Vermont EMS

Ketamine Administration Resource Kit

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Table of Contents

Content	Page Number
Learning Objectives	3
Lesson Plan	4
Ketamine Reference Sheet	10
Worksheet	12
Self-Assessment	15
Self-Assessment Answer Sheet	19
Self-Assessment Answer Key	21
Session Evaluation	22
Class Roster for Record Keeping	23
Annotated Bibliography	24
Acknowledgements	29

Learning Objectives

At the end of this session, the student will be able to:

Cognitive:

1. List and describe the indications, contraindications, dose, route, onset and duration of effects, therapeutic effects, side effects, precautions and special considerations of ketamine as used in this demonstration project.
2. Describe the requirements a paramedic must fulfill in order to be authorized, both initially and on a continuing basis, to administer ketamine
3. Given a scenario, determine how a paramedic should manage a patient, including:
   a. appropriate use of restraints
   b. whether to administer ketamine
   c. what dose and route of ketamine to use
   d. post-ketamine assessment and management
4. Describe the communication and documentation requirements associated with paramedic administration of ketamine

Psychomotor

1. Given a patient who is combative and in need of restraint, restrain the patient safely and humanely with physical and, if appropriate, chemical restraints
2. Given a patient's weight in pounds, calculate and draw up the correct volume of ketamine within 0.1 ml.

Affective

1. Given a patient experiencing an emergence reaction, appreciate the patient's mental status and condition.

Criteria for Authorization to Administer Ketamine

1. Successful completion of initial training:
   - Attend and participate in ketamine training session
   - Complete worksheet and self-assessment
   - Demonstrate ability to calculate doses and draw up appropriate volume of drug

2. Maintaining good standing as a credentialed paramedic in participating EMS District.

Lesson Plan

Materials Needed

- Projector
- Computer with Internet access (for videos)
- Packets of class materials, one (1) for each student containing the following:
    - Learning objectives
    - Ketamine reference sheet
    - Protocols:
        - Pain Management in the Adult: Protocol 2.17A
        - Traumatic Brain Injury in the Adult: Protocol 4.8
        - Restraints for Adults: Protocol 6.5
    - Worksheet
    - Self-Assessment
    - Annotated bibliography
    - Course evaluation form
- Syringes and needles (3 for each student)
- Alcohol pads
- Vials similar to the ones ketamine comes in (2 for each student – may be refilled with water during class)

Introduction, Background & Need for Education

1. Show short video about bath salts and excited delirium: ABC News (June 4, 2012)

   https://www.youtube.com/watch?v=bXo-0iFj8Ys

2. Lead a brief discussion of risks to patient, rescuers, others and need for quick, safe treatment.
3. Ketamine is a very powerful drug with unique characteristics that is well suited for these patients and others. Ketamine has a wide therapeutic index and has some features paramedics need to be aware of.

Distribute packet of class materials

Review learning objectives

Cognitive:

1. List and describe the indications, contraindications, dose, route, onset and duration of effects, therapeutic effects, side effects, precautions and special considerations of ketamine as used in this demonstration project.

2. Describe the requirements a paramedic must meet in order to be authorized, both initially and on a continuing basis, to administer ketamine
3. Given a scenario, determine how a paramedic should manage a patient, including:
    i. appropriate use of restraints
    ii. whether to administer ketamine
    iii. what dose and route of ketamine to use
    iv. post-ketamine assessment and management
4. Describe the communication and documentation requirements associated with paramedic administration of ketamine

Psychomotor

1. Given a patient who is combative and in need of restraint, restrain the patient safely and humanely with physical and, if appropriate, chemical restraints.
2. Given a patient's weight in pounds, calculate and draw up the correct volume of ketamine within 0.1 mL.

Affective

1. Given a patient experiencing an emergence reaction, appreciate the patient's mental status and condition

Review conditions of authorization to give ketamine:

Successful completion of initial training including:

1. Attend and participate in session
2. Complete the worksheet
3. Complete self-assessment
4. Demonstrate ability to calculate doses and draw up appropriate volume of drug

Review Pharmacology & Uses of Ketamine

1. Brief history of ketamine
    a. Creation, initial uses, abuse
    b. Hospital and field use
    c. Refer to annotated bibliography regarding ketamine in EMS and emergency medicine

2. Go over ketamine reference sheet
    a. Class
    a. Description
    b. Mechanism of action

c. Pharmacokinetics
d. Indications
e. Contraindications
f. Precautions
g. Side effects
h. Interactions
i. Dose and Route
j. Special Considerations

