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# A review of current literature regarding the factors affecting recovery rates after routine surgery in rabbits – part 2

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**ABSTRACT:** Registered Veterinary Nurses (RVN) and Veterinary Surgeons (VS) must understand the factors that contribute to anaesthetic recovery in rabbits, as emergencies and fatalities during the recovery stage are higher in comparison to cats and dogs. The first part of this article focused on stressors in rabbit handling, including tonic immobility, transport and the effects of stress on recovery rates. This part aims to cover factors which can affect recovery rate during the anaesthetic episode, including hypothermia and induction methods.

**Keywords:** Literature review; rabbit; peri-operative care; mortality rates

## Introduction

Several factors can influence a rabbit's recovery time as established in part 1; however, there are some known factors which can cause post-operative complications that occur during the immediate anaesthetic period. Hypothermia and induction methods are two notable factors which the RVN must be able to assess and provide species-specific care.

Rabbits are prone to hypothermia due to their size to body mass ratio, which increases the risk of hypothermia during anaesthesia (Ackermann & Aspinall, 2016). It is widely accepted that monitoring temperature is vital during any anaesthetic procedure of any species because anaesthetic gases and reduced mobility will cause hypothermia (Girling, 2003; Harcourt-Brown, 2005). All anaesthetic agents have a depressant effect on the central nervous system (CNS) to achieve the triad of anaesthesia; however, the thermoregulatory system also becomes depressed and the body is unable to regulate body temperature (Lamb, 2009). Consequently, it is the RVN's role to regulate the patient's temperature to prevent impaired enzyme

function, coagulopathies and eventually cell death (Rigotti & Vries, 2010).

Moreover, temperature under anaesthesia can be hard to control and a rabbit's temperature can fluctuate dramatically up to 48 hours after anaesthesia; this means that the RVN must warm the patient gradually to prevent hyperthermia and burns. Hypothermia post-operatively induces a complex array of physiological effects including slowed metabolism, inappetence, abnormal responses to drug administrations, circulatory or respiratory collapse (Staikou, 2011; Druce, 2015).

Induction via inhalation anaesthesia is likely to be stressful for rabbits, exacerbated by the relatively long time required for inhalation anaesthetics to induce unconsciousness; rabbits will breath-hold if induced with inhalation anaesthesia alone, causing hypoxia (Longley 2008). RVNs may not feel competent placing lateral ear vein catheters, preventing intravenous (IV) induction being used; therefore, intramuscular (IM) induction may be preferable. Furthermore, the VS

may not wish to intubate rabbits after IV induction due to difficulty and to prevent laryngeal spasm. In response to this, supraglottic airway devices have been developed and are now readily available for use in rabbits. They provide a safe way to deliver and maintain inhalation anaesthesia without intubation and laryngeal trauma (Richardson, 2015).

## Hypothermia

Peri-operative hypothermia in all species is the most common and well-known negative consequence of anaesthesia, especially if no measures are put in place to prevent hypothermia (Sikoski, 2007; Henderson, 2012). Longley (2008) noted how rabbits are more susceptible to heat loss due to their large surface area to volume ratio; additionally, during anaesthesia homeostatic thermoregulatory mechanisms are likely to be lost. Girling (2003) and Lennox (2014) highlighted that hyperthermia is irreversible and is as noteworthy as hypothermia during anaesthesia; the most common cause of hyperthermia is incorrect temperature readings prior to aggressive warming techniques, especially if a continuous temperature probe has become displaced.

Longley (2008), Wenger (2012) and Druce (2015) all established that hypothermia will initiate cardiovascular instability, poor recovery and fatalities. Staikou's (2011) publication demonstrated that hypothermia affected coagulation mechanisms but to a non-significant extent; however, haemodynamic responses are significantly suppressed, including arterial blood pressure and heart rate.

Monitoring temperature is a widely accepted component of anaesthesia; the RVN must understand the pathophysiological pathways of homeostasis to be able to monitor all patients effectively (Girling, 2003; Henderson, 2012). Lennox (2014) went on to state that core body temperature decreased within the first 20 minutes of induction of anaesthesia; therefore, the RVN should consider preventative measures prior to anaesthesia. It is essential that the RVN monitors temperature throughout anaesthesia, rather than at the end of the procedure, so that any changes in temperature can be identified and implementations to alter temperature can be put in place to decrease recovery time.

