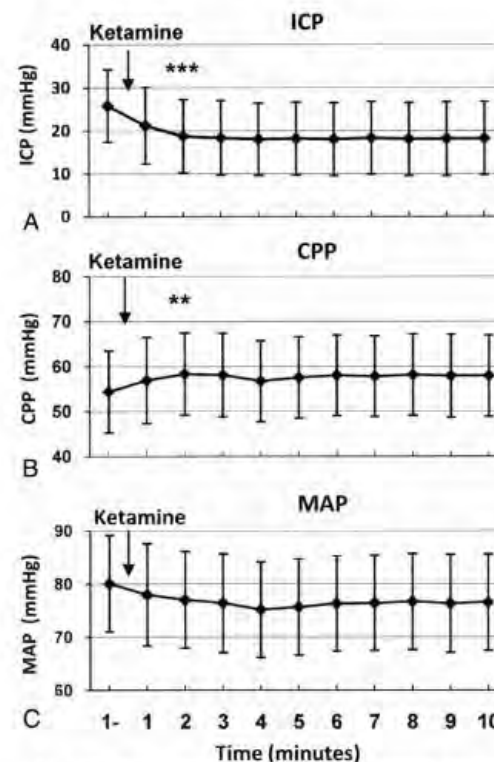


FIG. 1. Graphs showing ICP (A), CPP (B), and MABP (C; MAP) responses to ketamine administration in the entire study population (30 patients, 82 events). Intracranial pressure decreased by 30% within 2 minutes of ketamine administration. ** $p < 0.005$, *** $p < 0.001$.

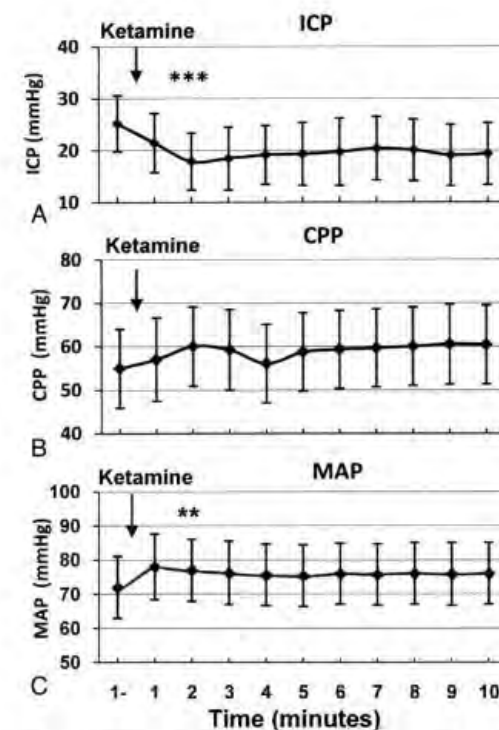


FIG. 2. Graphs demonstrating ICP (A), CPP (B), and MABP (C) responses to ketamine administration before a potentially distressing intervention in patients with intracranial hypertension (17 events, Group 1). Intracranial pressure decreased by ~20% within 2 minutes of ketamine administration and did not increase during the intervention. ** $p < 0.005$, *** $p < 0.001$.

BAR-JOSEPH G, ET AL, EFFECTIVENESS OF KETAMINE IN DECREASING INTRACRANIAL PRESSURE IN CHILDREN WITH INTRACRANIAL HYPERTENSION, JOURNAL NEUROSURGERY PEDIATRICS, 2009 JUL; 4(1):40-6

KETAMINE FOR THE CRITICALLY ILL PATIENT

WHATS NEW

REFRACTORY SEIZURES





HAZEL - 5 YEARS
OLD

PMH - EPILEPSY

**KETAMINE FOR REFRACTORY
AND SUPER REFRACTORY
STATUS SEIZURES**



STATUS SEIZURES
SEIZURES LASTING > 5
MINUTES



REFRACTORY

NO RESPONSE TO FIRST AND
SECOND LINE THERAPY

SUPER REFRACTORY

REFRACTORY FOR >24 HOURS



**PERMANENT BRAIN TISSUE
INJURY AFTER 30 MINUTES**



35 MINUTES
**AVERAGE TIME FROM EMS
ACTIVATION TO ARRIVAL AT ED**



REF: NEMESIS DATE, "AVERAGE EMS RESPONSE TIMES, SCENE TIMES, AND TRANSPORT TIMES (911 ONLY) (2010-2011)