3. Indications for use:
    a. Severe pain
    b. Traumatic brain injuries where:
        i. Patients who display violent behavior that endangers the patient, other, or EMS providers.
            1. On-line order is not required
    c. Behavioral Emergencies
        i. Patients who display violent behavior that endangers the patient, other, or EMS providers
        ii. Patients who are violent from conditions other than excited delirium syndrome may benefit from chemical restraint, e.g., overdose, traumatic brain injury, behavioral emergencies.
            1. For behavioral emergencies**, on-line order required from medical direction.**
    d. Describe excited delirium syndrome (ExDS):
        i. Bizarre and/or aggressive behavior (shouting, paranoia, panic)
        ii. Violence toward others
        iii. Unexpected physical strength
        iv. Hyperthermia (bad prognostic sign)
        v. ExDS is often, but not always, the result of drugs such as bath salts, methamphetamine, PCP, cocaine.
        vi. ExDS is sometimes the result of a behavioral emergency

****Avoid use of haloperidol in patients with suspected ExDs.**

<u>Review Protocols (ADULT ONLY)</u>

1. Pain Management 2.17A
2. Traumatic Brain Injury 4.8
3. Restraints 6.5

Review Dose and Route

1. The standard dose and route for an adult is 4 mg/kg (**maximum dose 500 mg**) administered by **intramuscular (IM) injection only.** Lateral thigh preferred administration site. Administer with a 22G 1-1/2" needle. May administer through clothing. May repeat 100 mg IM dose in 5-10 minutes for continued agitation. The concentration of ketamine to be used is 100 mg/mL. *Contact medical direction for additional doses*. Examples of typical doses include:

Weight (lb)	Dose (mg)	Volume in mL (100 mg/mL)
100	180	1.8
155	280	2.8
200	360	3.6
275	500	5.0

Review Post-Administration Monitoring and Treatment

1. Mental status: Observe the patient's response to stimuli and the environment. In case of emergence reaction, contact on-line medical direction for an order to administer a benzodiazepine, e.g., midazolam up to 5 mg IV or 10 mg IM. Evaluate the blood glucose level of a sedated patient if hypoglycemia cannot reasonably be ruled out.
2. Airway: In case of hypersalivation, suction the mouth. In case of laryngospasm, administer positive pressure ventilation. In case of vomiting, administer an anti-emetic such as ondansetron.
3. Oxygenation and Ventilation: Monitor SpO_2 and capnography when ketamine is used as a sedative. Administer oxygen and positive pressure ventilation as needed.
4. Vital Signs and ECG: Monitor pulse, blood pressure, respirations, temperature (in patients with suspected excited delirium) and ECG rhythm. There is no need to perform a 12-lead simply because the patient has received ketamine.
5. If restraints are being used: Keep the patient under constant observation and avoid the prone position. Follow Vermont EMS Medical Procedure 6.4, Restraints.
6. If not already done, gain IV or IO access when it is safe to do so.

Review Communication and Documentation

1. The type of medical direction order (on-line vs. off-line) for sedation of an adult with a behavioral emergency shall be consistent with the Vermont EMS Protocols and Department of Health guidance. Administration of ketamine for sedation of combative adults with overdose or head trauma may be performed as an off-line standing order.

2. When providing a patient report from the scene or enroute to the hospital, the paramedic should describe the dose and route of ketamine administration, as well as whether hospital security should be notified.
3. Document in SIREN the administration of ketamine like all other medications, including post-administration vital signs and side effects such as emergence reaction, hypersalivation, laryngospasm, vomiting and hypoxia.
4. If restraints were used, document the following, in accordance with Medical Procedure 6.5, Restraints:
    a. The reason(s) for restraint
    b. Time restraints were applied
    c. That the patient was kept under constant observation
    d. Which extremities were restrained
    e. The method/type of physical restraint
    f. Circulatory status of restrained extremities at least every 15 minutes
    g. Any injuries sustained as a result of the restraints

Review Application of What Students Have Learned

Show examples of different behaviors and discuss whether physical and chemical restraint would be appropriate.

https://www.youtube.com/watch?v=HfEepVOQrpE
Example of ExDS in Appleton (Jefferson St. incident)

https://www.youtube.com/watch?v=BKPygvCbqsc
1:25 Violent rampage inside police cruiser (apparently not ExDS)

https://www.youtube.com/watch?v=CtD2rNKaStU
3:30 (video lasts 6:52, but repeats 1st half) Bath salts agitation on ground outside (apparently not ExDS)

https://www.youtube.com/watch?v=OL_K6XAix6Q
2:49 News report on naked man in street possibly with ExDS – no violent behavior on video

- Have students complete worksheet/practice quiz and discuss answers

Complete Worksheet and Self-Assessment

1. Students complete worksheet in class individually or in groups. Discuss answers to worksheet as a larger group.

2. Have students practice calculating dose and drawing up from vial (use examples from worksheet)
3. Students complete self-assessment individually. Review self-assessment as a group and provide answers to self-assessment.
4. Ask students to complete course evaluation forms and collect them.
5. Congratulate students and send them home.

