A 3-year-old spayed female rabbit (case 1) was evaluated because of a 3-day-history of partial anorexia and lower than typical fecal production. On initial examination, the rabbit weighed 1.49 kg (3.28 lb) and had a normal body condition score (3/5). Diet was deemed appropriate for the species. Physical examination revealed signs of depression, 5% dehydration, congested mucous membranes, a hematoma involving the right auricular pinna, and hypothermia (rectal temperature, 36.9°C [98.4°F]). Abdominal palpation revealed a distended and firm stomach as well as a firm, circumscribed mass adherent to or associated with the right kidney. The rabbit was hospitalized for management of the gastrointestinal stasis. Intravenous fluid therapy was initiated with a constant rate infusion of lactated Ringer solution (200 mL/kg/d [91 mL/lb/d], IV, decreased to 100 mL/kg/d [45 mL/lb/d], IV, over the following days). Other treatments included gavage feeding (10 mL/kg [4.5 mL/lb], PO, q 8 h), buprenorphine (0.05 mg/kg [0.023 mg/lb], sublingual, q 6 h), midazolam (0.5 mg/kg [0.23 mg/lb], IM, q 24 h), enrofloxacin (5 mg/kg [2.3 mg/lb], PO, q 12 h), metronidazole (20 mg/kg [9 mg/lb], PO, q 12 h), cisapride (0.5 mg/kg, PO, q 8 h), and cholestyramine (1 g, PO, q 24 h).

The owner expressed reluctance to pursue diagnostic tests should the gastrointestinal stasis fail to improve, so additional diagnostic tests were performed following initial stabilization and improvement of the gastrointestinal stasis. These tests included a CBC, plasma biochemical analysis, urinalysis, abdominal ultrasonography, and fine-needle aspiration of the suspected renal mass for cytologic evaluation. Abnormal results included severe polycythemia (PCV, 0.75 L/L; reference range, 0.3 to 0.5 L/L), hemoglobinemia (blood hemoglobin concentration, 238 g/L; reference range, 80 to 175 g/L), and mild hypoglycemia (plasma glucose concentration, 5 mmol/L; reference range, 6 to 8.8 mmol/L), with a high plasma creatinine concentration (110 µmol/L; reference range, 53 to 74 µmol/L) and high creatine kinase activity (10,110 U/L; reference range, 140 to 372 U/L). Analysis of a free-catch urine sample obtained at the time of blood sample collection and after IV fluid administration began revealed a low specific gravity (1.007; reference range, 1.010 to 1.030).

Abdominal ultrasonography revealed a well-defined, hypechoic, slightly heterogeneous, and poorly vascularized mass involving the right kidney.

**CASE DESCRIPTION**

A 3-year-old and a 7-year-old spayed female rabbit (*Oryctolagus cuniculus*) were evaluated because of digestive stasis associated with renal asymmetry.

**CLINICAL FINDINGS**

Neoplasia of the right kidney was diagnosed via cytologic analysis in the 3-year-old rabbit. Ureterolithiasis of the left kidney was diagnosed via abdominal ultrasonography in the 7-year-old rabbit. To evaluate whether unilateral nephrectomy was indicated, evaluation of glomerular filtration rate by dynamic CT (CT-GFR) was performed on both rabbits. On the basis of the functional and morphological CT-GFR results, radical nephrectomy was recommended for the rabbit with renal neoplasia whereas a more conservative approach was recommended for the other rabbit.

**TREATMENT AND OUTCOME**

The rabbit with renal neoplasia underwent radical nephrectomy without complication. The rabbit with ureterolithiasis underwent ureteral stent placement, and the renal pelvic dilatation resolved. Both rabbits maintained unremarkable serum urea and creatinine concentrations after surgery.

**CLINICAL RELEVANCE**

GFR is a highly useful and reliable variable for the evaluation of renal function but is difficult to assess with routine clinical laboratory tests. The CT-GFR technique described here was quickly performed, was technically suitable for rabbits, and provided clinically relevant information. Studies are required to establish reference values for CT-GFR in rabbits. (*J Am Vet Med Assoc* 2017;250:681–687)
The mass represented approximately 80% of the kidney volume, with a maximal diameter of 4.4 cm. No evidence of vascular invasion or abdominal metastasis was detected. Results of cytologic evaluation of the fine-needle aspirate sample were compatible with renal carcinoma.