2 MAJOR BRAIN NEUROTRANSMITTERS

GAMMA-AMINOBUTYRIC ACID (GABA)

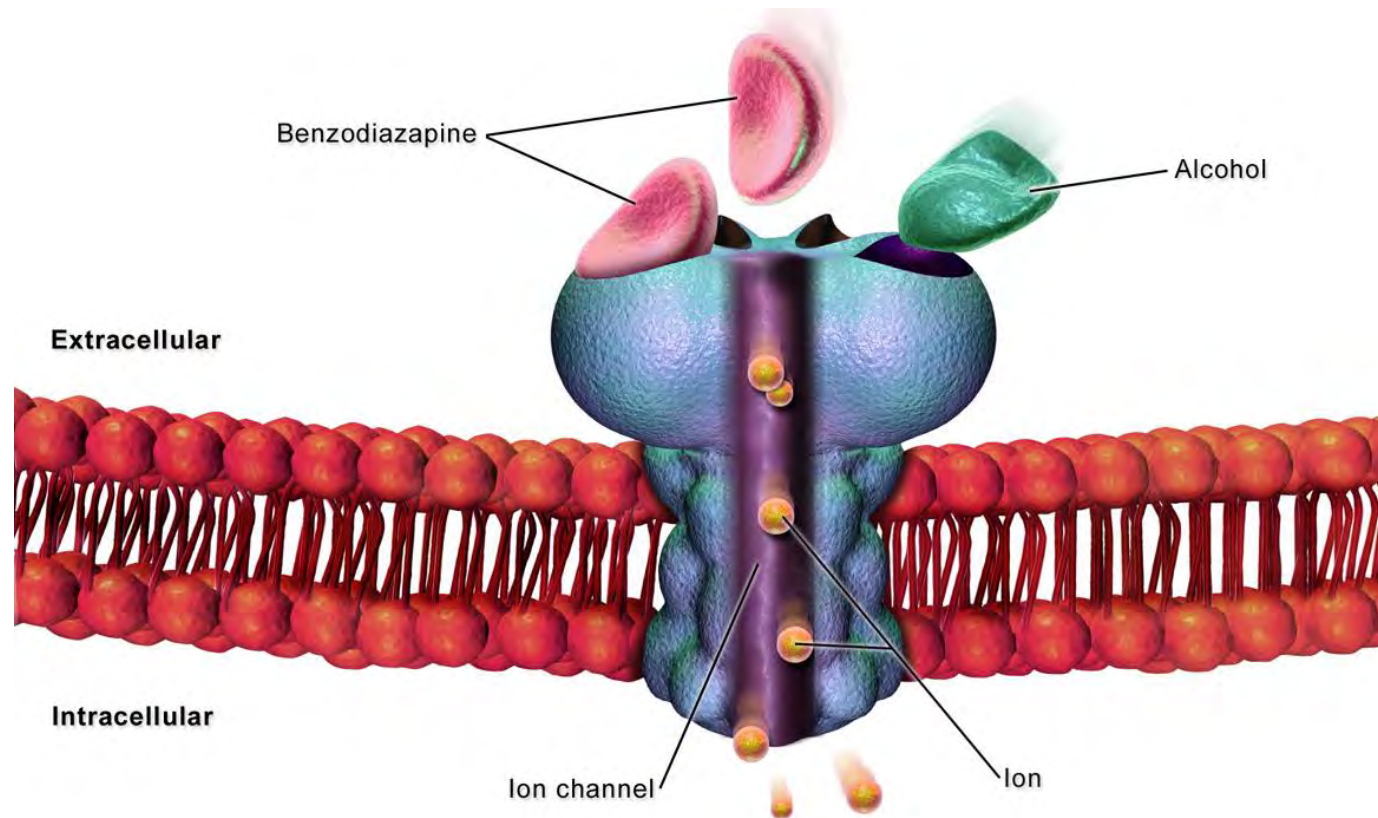
N-METHYL-D-ASPARTATE (NMDA)