Follow-up

1. Send to each paramedic agency a list of the paramedics who completed the training and are authorized to administer ketamine in accordance with the project protocol.
2. Send report to Vermont Dept of Health with list of paramedics who completed the training. You can send this to Lindsey Simpson, EMS Training Administrator at lindsey.simpson@vermont.gov.

Other Resources:

https://www.youtube.com/watch?v=63o1k_TTj_U
15:26 Excited Delirium, Part 1 – Aaron Burnett, MD
Very good overall; Refers to video example of ExDS, but doesn't include it.
At 9:58, starts going over definition of ExDS as described in ACEP paper; differentiates it from other conditions

https://www.youtube.com/watch?v=S0b0vbBkvpc
16:18 Excited Delirium, Part 2 – Aaron Burnett, MD
Continues discussion of ExDS, including specific signs and symptoms. At 7:30, describes hx of ExDS
At 8:31, describes physiological basis for dx at death

Mash DC[1], Duque L, Pablo J, Qin Y, Adi N, Hearn WL, Hyma BA, Karch SB, Druid H, Wetli CV. Brain biomarkers for identifying excited delirium as a cause of sudden death. Forensic Sci Int. 2009 Sep 10;190(1-3):e13-9. doi: 10.1016/j.forsciint.2009.05.012. Epub 2009 Jun 21.

Ketamine Reference Sheet

Class
Analgesic, sedative, dissociative anesthetic

Description
Ketamine is a rapid-acting dissociative anesthetic that in low doses produces analgesia without dissociation. It is unusual among anesthetics in that it does not depress airway reflexes or skeletal muscle tone and it stimulates the cardiovascular and respiratory systems.
Ketamine has a wide margin of safety. Patients who receive more than the recommended dose take longer to recover, but do not experience airway or respiratory problems. High doses may result in apnea. It is routinely used as the sole agent for general anesthesia in the developing world where sophisticated airway management is not available.

Mechanism of action
Ketamine is chemically similar to phencyclidine (PCP) and blocks the N-methyl-D-aspartate (NMDA) receptor. It separates or dissociates consciousness from control of the body. This results, when anesthetic doses are used, in a patient's eyes sometimes remaining open and the muscles retaining their tone, but the patient being unable to respond to questions or commands.

Pharmacokinetics

	Intramuscular
Onset of effects	< 5 min
Duration	20 – 30 min

Indications
- Sedation, including combative behavior, before painful procedures and after intubation. See standing orders for specific approved indication(s).
- Induction for RSI (for RSI-qualified providers)
- Analgesia (in hospital)
- Anesthesia (in hospital)

Contraindications
Known hypersensitivity to ketamine or patients for whom the risk of a transient significant rise in blood pressure outweighs the potential benefit of the drug.
Note: Head trauma is not a contraindication for ketamine since old reports of ketamine increasing intracranial pressure have not been borne out.

Precautions
Emergence reactions occur in 10% - 12% of adult patients. Emergence reactions are characterized by vivid, terrifying hallucinations, delirium, confusion, excitement and irrational

behavior. These reactions are less common in children, the elderly and those who receive the medication intramuscularly.
Administration of a benzodiazepine can reduce the frequency and intensity of emergence reactions, as can minimizing verbal and tactile stimulation of the patient. Vital signs can and should still be taken.
Use in pregnancy: Animal studies have not found adverse fetal effects in the first trimester, but there are no controlled studies in humans. In the second and third trimester, fetal harm appears unlikely.

Side effects

Hypertension, tachycardia, emergence reaction, fasciculations, hypersalivation. Rapid intravenous administration of high doses of ketamine has been associated with severe respiratory depression and apnea. Laryngospasm is rare but usually responds to positive pressure ventilation. Nausea and vomiting sometimes occur, but are not usually severe and should respond to an antiemetic. Occasionally, slight respiratory depression may occur, but it is transient and can usually be prevented by slow administration (IM or slow IV). Blood pressure may rise shortly after administration, but typically returns to pre-ketamine levels within 15 minutes. Hypersalivation can usually be managed with suction.

