

Constant Rate Infusion (CRI) gaining traction in veterinary practice

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Constant Rate Infusion (CRI), also known as Continuous Rate Infusion, refers to the intravenous administration of drugs at a predetermined, continuous rate using an infusion pump or through a calibrated fluid delivery system. Although both terms are used interchangeably, *Constant Rate Infusion* is the more widely accepted terminology in veterinary anaesthesia and critical care.

CRI has become an integral part of modern veterinary anaesthesia, analgesia, and intensive care as it enables accurate administration of drugs while maintaining relatively stable plasma concentrations of drugs. Unlike intermittent intravenous bolus injections, which produce fluctuations in drug concentrations characterized by peaks and troughs, CRI minimizes these variations, resulting in more consistent analgesia, sedation, or anaesthetic depth. Several studies have shown that CRI protocols often reduce the total dose of anaesthetic and analgesic agents required, thereby facilitating smoother maintenance of anaesthesia, earlier recovery, and potentially fewer side effects.

A wide range of drugs can be administered by CRI, including analgesics, sedatives, anaesthetics, cardiovascular agents, and antiarrhythmic drugs. Among analgesic protocols, the most commonly employed combinations include lidocaine-ketamine, ketamine-lidocaine-opioid, and combinations including fentanyl, morphine, methadone, or butorphanol depending on the availability of drugs, species and procedure. Lidocaine provides analgesic, anti-inflammatory, and anti-arrhythmic effects, particularly in dogs; while ketamine, administered at subanaesthetic doses effectively prevents central sensitization and wind-up pain. Opioids possess good analgesic property and are known to reduce the requirement of anaesthetics.

For maintenance of total intravenous anaesthesia (TIVA), propofol CRI, either alone or in combination with ketamine, dexmedetomidine, medetomidine, or opioids, has become increasingly popular in both companion animals and wildlife. More recently, alfaxalone CRI has emerged as an attractive alternative for TIVA because of its favourable cardiovascular profile and smooth recovery characteristics. Balanced anaesthesia protocols that combine propofol or alfaxalone with analgesic CRIs are increasingly being investigated to improve cardiovascular stability while minimizing the requirement for inhalant anaesthetics.

Alpha-2 adrenergic agonists, including dexmedetomidine, medetomidine, and xylazine, are also frequently administered as CRIs to provide sedation, analgesia, and to reduce the dose of inhalant agents

required for anaesthetic maintenance. These agents are particularly valuable in equine practice, ruminants, wildlife anaesthesia, and critically ill patients where balanced anaesthesia is desirable. Cardiovascular drugs such as dobutamine, dopamine, norepinephrine, and vasopressors are also routinely administered by CRI in critical care and during anaesthesia to maintain adequate tissue perfusion and blood pressure.

Another important reason for the increasing popularity of CRI is its usefulness in field conditions, ambulatory practice, and wildlife anaesthesia, where bulky inhalant anaesthetic machines may not be practical or available. Properly designed TIVA-CRI protocols can provide safe and effective anaesthesia under resource-poor conditions, by reducing the dependence on inhalant anaesthetic machines and volatile anaesthetics.

The concept of continuous intravenous infusion of drugs emerged in human medicine alongside the establishment of Intensive Care Units (ICUs), where infusion pumps and advanced physiological monitoring equipment enabled the precise administration of sedatives, analgesics, vasoactive drugs, and anaesthetic agents. Veterinary medicine adopted these principles during the late 1980s and early 1990s, particularly following the introduction of propofol and the expanding clinical use of lidocaine, ketamine, and opioid CRIs for perioperative analgesia. Over the last two decades, advances in balanced anaesthesia, multimodal analgesia, portable syringe pumps, and monitoring equipment have further accelerated the adoption of CRI across companion animal, livestock, equine, and wildlife practice.

In spite of having numerous advantages, CRI requires careful planning and vigilant patient monitoring. While drugs are administered at a constant rate, their pharmacokinetics, including distribution, metabolism, and elimination, vary considerably among species, breeds, age groups, disease states, and individual patients. Therefore, a uniform infusion rate cannot be recommended, and both underdosing and overdosing remain potential risks. Appropriate loading doses are often indicated to rapidly achieve therapeutic plasma concentrations before initiating the CRI for maintenance. Selection of proper drug/combination of drugs, along with accurate calculations of loading dose and infusion rate are therefore fundamental to successful CRI protocols.

Continuous monitoring of cardiovascular, respiratory, and anaesthetic parameters remains crucial throughout CRI administration and recovery. Adjustment of infusion rates based on patient response is often necessary to maintain optimal

analgesia and anaesthetic depth while minimizing adverse effects.

In conclusion, Constant Rate Infusion has evolved from a specialized anaesthetic technique into a key component of balanced anaesthesia, multimodal analgesia, and perioperative critical care in veterinary medicine. Contemporary CRI protocols employing combinations such as lidocaine-ketamine-opioids, propofol or alfaxalone-based TIVA, and alpha-2 agonist infusions are increasingly supported by clinical evidence and are being widely adopted across

species. Their ability to improve analgesia, reduce anaesthetic drug requirements, facilitate smoother recovery, and provide practical anaesthesia in resource-limited and field conditions has contributed to their growing popularity. The increasing number of experimental and clinical studies, including several recently published in the *Indian Journal of Veterinary Surgery*, reflects the renewed interest in CRI among veterinary surgeons in India and highlights its expanding role in contemporary veterinary anaesthesia and perioperative care.

EDITORS