KETAMINE FOR THE CRITICALLY ILL PATIENT

GABA RECEPTOR ACTIVATION

INHIBITORY RECEPTOR

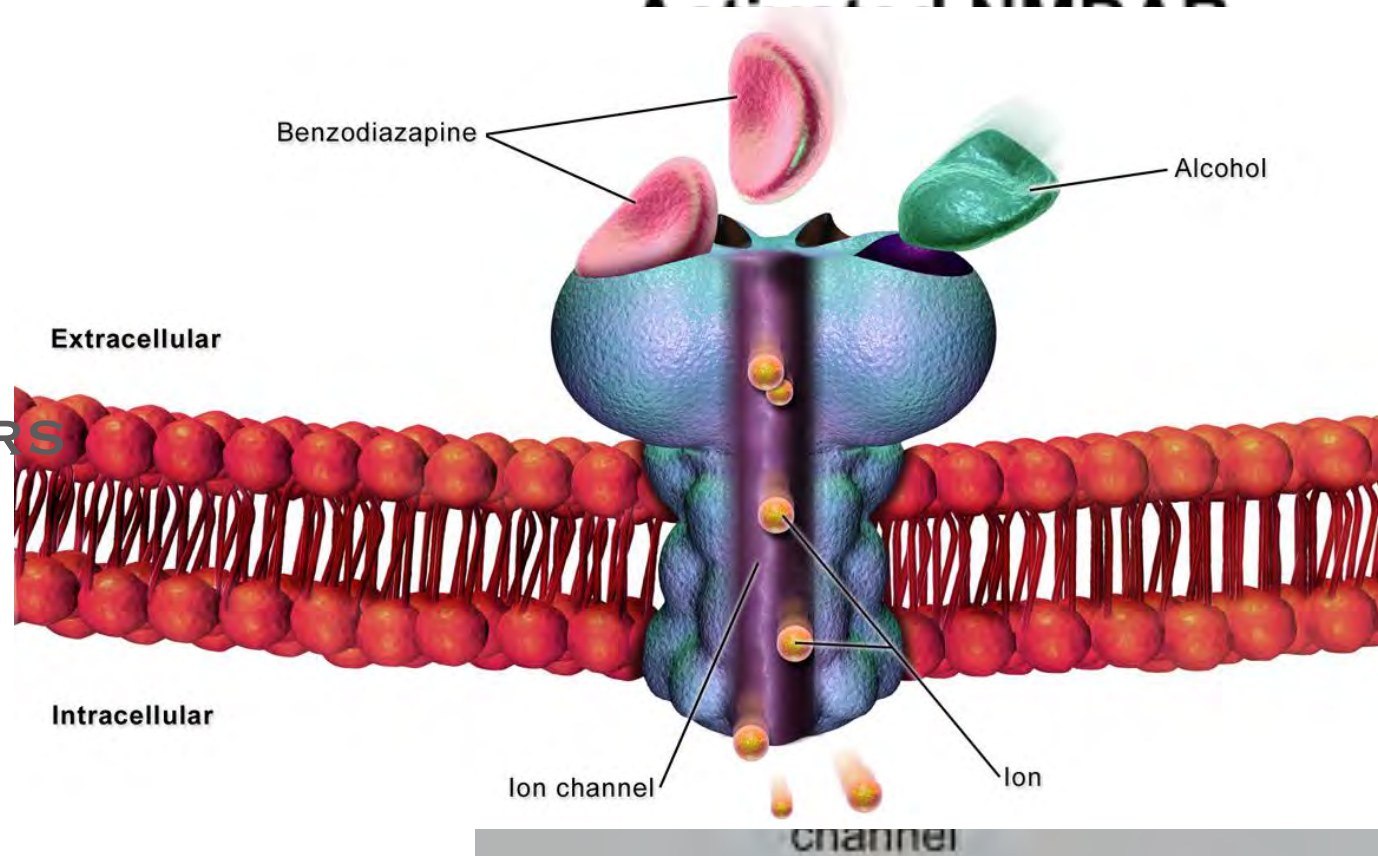


KETAMINE FOR THE CRITICALLY ILL PATIENT

GABA RECEPTORS
ACTIVATORS

NMDA

BENZODIAZEPINES /
KEPPRA / PROPOFOL /
VALPROIC ACID /
PHENYTOIN /
BARBITURATES



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KETAMINE EFFECTIVE FOR
SUPPRESSION OF REFRACTORY
AND SUPER REFRACTORY
SEIZURES



MUTKULE DP, RAO SM, CHAUDHURI JR, RAJASRI K. SUCCESSFUL USE OF KETAMINE FOR BURST SUPPRESSION IN SUPER REFRACTORY STATUS EPILEPTICUS FOLLOWING SUBSTANCE ABUSE. INDIAN J CRIT CARE MED. 2018;22(1):49-50.

**KETAMINE EFFECTIVE AS FIRST
LINE MEDICATION FOR
SUPPRESSION OF SEIZURES IN
14 OF 17 PATIENTS**



“KETAMINE MAY HELP REFRACTORY STATUS EPILEPTICS” PUBLISHED IN CLINICAL NEUROLOGY NEW - PUBLISHED JULY 11, 2013.