Interactions

Recovery may be prolonged if alcohol or narcotics are used concurrently with ketamine.

Dose and Route

For sedation to treat combative behavior: For adults, ketamine 4 mg/kg administered by intramuscular (IM) injection only. The concentration of ketamine to be used is 100 mg/mL. May repeat 100 mg IM dose in 5-10 minutes for continued agitation. Contact medical direction for additional doses. Refer to the protocol for whether an on-line order is required

Special Considerations

If family members, friends or other emergency service workers are present when the patient receives a sedation dose of ketamine, warn them that the patient may become unresponsive despite having eyes that may remain open. Nystagmus may occur.
Store ketamine at room temperature away from light.
If a paramedic sedates a patient with IM ketamine, he or she should gain IV access once it is safe to do so.
The concentration of 100 mg/mL carried by EMS is intended for intramuscular administration.

Worksheet: Ketamine Administration Review

Directions: *Complete all questions working alone or with your group.*

1. The approved indication for ketamine use by a paramedic is _____.
2. The only contraindication for ketamine in a combative patient is _____.
3. The standard sedation dose for ketamine is _____ by the _____ route.
4. The effects of ketamine are typically first seen in _____ minute(s) when given IM. The effects typically last approximately _____ minutes.
5. The therapeutic effect a paramedic desires when administering ketamine is _____.
6. An emergence reaction is characterized by the presence of _____, _____, _____.
7. The best pharmacologic treatment for an emergence reaction is _____ at a dose of _____ mg by _____ route.
8. The most common changes in vital signs after ketamine administration are (circle one for each vital sign):

Pulse	increase	no change	decrease
BP	increase	no change	decrease
Respiration	increase	no change	decrease

9. How should you manage the following uncommon side effects of ketamine?

   Laryngospasm _____

   Hypersalivation _____

   Nausea and vomiting _____

10. Two ways to prevent or reduce the intensity of an emergence reaction are

_____ and _____.

11. After you administer ketamine to a patient and he is sedated, his mother becomes upset when she sees his eyes open and moving, but he doesn't respond to her. What should you say to her?

    _____

    _____

    _____

12. To maintain authorization to administer ketamine, a paramedic must complete initial training and remain in _____.

13. The most dangerous position to transport a restrained patient in is _____.

14. After physically restraining a patient, a paramedic must document the following in SIREN:
    a. The _____ of restraints used.
    b. The _____ restraints were applied.
    c. Circulation status of extremities at least every ____ minutes
    d. Patient was transported in the _____ or _____ position
    e. Patient was transported under constant _____.

15. After administering ketamine to sedate a patient, the paramedic should assess vital signs and these physiological measures:

    _____

    _____

16. A 22 year-old, 180 lb. male was found staggering down the middle of a street in a residential neighborhood. He is yelling, but his words don't make any sense and he keeps repeating himself. He punched a car several times before police stopped him and, after a great deal of struggling, they got him face down on the ground and handcuffed his wrists behind his back. He is still yelling and struggling, even with three police officers holding him down. His airway is obviously open, his breathing is rapid and somewhat labored and his skin is pink, very warm and sweaty.

    Describe how you should manage this patient, including re-assessment and transport. Include the following in your answer:

    - the position you should put him in
    - how you will address the metabolic problems he is at risk for
    - the role of medical direction

    _____

    _____

    _____

    _____

    _____

17. For each of the following weights, complete the following table. Assume the patient in each case will receive the standard IM dose of ketamine supplied in a 100 mg/mL concentration.

Weight (lb)	Weight (kg)	Dose (mg/kg)	Volume to be administered
90 lb	_____	_____	_____
110 lb	_____	_____	_____
140 lb	_____	_____	_____
180 lb	_____	_____	_____
220 lb	_____	_____	_____
260 lb	_____	_____	_____
300 lb	_____	_____	_____

Vermont EMS Paramedic Administration of Ketamine

Self Assessment

Directions: Circle the best answer

1. Paramedics are authorized to administer ketamine for what indication(s)?
   a) sedation and analgesia
   b) sedation but not analgesia
   c) anesthesia and RSI
   d) anesthesia but not RSI

2. Which of the following is a contraindication to ketamine?
   a) known sensitivity
   b) hyperthermia
   c) head trauma
   d) chest trauma

3. The standard dose and route of ketamine for an adult are:
   a) 2 mg/kg IM
   b) 4 mg/kg IM
   c) 2 mg/kg IV/IO
   d) 4 mg/kg IV/IO

