

TIVA Perspectives and Potential Military Applications

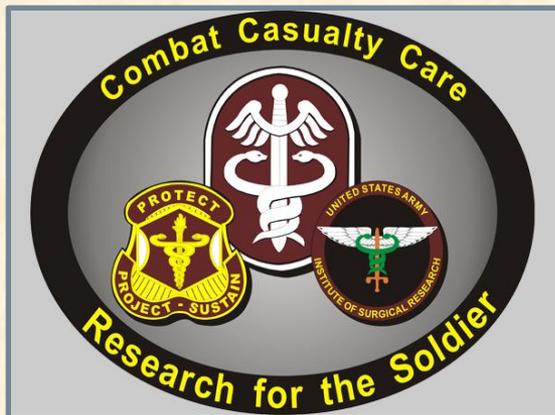
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Overview

- Historical background TIVA
- Development and the evolution of TIVA in previous military conflicts
- Current anesthesia practice
- Potential military applications of TIVA
- Describe the future of TIVA in combat casualty care.

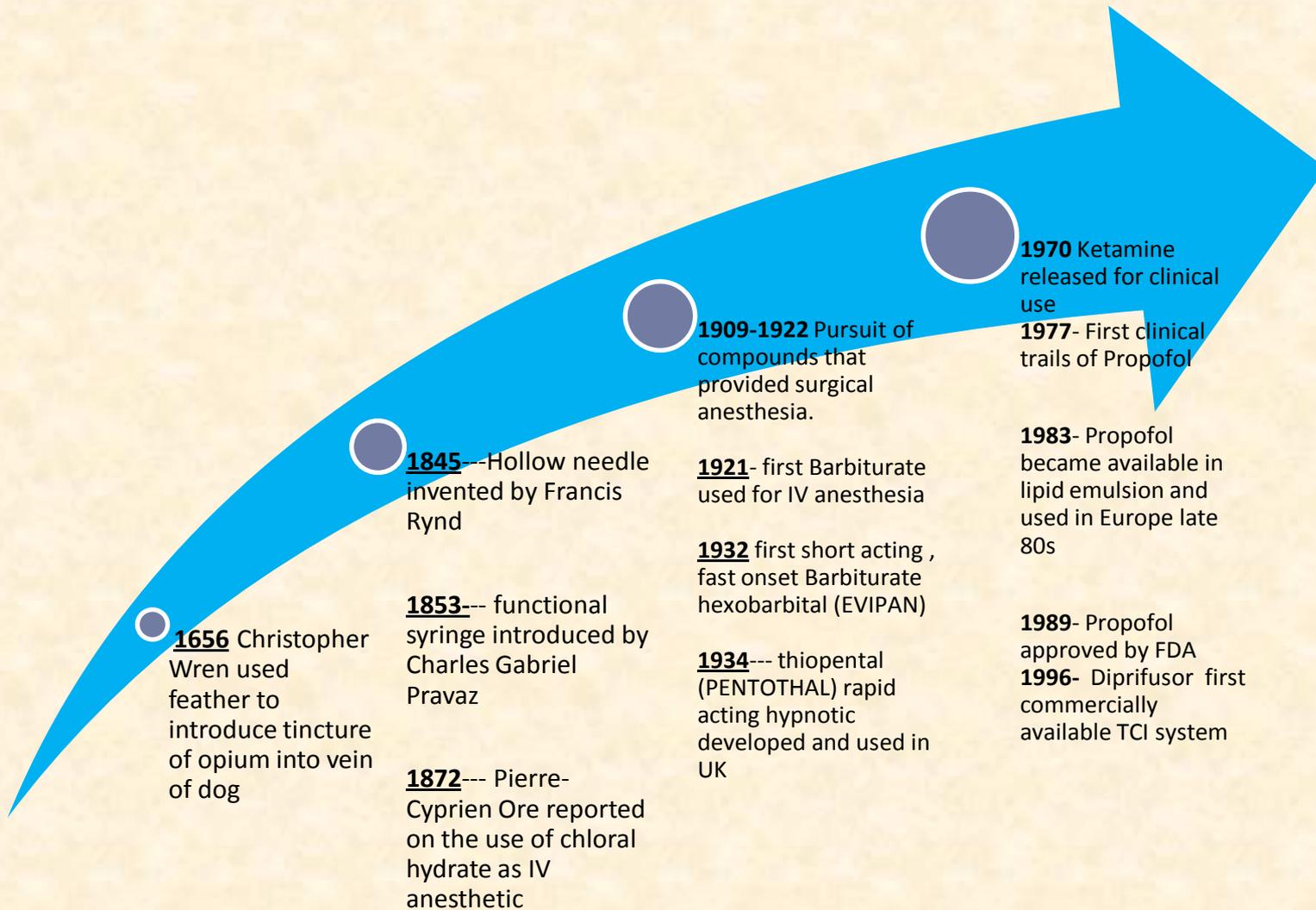
Total Intravenous Anesthesia (TIVA)

