Second Edition

Farm Animal Anesthesia

Cattle, Small Ruminants, Camelids, and Pigs

Edited by
HuiChu Lin
Thomas Passler
Stuart Clark-Price

with website

WILEY Blackwell

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I dedicate this book to my colleagues in the Food Animal Section of Auburn University for your team spirit and for making my job as an anesthesiologist easy and fun. I appreciate all the more your unreserved friendship and support. This book would not be a reality without you all.

HuiChu Lin, DVM, MS, DACVAA

To the most important people in my life: my parents Barbara Fechner and the late Hans Passler, my wife Nicole, my son William, and my American family, the Borgmeyers. Thank you for your unwavering love and support! And to my colleagues – the Auburn family – for their collegiality, friendship, and words of wisdom.

Thomas Passler, DVM, PhD, ACVIM

I would first like to start by thanking Dr. Hui-Chu Lin for inviting me to participate in the second edition of this textbook. It is exciting to see anesthesia and pain management for farm animals advance and to know that practitioners are utilizing this information to improve the lives of the animals and clients they serve. I therefore dedicate this book to those practitioners, some of whom have been students of mine, who tirelessly endeavor to provide care to the best of their abilities.

Stuart Clark-Price, DVM, MS, DACVIM, DACVAA

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Preface

The first edition of *Farm Animal Anesthesia: Cattle, Small Ruminants, Camelids, and Pigs* was published in 2014. Since then we have received encouraging comments from veterinarians on the usefulness and practicality of the information provided in the book. Many veterinarians complimented the ease of searching for the information needed for their daily practice: anesthetic patient care, drug dosages, and drug combinations for different circumstances and surgical procedures (Chapters 1–6 and Chapters 8 and 10). Information on the local and regional anesthetic techniques and pain management chapters provided many options to minimize perioperative and postoperative pain, and reduce patient suffering (Chapters 7 and 10). The chapter on regulatory and legal considerations of anesthetics and analgesics ensured avoidance of human consumption of drug residues in meat and milk from food-producing animals (Chapter 11). The euthanasia chapter offered clear information on different methods that a veterinarian can use to effectively and humanely end an animal's suffering when there are no available treatments that can improve an animal's deteriorating condition (Chapter 12). The contributing authors and editors are extremely proud and honored that the first edition of the book was well received by our professional colleagues, who continue to provide best patient care.

Great advances have been made in farm animal medicine and surgery in the recent years. Many farm animal species are now also kept as companion animals, particularly small ruminants and potbellied pigs. Advanced treatment options and complex surgeries have become available. The second

edition of the book includes new information published since the first edition, including newer anesthetics and analgesics, surgical procedures, fluid therapy, and updates on regulations pertaining to anesthetic drugs used in farm animals. We believe farm animal veterinarians will continue to find the second edition to be a useful and practical guide for anesthetics and pain management in their daily practice. Included in this edition are videos of different local and regional anesthetic techniques to guide veterinarians to perform nerve blocks for intended surgeries safely and effectively. Also included is information on the application of neuromuscular blocking agents and the clinical use of ventilators when complicated and long duration surgery is necessary. As surgical techniques progress, the increased complexity will require that some patients are administered neuromuscular blocking agents and the knowledge of the use of these drugs and mechanical ventilators will become an essential part of anesthetic management.

The editors greatly appreciate the contributing authors, Drs. Benjamin Newcomer, Manuel Chamorro, Jessica Rush, and Jenna Workman Stockler, for their work and efforts in making this book a complete book on farm animal anesthesia. We thank the illustrators, Kim Crosslin and Katlyn King, for their picture-perfect artwork and Dr. Ray Wilhite for excellent anatomical images. We also want to thank Merryl Le Roux, Managing Editor, and her staff at John Wiley & Sons for their patience and much needed assistance throughout this process.

HuiChu Lin
Thomas Passler
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About the Companion Website

This book is accompanied by a companion website:

www.wiley.com/go/lin/farm

The website includes:

- Video clips

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Preanesthetic Considerations