4. You are going to administer ketamine to a 280 pound male. What is the most appropriate dose?
   a) 200 mg
   b) 300 mg
   c) 400 mg
   d) 500 mg

5. When a patient receives a standard dose of ketamine, the typical onset of effects occurs:
   a) instantaneously
   b) between 2 and 5 minutes
   c) between 5 and 7 minutes
   d) between 8 and 10 minutes

6. When a patient receives a standard dose of ketamine, the effects typically last:
   a) 5 – 10 minutes
   b) 10 – 20 minutes
   c) 20 – 30 minutes
   d) 30 – 45 minutes

7. Which of the following is typically present during an emergence reaction?
   a) pleasant delusions
   b) terrifying hallucinations
   c) hearing voices
   d) fever

8. Which of the following would be the most appropriate treatment for an emergence reaction?
   a) midazolam 5 mg IV
   b) midazolam 2.5 mg IM
   c) haloperidol 5 mg IM
   d) haloperidol 10 mg IM

9. Which of the following describes a typical set of vital sign changes in a patient who received ketamine?
   a) tachycardia, hypotension, tachypnea
   b) bradycardia, hypertension, respiratory depression
   c) tachycardia, hypertension, tachypnea
   d) bradycardia, hypotension, respiratory depression

10. After you administer ketamine to a patient, he begins to drool significantly. Your first intervention should be to:
   a) administer atropine 0.5 mg IV
   b) ventilate him
   c) suction his airway
   d) administer naloxone 0.4 - 2 mg IV

11. After you administer ketamine to a patient, he exhibits stridor and his oxygen saturation begins to drop. You should:
   a) administer naloxone 0.4 - 2 mg IV
   b) ventilate him
   c) insert an oropharyngeal airway
   d) observe him closely

12. After you administer ketamine to a patient, he begins to vomit. After you suction his airway, you should administer:

a) atropine 0.5 mg IV
b) atropine 1.0 mg IV
c) 4 mg ondansetron IV
d) 8 mg ondansetron IV

13. One method of reducing the likelihood of an emergence reaction is to:

a) administer ketamine as rapidly as possible
b) reassure the patient frequently that he will be OK
c) administer haloperidol
d) reduce the amount of physical stimulation

14. A woman who is seven months pregnant was behaving erratically and violently. Police have restrained her and ask you to sedate her. Which of the following best describes the risk/benefit ratio of administering ketamine?

a) Serious birth defects are very likely to occur and ketamine is not justified.
b) Minor birth defects are almost certain and ketamine is not justified.
c) Even though minor birth defects are likely, the benefits outweigh the risks and you should administer ketamine.
d) Although the evidence is not conclusive, there is a low probability of harm to the fetus and you should administer ketamine.

15. After you administer ketamine to a violent teenage male, he becomes unresponsive but his eyes remain open and they start to move rhythmically back and forth. His girlfriend starts to become very upset when she sees this. What should you tell her?

a) This happens to some people, but is not harmful.
b) This is a common side-effect and you should stroke his arm to help him recover.
c) This is a rare side-effect, but we'll give him a medication that will prevent any more problems.
d) This is the price you pay for doing drugs.

16. The most dangerous position for a restrained patient is:

a) supine
b) Fowler's
c) lateral
d) prone

17. Which of the following most accurately describes standard monitoring and treatment after ketamine administration?

a) vital signs, oxygen saturation, capnography, 12-lead ECG
b) oxygen saturation, capnography, ECG rhythm, low flow oxygen
c) capnography, ECG rhythm, vital signs, oxygen saturation
d) 12-lead ECG, vital signs, oxygen saturation, low flow oxygen

18. Which of the following most accurately describes the role of medical direction in ketamine administration?

a) An on-line order is required for all ketamine administration.
b) An on-line order is required for behavioral emergencies, but not head trauma or overdose.
c) An on-line order is required for head trauma or overdose, but not behavioral emergencies.
d) All ketamine administration is done by off-line authorization.