- ❖ Combination of intravenous anesthetics administered through a continuous infusion pump for maintenance of anesthesia
- ❖ TIVA has gained a renewed interest in the military anesthesia community for use in combat casualty care

HISTORY OF TIVA



History of TIVA



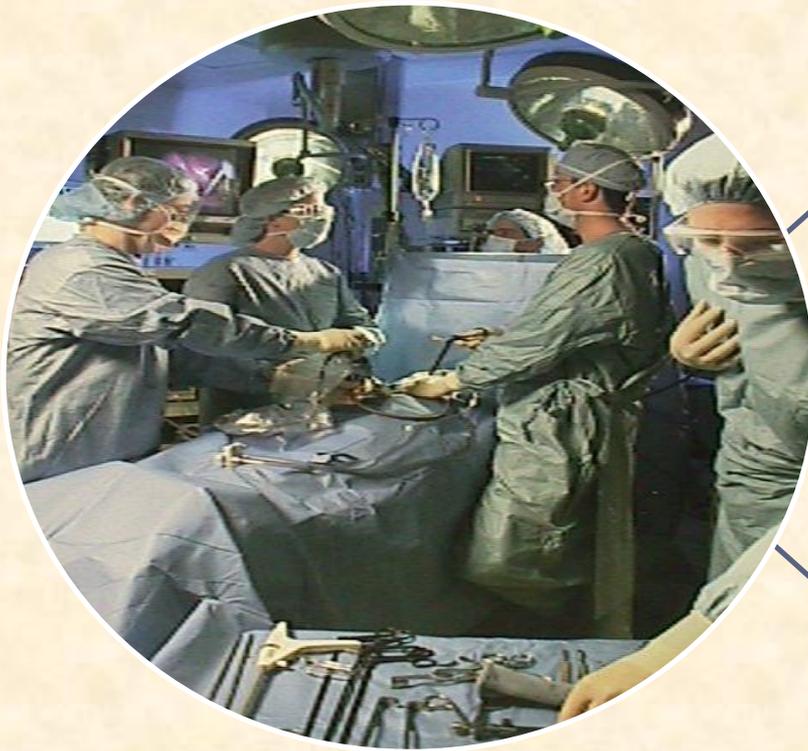
Military Anesthesia History

- ❖ After development in 1934, experience with thiopentone (Pentothal) in the military was gained during Spanish Civil War (1936-1939).
 - ❖ Mortality associated with over dosage
- ❖ 1941- After bombing of Pearl Harbor Thiopentone and other barbiturates used during trauma surgery.
 - ❖ It was believed that IV anesthesia was the cause of more casualties than enemy bombs
 - ❖ This led to the belief that IV agents were dangerous for shocked patients suffering from heavy blood loss
- ❖ Intravenous barbiturates saw continued use through the Korean and Vietnam Wars

ANESTHESIA PRACTICE



Overview of Anesthetic Techniques



Volatile Anesthetics

- Desflurane
- Isoflurane
- Sevoflurane
- Nitrous

Intravenous Anesthetics and Analgesics

- Hypnotics
- Opioid and non-opioid analgesics
- Muscle relaxants

Regional Anesthetics

- Local Anesthetics

Anesthesia Practice Using TIVA

I) Traditional practice

a) Bolus IV drugs

b) Continuous IV infusions- conventional infusion pumps

II) Target Controlled Infusions (TCI)

Anesthesia provider chooses “target” blood or brain drug concentration

Microprocessor- controlled pump infuses the drug at a rate to achieve desired concentration

a) Advanced TCI- model based

b) Closed loop control (future application)

PROS VS. CONS OF TIVA



Benefit of TIVA

- ❖ Potential for postoperative pain reduction when compared to VGA's
- ❖ Allows precise control each component of case
 - ❖ hypnosis, amnesia, analgesia
- ❖ Target Controlled Anesthesia
 - ❖ Better hemodynamic control with fewer episodes of instability (i.e. ketamine– increased SNS response)
 - ❖ Smaller total drug doses
 - ❖ More rapid return to awake state
- ❖ Possibility to maintain airway reflexes

Cons of TIVA

- ❖ Prone to equipment problems
- ❖ Resource intensive (money, equipment & labor)
- ❖ Overdose → respiratory depression and arrest
- ❖ Hemodynamic and respiratory instability with bolus administration