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General anesthesia in farm animals, like cattle, sheep, goats, llamas, alpacas, and pigs, requires special attention due to the uniqueness of the anatomical and physiological characteristics as compared to dogs, cats, and horses. Camelids (llamas and alpacas) only have two forestomachs but are otherwise similar in many ways to cattle and small ruminants. Although some farm animals may cost as much as purebred companion animals, farm animal veterinarians are often faced with economic constraints and a limited number of approved drugs for use in surgical procedures requiring anesthesia. Physical restraint and local anesthetic techniques are most commonly employed to produce immobility and analgesia for these species. Ruminants generally tolerate physical restraint and recumbency well. This, along with local and/or regional anesthetic techniques, allows many minor surgical procedures to be performed in the standing position and under field conditions. General anesthesia is more frequently performed in camelids and swine for even minor surgical procedures due to their intolerance of physical restraint. It is important to remember that farm animals perceive pain no differently than other species, therefore analgesia for prevention and easing of pain is just as important as it is for companion animals. With surgical procedures requiring general anesthesia, balanced anesthetic technique should be employed to provide narcosis, analgesia, and muscle relaxation, thereby

minimizing the stress response induced by surgery and anesthesia. Most of the anesthetics and anesthetic adjuncts commonly used in farm animal practice do not have Food and Drug Administration (FDA) approval for use in ruminants, camelids, and swine [1, 2]. However, per the Animal Medicinal Drug Use Clarification Act (AMDUCA) of 1994, extralabel use of drugs is permitted when animal health is threatened or death may result if not treated [3]. While prevention of violative residues should always be considered, anesthetics are usually used for a short duration, and anesthetized animals are unlikely to be marketed immediately after surgery. Furthermore, anesthetics used today tend to have very short half-lives ($t½$), and they are potent enough that only low doses are required to produce general anesthesia. The possibility of an animal carrying anesthetic residues within its edible tissues after the surgical incision has healed, which normally occurs within an average of 14 days, is extremely low. Thus, problems with anesthetic drug residues appear to be rare [4]. Nevertheless, veterinarians should consult the Food Animal Residue Avoidance Databank (FARAD) for meat and milk withdrawal intervals for extralabel use of analgesics, sedatives, and injectable anesthetics as well as for updates of drugs prohibited from extralabel use [1, 2].

Prior to anesthesia, an appropriate patient history, including breed, age, sex, condition, and temperament of the patient, and a complete physical examination are indicated. Due to economic reasons, blood work including complete blood count and chemistry profile is performed only in farm animals with significant systemic diseases and those considered to have a higher anesthetic risk. For example, animals with severe gastrointestinal (GI) abnormalities often suffer extreme dehydration with or without electrolyte alteration, which may require intervention to optimize the patient's condition with fluid

therapy prior to the induction of anesthesia [5]. In healthy animals, total plasma protein and packed cell volume are sufficient indicators of a patient's hydration status.

Most sedatives and general anesthetics cause some degree of cardiovascular depression, which may not be a great concern for healthy patients. However, normal cardiovascular protective mechanisms or reflexes in response to the depressing effects of anesthetics may be obtunded in animals with compromised cardiac function or severe electrolyte imbalances as a consequence of disease conditions. Maintaining a balance of concentrations of electrolytes like calcium, sodium, and potassium across the cell membranes is essential in establishing normal cell membrane potential and contractility. Disturbance of these electrolyte balances across cell membranes changes cellular resting membrane potentials and subsequent initiation and propagation of cellular depolarization and repolarization. Acidosis has been shown to cause electrolyte imbalances resulting in decreased myocardial contractility and increased response of the myocardial cells to circulating catecholamines. Therefore, anesthetic-induced cardiovascular depression combined with severe preexisting acidosis and electrolyte imbalances can lead to detrimental side effects like severe cardiac arrhythmias, bradycardia, decreased myocardial and vascular cellular contractility, reduced cardiac output, and hypotension. As a result, anesthetized animals may not be able to maintain adequate cardiac output or arterial blood pressure leading to significantly decreased peripheral tissue and muscle perfusion with subsequent development of severe adverse effects such as irreversible postanesthetic neuromyopathy [6].

1.1 Positioning

Ruminants, camelids, and swine are susceptible to complications associated with anesthesia and recumbency. Positioning of these animals, particularly adult cattle, in dorsal or lateral recumbency for surgery allows for the weight of abdominal viscera to shift ventrally and cranially, causing the diaphragm to be pushed further into the thoracic cavity, thereby reducing the functional residual capacity of the lungs (Figure 1.1). As a result, an increased ventilation/perfusion mismatch may lead to significant hypoventilation and hypoxemia during anesthesia. Furthermore, the weight of the abdominal viscera may compress great vessels such as the vena cava leading to decreased venous return, cardiac output, and arterial blood pressures [7]. Therefore, close monitoring of cardiovascular and pulmonary functions and institution of appropriate treatments to ensure normal arterial blood pressure and adequate ventilation are important parts of perioperative anesthetic management.

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