Rectal thermometers are invaluable for assessing core body temperature (Longley, 2008); Lennox (2014) recommended that core body temperature should be

monitored continuously with a flexible temperature probe. Druce (2015) discussed monitoring, prevention and treatment of hypothermia in anaesthetised rabbits and stated that body temperature can be obtained via continuous rectal thermometers, thermosensors or ear thermometers. It is worth noting that ear thermometers must be validated for use in rabbits and calibrated between species to prevent inaccurate results. The RVN may find a thermosensor or an ear thermometer useful in routine neutering procedures or where the rectum is not easily accessible without disturbing the sterile field; however, where possible a continuous rectal thermometer should be used for accuracy (Sousa, Carareto, Pereir, & Aquino, 2011). The patient may benefit from the use of an ear thermometer peri-operatively as it is less invasive and can aid in reducing stress (Lennox, 2014).

It is the RVN's role to prevent hypothermia occurring; therefore, it is essential that the RVN knows how and when to implement preventative measures. The RVN should maintain the external environment temperature pre-operatively to ensure that the patient is warm prior to anaesthesia. Longley (2008) noted that it may be beneficial to provide heat pads or blankets after pre-medication and during recovery; however, it is important to ensure that hyperthermia does not occur, as the patient will be unable to move away from the heat sources. Additionally, under VS guidance warmed intravenous fluids can be provided prior or after induction to maintain circulating volume and core body temperature.

Forced-air warming blankets (FAWB) have been shown to minimise anaesthetic-induced hypothermia in cats (Machon, Raffae, & Robinson, 1999) and Henderson (2012) noted that FAWB is a common and effective method of preventing hypothermia. Sikoski (2007) showed no significant loss in body temperature with the use of the FAWB and a minor increase in body temperature with the use of the circulating warm-water blanket; therefore, they should only be used for anaesthesia.

## Induction methods

Borkowski and Karas (1999) stated that rabbits are challenging to anaesthetise, as did many recent publications (Orr, Roughan, & Flecknell, 2005; Longley, 2008; Brodbelt, 2012; Hedenqvist, Edner, Fahlman, & Jensen-waern, 2013); this further proved the need for research as

this topic has not progressed in the same way as canine and feline anaesthesia.

The work of Flecknell et al. (1996) explored the differences in stress and resistance to induction anaesthesia comparatively between the facemask and chamber method. Significantly, all the rabbits in this study had periods of apnoea and bradycardia during induction, some resulting in moderate hypercapnia and acidosis before an adequate plane of anaesthesia had been obtained. Flecknell et al. (1996) point out that all the rabbits in the study avoided inhalation anaesthesia, with studies in canines and felines showing the same results. The behaviour these rabbits expressed and the rates of post-inhalation anaesthesia apnoea show that these induction methods are stressful and should be avoided (Dugdale, 2010).

Premedication or a short-acting induction agent should be used to prevent stress and the consequences of apnoea. Lui et al. (2012) and Hedenqvist et al. (2013) both agreed that continuous IV anaesthesia produces a smooth induction and recovery with some respiratory depression.

Allweiler, Leach, and Flecknell (2010) noted that to prevent bradycardia, hypercapnia and hypoxia, an anaesthetic protocol with successful induction should be put in place to lead to a rapid recovery; Lennox (2014) expanded on Flecknell et al.'s (1996) suggestion that pre-medication should be used to prevent a stressful induction. Controversially, Lennox (2014) suggested that pre-medication will not prevent apnoea and a balanced anaesthetic approach is preferred. Every anaesthetic agent will have CNS depressant effects and it is important that a balanced approach to anaesthesia is performed to increase recovery rates (Riggoti, 2012). To achieve a suitable plane of anaesthesia and increase the likelihood of a good recovery, the triad of anaesthesia should be met, and pre-anaesthetic agents should be used to calm the patient prior to induction, provide analgesia, prevent hyperaesthesia and potentially emergence delirium post-operation (Longley, 2009).

