



## Total Intravenous Anesthesia (Tiva)-A Brief Review

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### Abstract

Total intravenous anesthesia is a technique of general anesthesia which combines agents to be given exclusively via intravenous route. It has become more practical and popular, as pharmacokinetics and pharmacodynamics of popular intravenous drugs like propofol, and newer shorter acting opioids is well known, and newer concepts in pharmacokinetic models coupled with advanced technology in infusion pumps are available which allow the use of algorithms such as target controlled infusion (TCI). In this small editorial, TIVA, its potential benefits, pharmacokinetics, models, uses, advantages and disadvantages are been described briefly.

**Keywords:** Anesthesia; Intravenous; Pharmacokinetics; Pharmacodynamics

**Abbreviations:** TIVA: Total Intravenous Anesthesia; TCI: Target Controlled Infusion; TCIS: Target Controlled Infusion Systems; AEPI: Auditory Evoked Potential Index; CLAN: Closed Loop Anesthesia; CSHT: Context Sensitive Half Time; QT syndrome: Quality Time Syndrome.

### Advantages of TIVA

- Post-operative incidence of nausea and vomiting is significantly reduced.
- There is reduced operation theatre pollution from inhalational gases and overall reduced greenhouse effect.
- TIVA provides better hemodynamic stability.
- Hypoxic Pulmonary Vasoconstriction is preserved.
- There is reduction in intra cerebral pressure.
- Overall there is reduced risk of organ toxicity as is seen with halothane having hepatotoxic potential and sevoflurane under low flow having nephrotoxic potential.

### Specific Indications of Tiva

- Patients at risk of malignant hyperthermia,
- Patients with long QT syndrome,
- Patients with history of post-operative nausea and vomiting,
- Patients with anticipated difficult intubation or extubation,
- In neurosurgery cases to limit intracranial volume,
- Surgery requiring neurophysiological monitoring,
- Myasthenia gravis/ neuromuscular disorders and situations where neuromuscular agents are avoided,
- Anesthesia in remote locations,
- Transfer of un-anesthetized patients between environments,
- Day care surgery,
- Patient's choice

TIVA is highly effective at achieving a deep plane of anesthesia. Consequently, this technique must be used cautiously in patients compromised by advanced age or poor ASA status but still confers advantage in terms of recovery profile [1].

### TIVA can be provided via

- a. Intermittent boluses
- b. Continuous infusion

### Advantages of infusion

- a. Oscillations in drug concentration are avoided
- b. Overdosing and under dosing is avoided
- c. Provides stable depth of anesthesia
- d. Side effects are reduced
- e. Recovery time is reduced
- f. Total drug requirement is reduced

### Disadvantages

- a. More expensive
- b. Difficult to use complicated equipment

### Recent Advances in Tiva

- a. TCIS-target controlled infusion systems (Diprifusor).
- b. TIVA with closed loop control of anesthesia with BIS and AEPI (auditory evoked potential index).
- c. CLAN (Closed Loop anesthesia) [2].

### Pharmacokinetics and Tiva

There are different types of pharmacokinetic models [3]:

1. Compartmental models
2. Physiological models
3. Hybrid models

### Compartmental model

The rate constants describe the rate of movement by the drug between the central compartment and each of the other compartments and also the rate of elimination, usually from the central compartment.

### Limitations of compartmental model

- a. There are inter-individual pharmacokinetic variability's.
- b. There is assumption that there is immediate mixing of drug in the compartments and cannot be used to describe lung uptake.

c. A dose of drug given intravenously doesn't equilibrate instantaneously in practice.

d. 'Static' model

e. The model doesn't include aspects of dynamic state which are blood loss, hemodilution, and altered protein binding.

### Physiological models

Physiological Models describe drug uptake in different tissues under influence of circulation and re-circulation on drug distribution and adjusts it according to pathological state of the patient.

### Hybrid models

Hybrid model is a type of compartmental model which is adjusted to physiological parameters of the patient such as cardiac output etc.

### Context Sensitive Half Time (CSHT)

Context sensitive half life is the time in which plasma concentration of a drug is reduced by 50% on discontinuing the infusion that is described as context of a specified duration of infusion. Drugs with short CSHT are desirable as it would indicate quick recovery from anesthesia. However the time a patient takes to recover from a drug does not necessarily correlate with plasma concentration of 50%.

### Clinical Utility of Tiva

To achieve and maintain a constant plasma concentration over a time period, a bolus dose (B) is calculated so as to fill the central compartment. A constant rate infusion is made to replace drug lost during elimination (E) and an exponentially decreasing infusion that will replace drug lost from plasma by distribution (T) to peripheral tissues [4].

### Ideal properties of drugs used in Tiva

- a. Drug should be soluble in water so as to minimize toxicity with the solvent,
- b. Should be stable in solution.
- c. There should be no perivascular sloughing in case drug extravasates
- d. It should not be absorbed over plastic
- e. It should not promote bacterial growth
- f. It should have a rapid onset and rapid predictable recovery
- g. It should be devoid of any side effects
- h. Drug should be potent and lipid soluble
- i. It should be relatively cheap

**Drugs used in Tiva**

- a. Hypnotics: Propofol, Ketamine, Benzodiazepines, Etomidate, Barbiturates
- b. Analgesics: Fentanyl, Remifentanyl, Sufentanil, Alfentanil
- c. Muscle relaxants: Atracurium, Vecuronium

**Uses of Tiva**

- a. General anesthetic-neurosurgery, day care surgery.
- b. Supplement to regional, local anesthetic.
- c. Sedation analgesia for diagnostic/therapeutic Procedures.

**Potential Problems with Tiva**

1. Awareness During Anesthesia
2. Propofol infusion syndrome: Propofol-related infusion syndrome presents as acute metabolic acidosis and cardiac dysfunction in combination with one or more of the following features: rhabdomyolysis, hyper-triglyceridaemia, or renal failure [5].
3. Concerns in morbidly obese: TIVA for the morbidly obese is challenging but regularly

practiced, although the current TCI models are not formally validated for use in such patients.

4. Analgesia and hyperalgesia: The phenomenon of acute opioid tolerance after remifentanyl has been addressed and that the use of high intraoperative concentrations is associated with small but significant increases in acute pain after surgery.

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