Three days after the rabbit was admitted to the hospital and once dehydration had clinically resolved, evaluation of GFR by means of CT (CT-GFR) was performed to determine whether unilateral nephrectomy would be an appropriate treatment option. The rabbit was sedated with buprenorphine (0.05 mg/kg, SC) and midazolam (1 mg/kg [0.45 mg/lb], IM). A catheter was placed in a cephalic vein for contrast medium administration. Anesthesia was induced with propofol (2 to 3.6 mg/kg [0.9 to 1.6 mg/lb], IV, to effect), tracheal intubation was performed, and anesthesia was maintained with isoflurane (1.5% to 3%) in oxygen. Lactated Ringer solution (10 mL/kg/h, IV) was administered throughout the anesthetic period. Anesthetic monitoring included ECG, pulse oximetry, rectal temperature measurement, and capnography.

The anesthetized rabbit was positioned in ventral recumbency, and CT-GFR was performed as described elsewhere by use of a 16-detector-array helical unit. Three sets of scans were performed: baseline (initial whole-body helical scan before contrast medium administration), dynamic (postcontrast single-slice scan to measure clearance of administered contrast medium), and renal volume determination. General settings for the CT scans were as follows: pitch, 0.938:1 with 1.25-mm overlap; matrix, 512 X 512 pixels; display field of view, 153 mm; and scan field of view, small. For the baseline scanning session, additional settings included 120 kVp, 200 mAs, and a slice thickness of 2.5 mm. During this session, the kidneys and abdominal aorta were identified and the urinary tract was evaluated (Figure 1). For the dynamic CT session, a tube rotation of 0.7 seconds was used, with settings of 120 kVp and 250 mAs. A bolus of iopamidol (150 mg of I/kg [68 mg of I/lb]; calculated on the basis of the rabbit’s body weight the morning of the procedure) was rapidly (approx 3 mL/s) manually injected IV, and acquisition of postcontrast images was initiated a few seconds after the injection began. Review of postcontrast images confirmed that 80% of the renal parenchyma appeared to be occupied by a heterogeneous and multilobulated mass. A 5-mm-thick slice centered at the hilus of both kidneys was obtained every 2 seconds for 190 seconds. Functional volume of the right kidney appeared reduced relative to that of the left kidney (Figure 2).

Immediately following the dynamic scanning session, a postcontrast whole-abdomen scan was performed by use of the same settings as for the baseline scan. This final step was performed to measure renal volume and identify renal abnormalities. Determination of GFR was based on Patlak plot analysis as described elsewhere. Briefly, an ROI was manually drawn around the contour of each kidney, excluding any abnormal region, by use of an image-analysis workstation. The neoplastic mass was not included in the ROI because it was composed of abnormal tissue. An ROI was placed within the abdominal portion of the aorta on each dynamic slice and on the equivalent baseline slice. Postcontrast renal and aortic attenuation values (Hounsfield units) were corrected by subtracting the precontrast mean attenuation value within the ROI from each postcontrast attenuation value.

Time-attenuation curves were constructed for the aorta and both kidneys, revealing a normally shaped vascular peak with bilateral absence of a glomerular filtration peak in attenuation (Figure 3). Data were used to generate a linear Patlak plot for each kidney. The slope of the Patlak plot represents the clearance rate of iodinated contrast medium from the bloodstream per unit volume of the renal parenchyma. This slope value must then be corrected by multiplying it by (1 - preanesthetic PCV) to obtain the plasma clearance rate of contrast medium per milliliter of renal tissue. This plasma clearance value...
is multiplied by renal volume to obtain the value for overall renal clearance rate. This overall value is divided by the subject’s preanesthetic body weight to obtain GFR.

Glomerular filtration rate in the rabbit was accordingly estimated as 0.65 mL/min/kg for the left kidney, accounting for 83% of total GFR, and 0.13 mL/min/kg for the right kidney. The lack of a glomerular filtration peak on the time-attenuation curve suggested overall prerenal kidney failure, and calculated values indicated minimal contribution to renal function by the neoplastic right kidney. The neoplastic kidney was considered a potential cause of prerenal kidney failure because the neoplastic tissue could have been producing an excess of erythropoietin, leading to secondary erythrocytosis. Because PCV is used to calculate the GFR, polycythemia results in a decreased GFR value. Subclinical dehydration secondary to pain-related gastrointestinal stasis caused by the mass effect of the neoplastic kidney would also lead to a high PCV and prerenal failure. Considering the minor contribution of the diseased kidney to the total GFR, we believed that nephrectomy would overall improve renal function.