19. A significant reason to advise the emergency department you are transporting a patient who has received ketamine is so that the staff can:

a) make sure the psychiatric room is available
b) have restraints prepared
c) be ready to intubate
d) contact the police

20. The Vermont procedure for restraints requires you to document that you checked the circulatory status of a restrained patient's extremities every:

a) 5 minutes
b) 10 minutes
c) 15 minutes
d) 20 minutes

21. The maximum single dose of ketamine a paramedic is allowed to administer is:

a) 250 mg
b) 500 mg
c) 750 mg
d) 1000 mg

22. A paramedic can administer ketamine by which route(s) of administration?

a) IM only
b) SQ and IM only
c) SQ, IM, IV only
d) SQ, IM, IV, IO only

23. The appropriate dose of ketamine for a patient who weighs 90 pounds is:
    a) 160 mg
    b) 200 mg
    c) 300 mg
    d) 360 mg

24. The appropriate dose of ketamine for a patient who weighs 155 pounds is:
    a) 280 mg
    b) 320 mg
    c) 360 mg
    d) 400 mg

25. The appropriate volume of ketamine (100 mg/mL) for a patient who weighs 200 pounds is:
    a) 0.9 mL
    b) 1.8 mL
    c) 2.4 mL
    d) 3.6 mL

Self-Assessment Answer Sheet

Name _____ Date _____

1.	a	b	c	d
2.	a	b	c	d
3.	a	b	c	d
4.	a	b	c	d
5.	a	b	c	d
6.	a	b	c	d
7.	a	b	c	d
8.	a	b	c	d
9.	a	b	c	d
10.	a	b	c	d
11.	a	b	c	d
12.	a	b	c	d
13.	a	b	c	d
14.	a	b	c	d
15.	a	b	c	d
16.	a	b	c	d
17.	a	b	c	d
18.	a	b	c	d
19.	a	b	c	d
20.	a	b	c	d
21.	a	b	c	d
22.	a	b	c	d
23.	a	b	c	d
24.	a	b	c	d
25.	a	b	c	d

Self-Assessment Key

1. b
2. a
3. b
4. d
5. b
6. c
7. b
8. a
9. c
10. c
11. b
12. c
13. d
14. d
15. a
16. d
17. c
18. b
19. b
20. c
21. b
22. a
23. a
24. a
25. d

Session Evaluation

Please help us to improve this continuing education session by responding to these questions. Use this scale for ratings:

1= Strongly disagree 2=Disagree 3=Neutral 4=Agree 5=Strongly agree

	1	2	3	4	5
1. If I had to manage a combative patient now, I would be prepared to:					
a. assess the patient appropriately.	☐	☐	☐	☐	☐
b. decide whether to restrain the patient chemically.	☐	☐	☐	☐	☐
c. administer chemical restraint.	☐	☐	☐	☐	☐
2. The session met my expectations.	☐	☐	☐	☐	☐
3. The way the session was conducted helped me to learn and reinforced important concepts.	☐	☐	☐	☐	☐
4. There was sufficient opportunity to practice and ask questions.	☐	☐	☐	☐	☐
5. The exam was fair and relevant.	☐	☐	☐	☐	☐
6. I would recommend this session to other paramedics.	☐	☐	☐	☐	☐

Comments or suggestions?

_____

_____

_____

Class Roster for Ketamine Training

Date:	
Ketamine Administration:	
Instructor(s):	
Location:	

Name	**Signature**	**Vermont License #**

Annotated Bibliography

Reviews

Hughes S. Towards evidence based emergency medicine: best BETs from the Manchester Royal Infirmary. BET 3: is ketamine a viable induction agent for the trauma patient with potential brain injury. Emerg Med J. 2011 Dec;28(12):1076-7. doi: 10.1136/emermed-2011-200891.

This review found no evidence to support the traditional teaching that ketamine is harmful in patients with head injury and low level evidence suggesting that ketamine is beneficial. Perhaps the most useful part of the review is the description of how some of the original evidence used to claim that ketamine harms head injured patients was misinterpreted. The evidence actually suggests that ketamine may be helpful to these patients by increasing cerebral perfusion pressure.

Randomized Controlled Trials

Sener S, Eken C, Schultz CH, Serinken M, Ozsarac M. Ketamine with and without midazolam for emergency department sedation in adults: a randomized controlled trial. Ann Emerg Med. 2011 Feb;57(2):109-114.e2. doi: 10.1016/j.annemergmed.2010.09.010. PMID: 20970888,

Randomized double-blind controlled trial in which182 adult ED patients in Turkey received either 1.5 mg/kg IV or 4 mg/kg IM ketamine with or without 0.03 mg/kg IV midazolam for a variety of painful procedures. Median sedation time was 24 minutes in the IV ketamine group and 43 minutes in the IM group. Patients who received midazolam were significantly less likely (8% vs. 25%) to experience recovery agitation very loosely defined as "any moaning, screaming, cursing, unpleasant dreams, or unpleasant hallucinations, regardless of severity." Nausea occurred in about 20% and vomiting in about 10% of subjects regardless of group assignment. No subject experienced apnea, laryngospasm or oxygen desaturation.