**DOSING FOR SEIZURE
SUPPRESSION?**

1 MG/KG

FOLLOWED BY

2MG/KG/HR INFUSION



MUTKULE DP, RAO SM, CHAUDHURI JR, RAJASRI K. SUCCESSFUL USE OF KETAMINE FOR BURST SUPPRESSION IN SUPER REFRACTORY STATUS EPILEPTICUS FOLLOWING SUBSTANCE ABUSE. INDIAN J CRIT CARE MED. 2018;22(1):49-50.

KETAMINE FOR THE CRITICALLY ILL PATIENT

WHATS NEW

REFRACTORY ASTHMA





REFRACTORY STATUS
ASTHMATICS

**PERSISTENT ASTHMA ATTACKS
DESPITE MEDICATIONS.**



RX
STANDARD THERAPY
CONTINUOUS BETA NEBS
STEROIDS
EPI
MAG
FLUID BOLUS
BPAP



KETAMINE IS INDUCTION
AGENT OF CHOICE FOR RSI

BRONCHODILATION



KETAMINE AS RESCUE THERAPY TO PREVENT INTUBATION



ESMAILIAN M, KOUSHKIAN ESFAHANI M, HEYDARI F. THE EFFECT OF LOW-DOSE KETAMINE IN TREATING ACUTE ASTHMA ATTACK; A RANDOMIZED CLINICAL TRIAL. EMERG (TEHRAN). 2018;6(1):E21.