Cons of TIVA

- ❖ More difficult to measure plasma & brain drug concentration of IV drugs when compared to end tidal gas concentrations of VGA's
- ❖ IV drugs may influence unwanted responses
 - ❖ i.e.- Ketamine may increase ICP in patients with head trauma.
- ❖ Relies upon a good indicator for depth of anesthesia

MILITARY RELEVANCE OF TIVA



Military Anesthesia Practice

- ❖ Report from USNS Comfort Anesthesia Services
 - ❖ 83% of patients received GETA via VGA, TIVA or combination as primary anesthetic techniques during major hostilities from Mar to May in 2003.
- ❖ Army still uses electric powered gas vaporizers & vents for majority of cases.

Benefits of TIVA on the Battlefield

- ❖ Minimal Impact on Medic Carrying Capacity
- ❖ Mass Casualties may exceed ability of small medical teams to provide Inhalational anesthesia or individual monitoring
- ❖ Withstand Environmental Extremes
- ❖ Stable hemodynamic profile
- ❖ Non-flammable
- ❖ Does not rely solely on electrical power

Hemorrhage and TIVA

- ❖ *Uncontrolled bleeding accounts for over 1/3 of trauma related deaths and is the leading cause of potentially preventable deaths following major trauma.*

Maani, C.V., P.A. DeSocio, and J.B. Holcomb, *Coagulopathy in trauma patients: what are the main influence factors? Current Opinion in Anaesthesiology*, 2009. **22(2)**: p. 255-260.

- ❖ *DePaepe et al. have demonstrated that moderate blood loss (17ml/kg) **decreases Propofol's central compartment clearance and volume plus increases end organ sensitivity** in isovolemic rat hemorrhage model*

De Paepe, P., et al., *Influence of hypovolemia on the pharmacokinetics and the electroencephalographic effect of etomidate in the rat. Anesthesiology*, 2000. **93**: p. 1482-1490.

- ❖ *Johnson, KB et al. Have demonstrated in several studies that hemorrhagic shock (30ml/kg) results in **altered pharmacokinetics** of individual IV anesthetic agents using isovolemic swine hemorrhage model.*

Johnson, K.B., et al., *The Influence of Hemorrhagic Shock on Propofol: A Pharmacokinetic and Pharmacodynamic Analysis. Anesthesiology*, 2003. **99(2)**: p. 409-420.

- ❖ *In a separate, Johnson, KB et al. showed that hemorrhagic shock followed by resuscitation with LR's solution did not alter the pK **but did increase potency of propofol.***

Johnson, K.B., et al., *Influence of Hemorrhagic Shock Followed by Crystalloid Resuscitation on Propofol. Anesthesiology*, 2004. **101(3)**: p. 647-659.

TIVA on the Battlefield

- ❖ Grathwohl et al. retrospectively reviewed 252 patients with combat related TBI who underwent operative neurosurgical intervention and compared TIVA to VGA for good neurologic outcome.
 - ❖ No difference observed
 - ❖ TIVA (including ketamine) seemed at least as efficacious and safe as VGA

FUTURE DIRECTION FOR MILITARY APPLICATIONS



Ultra Rapid Opioid Detoxification (UROD)

- ❖ Increased numbers of soldiers suffer from opioid addiction and dependence from the medications required to control chronic pain.
- ❖ UROD using TIVA techniques is one method to abbreviate the symptomatic withdrawal syndrome seen when discontinuing opioids.
- ❖ In theory, UROD in select patient populations may reduce relapse rates, by inducing GA through TIVA techniques, and bypass conscious withdrawal symptoms.

Target controlled infusion (TCI)

- ❖ First described in early 1980s
- ❖ Diprifusor[®] was introduced in late 1990s
- ❖ 1996 TCI device came on the scene in Europe
- ❖ Automated drug delivery is common internationally
- ❖ Pharmacokinetic model-driven infusion has several theoretical advantages over manual infusion
 - ❖ **reducing human error in medicine**
 - ❖ further improvements in hemodynamic control
 - ❖ more predictable rapid awakening
 - ❖ May decrease side effects and recovery times



TARGIT

**TRISERVICE ANESTHESIA RESEARCH
GROUP INITIATIVE ON TIVA (TARGIT)**

TARGIT

- ❖ TARGIT was the initiative to promote the use of TIVA within the U.S. armed forces.
- ❖ This initiative was created to develop techniques and strategies that will lead to the advancement, research, education and implementation of total intravenous anesthesia on the battlefield and in austere environments.

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Questions?