Prospective observational studies

Melamed E, Oron Y, Ben-Avraham R, Blumenfeld A, Lin G. The combative multitrauma patient: a protocol for prehospital management. Eur J Emerg Med. 2007 Oct;14(5):265-8. PMID: 17823561.

Description of 11 patients, 5 of whom were treated by Israeli military medical personnel for agitation with unknown doses of IV ketamine. No adverse effects were recorded. A team of experts drafted a protocol for the combative patient without IV access, which included 5 mg/kg IM ketamine, followed if that didn't work within 5 minutes by 5 mg midazolam IM.

Isbister GK, Calver LA, Downes MA, Page CB. Ketamine as Rescue Treatment for Difficult-to-Sedate Severe Acute Behavioral Disturbance in the Emergency Department. Ann Emerg Med. 2016 Feb 10. pii: S0196-0644(15)01562-0. doi: 10.1016/j.annemergmed.2015.11.028. [Epub ahead of print]. PMID: 26899459.

Prospective evaluation of 49 Australian ED patients with acute behavioral disturbance who received a median dose of 300 mg ketamine IM. All were in a study of sedation and

all failed to respond to droperidol. Forty-four (90%) responded to ketamine (median time to sedation 20 minutes, IQR 10 – 30 min). Four of the 5 who failed to respond received ≤ 200 mg. Adverse effects occurred in in two who vomited and one who had a transient hypoxic episode (SpO_2 of 90%) that improved with oxygen and no other interventions.

Retrospective Observational Studies

Scheppke KA, Braghiroli J, Shalaby M, Chait R. Prehospital use of IM ketamine for sedation of violent and agitated patients. West J Emerg Med. 2014 Nov;15(7):736-41. doi: 10.5811/westjem.2014.9.23229. Epub 2014 Nov 11. PMID: 25493111

Retrospective chart review of 52 patients who received paramedic-administered ketamine for violent behavior in the Miami, Florida area. The dose was 4 mg/kg IM and resulted in adequate sedation in just over 2 minutes in 50 (96%). Half of the patients received the protocol-required dose of 2 – 2.5 mg midazolam IV or IM. Three of these patients (but no others) experienced respiratory depression that required treatment (BVM in one and ETI in two).The route of midazolam in these cases was not noted. On arrival at the ED after a mean transport time of 19 minutes, sedation had not worn off.

Keseg D, Cortez E, Rund D, Caterino J. The Use of Prehospital Ketamine for Control of Agitation in a Metropolitan Firefighter-based EMS System. Prehosp Emerg Care. 2015 January-March;19(1):110-115. Epub 2014 Aug 25. PMID: 25153713

Retrospective chart review of 35 patients in Columbus, Ohio who received prehospital ketamine by paramedics for sedation between October 2010 and October 2012. Protocol called for 4 mg/kg IM or 2 mg/kg IV. Mean dose (SD) was 324 mg (120) for IM (n=31) and 138 mg (59.5) for IV (n=6). Two patients received both IV and IM ketamine. Improvement was noted in 32 (91%). Seven patients (20%) were intubated in the ED, four at the same hospital. Not all hospitals apparently supported EMS administration of ketamine.

Bredmose PP, Lockey DJ, Grier G, Watts B, Davies G. Pre-hospital use of ketamine for analgesia and procedural sedation. Emerg Med J. 2009 Jan;26(1):62-4. doi: 10.1136/emj.2007.052753. PMID: 19104109

Retrospective review without specified methods of 1030 adults treated with IV (>99%) or IM ketamine by a physician/paramedic helicopter service in London for numerous reasons that are not clearly specified. Almost 89% of patients also received midazolam. There were no documented cases of basic airway maneuvers being needed. There were minor oxygen desaturations in 6 (0.7%).

Burnett AM, Peterson BK, Stellpflug SJ, Engebretsen KM, Glasrud KJ, Marks J, Frascone RJ. The association between ketamine given for prehospital chemical restraint with intubation and hospital admission. Am J Emerg Med. 2015 Jan;33(1):76-9. doi: 10.1016/j.ajem.2014.10.016. Epub 2014 Oct 22. PMID: 25455046

Retrospective chart review of 49 patients transported to a Level 1 trauma center in Minnesota after receiving paramedic-administered 5 mg/kg IM ketamine for chemical restraint between July 2011 and June 2013. Mean (SD) dose was 5.26 (1.65) mg/kg.