YOUR BEST
TEACHER
IS
YOUR LAST
MISTAKE





MARCO - 57 YEAR OLD
HISTORY
-DEPRESSION AND
SUICIDE ATTEMPTS

KETAMINE FOR THE CRITICALLY ILL PATIENT



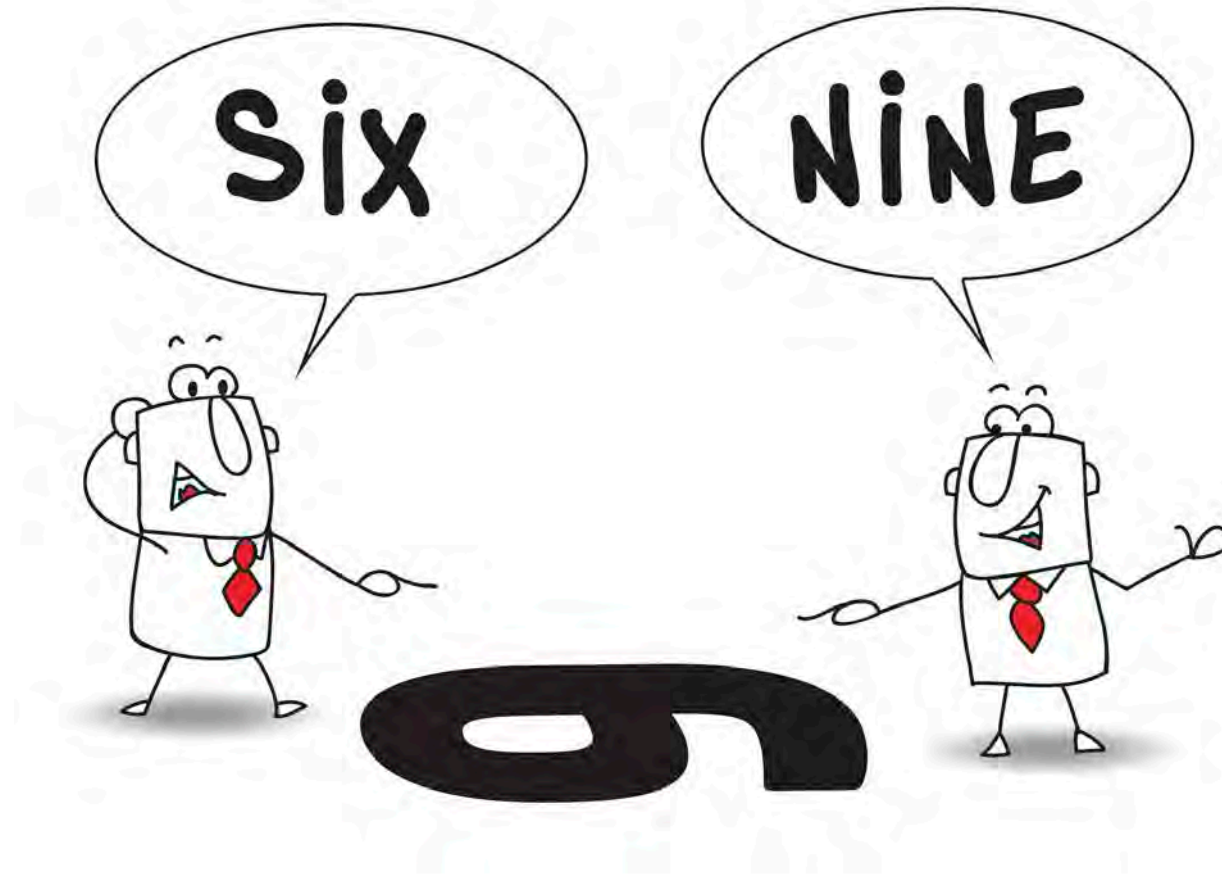
REF - [HTTPS://WWW.ACEPNOW.COM/ARTICLE/TIPS-TRICKS-PERFORMING-CRICOthyrotomy](https://www.acepnow.com/article/tips-tricks-performing-cricothyrotomy)

KETAMINE FOR THE CRITICALLY ILL PATIENT

TAKE HOME POINTS

- KETAMINE RELIABLY PRODUCES BOTH ANALGESIA AND SEDATION
- KETAMINE CAN BE GIVEN IV, IM, AND IN
- KETAMINE CAN BE DELIVERED QUICKLY AND SAFELY WITHOUT THE NEED TO "TITRATE TO EFFECT."
- KETAMINE CAN BE USED WITHOUT THE RISK OF RESPIRATORY COLLAPSE.
- KETAMINE CAN BE GIVEN TO PATIENTS WITH ELEVATED ICP
- KETAMINE SHOULD BE CONSIDERED EARLY TO TREAT SEIZURES REFRACTORY TO STANDARDS FIRST LINE MEDICATION.
- KETAMINE SHOULD BE CONSIDERED EARLY FOR RESCUE THERAPY BEFORE INTUBATING PATIENTS WITH REFRACTORY ASTHMA.