## Conclusion

Each of the main factors identified – thermoregulatory systems, stress, handling and induction methods – makes an important contribution to the understanding of rabbit mortality and recovery rates. However, it is evident that each factor has a different relevance to patient mortality rates and that the RVN must be

**Table 1.** Suggested protocols for veterinary practice.

Guideline	Justification
Intravenous induction agents	IV induction agents are often dismissed to maintain routine and due to a lack of confidence and research in veterinary practice. There are several studies regarding IV induction agents which can build confidence among the veterinary team
Intravenous access	Any patient undergoing an anaesthetic procedure should have IV access to provide fluid support and to administer emergency drugs if necessary
Intramuscular induction agents (such as alfaxalone and ketamine)	Injectable induction agents such as alfaxalone and ketamine can be given IM to avoid handling and the associated stress of IV inductions; however, an IV catheter should be placed immediately after induction (West, 2017)
Intubation	Any patient undergoing general anaesthesia should have an endotracheal tube or supraglottic device placed when possible. Intubation allows for a patent airway to be secured and for effective and reliable inhalation anaesthesia. Several studies in rabbits have suggested that to avoid laryngeal collapse, intubation should not be attempted more than three times
Continuing professional development events	Training days for VSs and RVNs including supraglottic devices, IV catheterisation and intubation techniques could be useful to increase confidence among the veterinary team
Nurse clinics	RVNs could employ nurse clinics and marketing techniques to guide owners on how to hold their rabbit and help reduce stress prior to an appointment

able to assess each factor individually and understand the complications of each one. Although the individual factors can result in a decreased recovery rate and increased risk of fatality, the combination of these factors will produce a much higher risk of mortality. Accordingly, the RVN must have a holistic approach to rabbit peri-operative care, as it is the combination of such factors and the potential problems that are evident that can significantly decrease recovery rates and increase the risk of fatalities.

The questions raised have been answered in that rabbit medicine has evidently not improved as rapidly as canine and feline medicine; however, due to the short domestication period and the rapid increase in rabbit popularity, the reason why research has not advanced within this short time frame is clear. Despite the research available, some veterinary professionals may choose to disregard it as the number of rabbits that are present in practice is lower than canine and feline patients, and rabbit protocols may become neglected.

Before considering areas of further studies, it is important to note that it is evident that veterinary professionals still fear and struggle with rabbit anaesthesia. More research about why veterinary professionals feel this way may allow for changes and recognition of this problem (Allweiler et al., 2010; Talukdar, Shyam, Deuri, & Talukdar, 2016; West, 2017). On that note, further research regarding rabbit-specific monitoring and heating devices is necessary. While canine and feline research is still useful, rabbit-specific literature would be valuable as hypothermia is so prevalent (Machon et al., 1999; Druce, 2015).

In regard to handling, the effectiveness of selective breeding for tameness and the use of human-scented objects with neonates could revolutionise how rabbits are bred and hopefully increase health and welfare standards. Additionally, the majority of the research papers discussed did not debate the welfare effects of different handling practices that are commonly used by owners and veterinary professionals.

Moreover, it may be beneficial to establish rabbit medicine on canine and feline medicine as there is evidence that they show similar anaesthetics reactions (Dugdale, 2010; Ayers, 2016); however, more research is needed on which anaesthetic protocols produce a good plane of anaesthesia while aiming for a safer recovery. With sufficient research and the use of protocols, the RVN can encourage and train staff to implement such provisions which will help reduce fatalities and recovery rates. The whole veterinary team must be committed to set protocols (Table 1) to allow for evidenced-based medicine and advances in rabbit care.

To conclude, as the rabbit population continues to grow and present in practice, it is the RVN's role to provide evidence-based and holistic care, while setting an example for clients on how to assist veterinary professionals and meet their rabbit's health and welfare needs. Moreover, it is evident that the standard of care for rabbits has been poor in comparison to canines and felines, and it is the veterinary professional's role to not deem rabbits as a high fatality risk but to continue evidence-based research and staff training to enable appropriate and efficient peri-operative care.

## Disclosure statement

No potential conflict of interest was reported by the author(s).

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