None were intubated in the field; 14 (29%) were intubated in the ED, with higher doses associated with more frequent intubation. Indications for intubation included failure to protect airway (7), need for additional sedation (2), lumbar puncture (1), hypoxia (1), laryngospasm (1), unknown (2).

Case Reports and Case Series

Hopper AB, Vilke GM, Castillo EM, Campillo A, Davie T, Wilson MP. Ketamine use for acute agitation in the emergency department. J Emerg Med. 2015 Jun;48(6):712-9. doi: 10.1016/j.jemermed.2015.02.019. Epub 2015 Apr 2. PMID: 25843924

Retrospectively collected case series of 32 patients who received ketamine for acute agitation in two San Diego university EDs. Primary outcomes were changes in vital signs, with an emphasis on oxygen saturation. More than half received medication for their agitation before ketamine, most commonly an antipsychotic and a benzodiazepine. More than a third of patients had alcohol or other drugs on board. Changes in pulse rate and blood pressure were clinically insignificant and no episodes of desaturation occurred. Vital sign data were missing for a few patients. There were no emergence reactions.

Ho JD, Smith SW, Nystrom PC, Dawes DM, Orozco BS, Cole JB, Heegaard WG. Successful management of excited delirium syndrome with prehospital ketamine: two case examples. Prehosp Emerg Care. 2013 Apr-Jun;17(2):274-9. doi: 10.3109/10903127.2012.729129. Epub 2012 Dec 11. PMID: 23231451

Case reports of two adult males in Minnesota with excited delirium syndrome who were sedated by paramedics with 5 mg/kg ketamine IM. Both had good outcomes without complications.

Svenson JE, Abernathy MK. Ketamine for prehospital use: new look at an old drug. Am J Emerg Med. 2007 Oct;25(8):977-80. PMID: 17920984

This retrospective chart review without specified review methods describes 40 patients treated by a physician/nurse team on a helicopter in Wisconsin. Patients of all ages received between 1 mg/kg IV and 5 mg/kg IM ketamine for pain, burns, sedation, extrication and intubation. Both cardiac and trauma patients with hypotension received ketamine with no drop in BP. 12 patients received more than one dose. No adverse effects were noted.

Burnett AM, Watters BJ, Barringer KW, Griffith KR, Frascone RJ. Laryngospasm and hypoxia after intramuscular administration of ketamine to a patient in excited delirium. Prehosp Emerg Care. 2012 Jul-Sep;16(3):412-4. doi: 10.3109/10903127.2011.640766. Epub 2012 Jan 17. PMID: 22250698

This case report describes the first known case of laryngospasm after prehospital IM ketamine. About 15 minutes after a 97 kg male received 500 mg of ketamine from EMS, he developed laryngospasm in the ED that responded quickly and adequately to positive pressure ventilation with a BVM. Several minutes later, he experienced another similar episode that responded to the same treatment. The authors stress that this rare adverse effect of ketamine can be treated adequately with basic life support maneuvers.

Porter K. Ketamine in prehospital care. Emerg Med J. 2004 May;21(3):351-4. PMID: 15107382.
Description of 32 patients treated over ten years by a British trauma surgeon who works on an ambulance. Reasons for ketamine use included extrication, splinting and amputation. Some patients were hypotensive and had GCS < 15.

Burnett AM, Salzman JG, Griffith KR, Kroeger B, Frascone RJ. The emergency department experience with prehospital ketamine: a case series of 13 patients. Prehosp Emerg Care. 2012 Oct-Dec;16(4):553-9. doi: 10.3109/10903127.2012.695434. Epub 2012 Jul 18. PMID: 22809253
This article describes the ED experiences of 13 patients who received 5 mg/kg IM ketamine from EMS in Minnesota for excited delirium between April and December 2011. Three patients were treated for hypoxia, 2 of whom were intubated (recurrent laryngospasm and intracranial hemorrhage). One patient had hypersalivation, which was successfully treated with suction. All 3 of the patients who had emergence reactions were successfully treated, two with IV midazolam and one with reassurance.

Cottingham R, Thomson K. Use of ketamine in prolonged entrapment. J Accid Emerg Med. 1994 Sep;11(3):189-91. PMID: 7804588
Description of 4 patients in the UK who experienced prolonged extrication times after collisions (3 motor vehicles and one train). In one case, it took 4 hours to get the patient out. At least 3 of the patients had no memory of the events of that day.

Vermont EMS Paramedic Administration of Ketamine Demonstration Project

Special thanks for the development of this project to:

Mike O'Keefe, Laurel Plante, Jim Suozzi, Liam Gannon, Kyle DeWitt and Vermont Districts 3, 4, and 13.