KETAMINE FOR THE CRITICALLY ILL PATIENT



KETAMINE FOR THE CRITICALLY ILL PATIENT

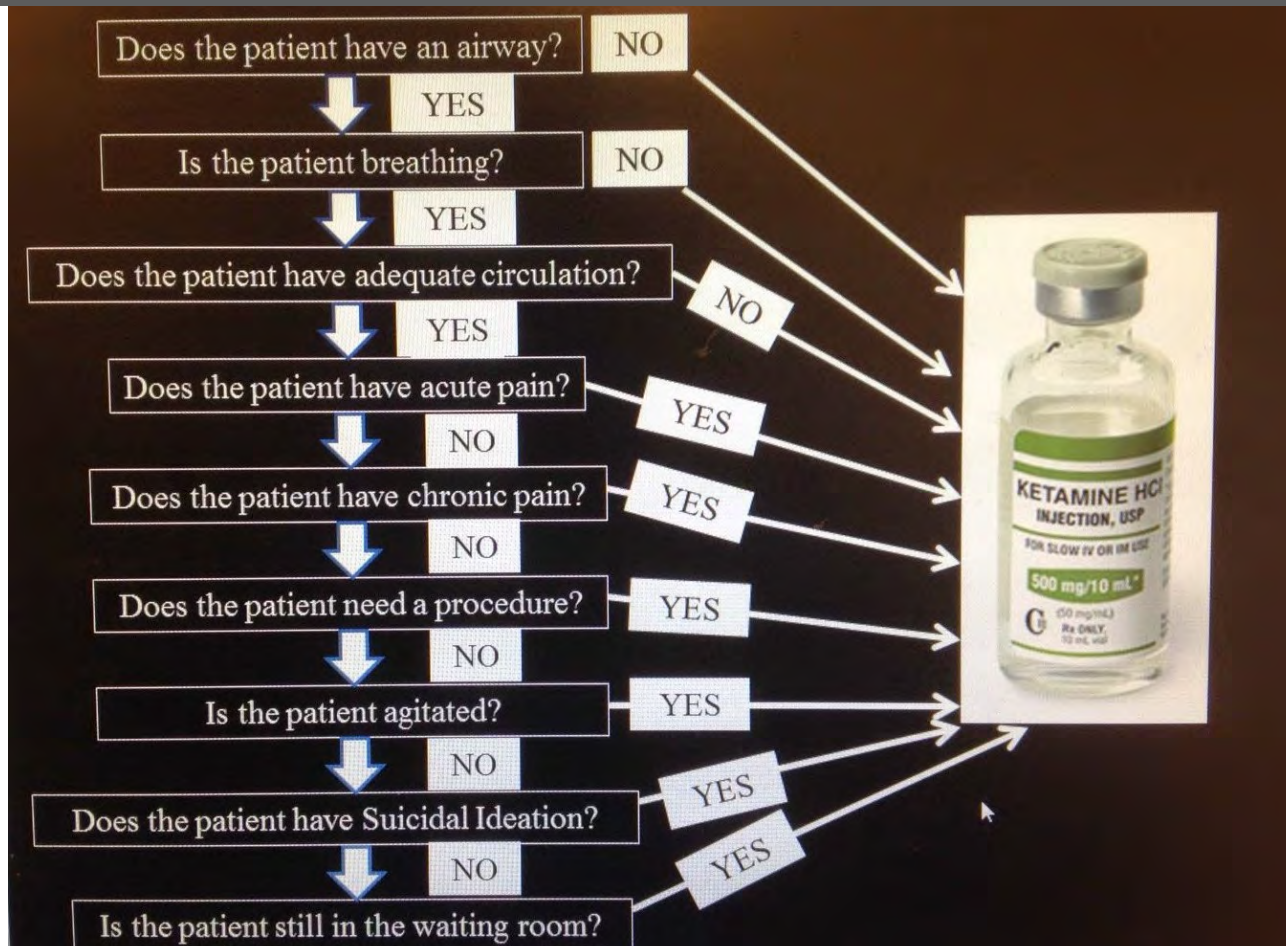


IMAGE CREDIT: DR. STEVE CARROLL, DO - EMBASICS.COM

KETAMINE FOR THE CRITICALLY ILL PATIENT

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