The neoplastic mass was multilobulated and heterogeneous even before contrast medium administration (Figure 1). Located at the cranial pole of the right kidney, the mass measured 5 X 4 X 3 cm, which represented approximately 80% of the renal volume. No evidence of metastasis was identified. Right nephrectomy was performed, and the rabbit recovered without complication. Results of histologic evaluation of a tissue sample obtained from the mass were consistent with a renal nephroblastoma. Plasma creatinine concentration progressively decreased to 81 µmol/L in association with a decrease in PCV to 57% within 10 days after nephrectomy. Within the same period, urine specific gravity increased to 1.021 and IV fluid administration was progressively reduced to 40 mL of lactated Ringer solution/kg/d (18 mL/lb/d). The owners elected not to return the rabbit for a recheck examination but reported that clinical signs had not recurred after surgery. Further details regarding this rabbit’s progress could not be obtained.

A 7-year-old spayed female rabbit (case 2) was referred for management of left renal and ureteral lithiasis. The rabbit had a 2.5-month history of urination outside the litter box and recent signs of lethargy and lower than typical appetite. At the initial evaluation, the rabbit weighed 2.6 kg (5.72 lb) and was slightly overweight (body condition score, 4/5). Diet was deemed adequate for the species. Abdominal palpation revealed an enlarged left kidney. Initial diagnostic testing included a CBC, plasma biochemical analysis, urinalysis, microbial culture of a urine sample, and abdominal ultrasonography. Results of all laboratory tests were unremarkable. Abdominal ultrasonography revealed occlusive ureterolithiasis associated with severe hydronephrosis (renal pelvis dilatation to 1.7 cm) and 2 nephroliths in the left kidney.

The CT-GFR technique was performed as described for case 1 to measure ureter diameter, precisely locate the site of lithiasis, and evaluate function in the contralateral kidney. Settings used for performance of CT-GFR were the same as for case 1, except that 250 mAs was used for the baseline scanning session and the display field of view was 122 mm. The GFR in the right kidney was 1.02 mL/min/kg and represented 62% of the total GFR; that in the left kidney was 0.62 mL/min/kg. The total CT-GFR value was therefore below the lower limit of 2.5 mL/min/kg expected in other species such as cats.\footnote{Time-attenuation curves revealed a widened vascular peak for the left kidney, suggestive of systemic or renal vascular stasis (Figure 4). Flattened glomerular peaks indicated a decreased filtration solution/kg/d (18 mL/lb/d). The owners elected not to return the rabbit for a recheck examination but reported that clinical signs had not recurred after surgery. Further details regarding this rabbit’s progress could not be obtained.}

Figure 3—Time-attenuation curve for CT-GFR analysis of the right (gray line) and left (black line) kidneys of the rabbit of Figure 1. The vascular peak (arrow) is normally shaped for both kidneys. No significant glomerular peak is visible.

Figure 4—Time-attenuation curve for CT-GFR analysis of the right (gray line) and left (black line) kidneys of a 7-year-old spayed female rabbit with ureterolithiasis of the left kidney. The vascular peak for the left kidney appears widened, which is a pattern consistent with systemic or renal vascular stasis. Glomerular peaks are flattened in both kidneys, indicating a decrease in GFR. See Figure 3 for remainder of key.
rate of contrast medium in both kidneys. The finding of a decrease in GFR without azotemia was consistent with a diagnosis of subclinical bilateral renal insufficiency without compensatory hypertrophy of the right kidney. Morphological evaluation revealed a left ureter large enough to allow placement of a stent.

In agreement with the owners, a decision was made to preserve the 2 kidneys and so a ureteral stent was surgically placed in the left ureter. A follow-up abdominal ultrasonographic examination was performed 1 month after stent placement, revealing resolution of the pelvic dilatation. Results of CBC, plasma biochemical analysis, and urinalysis were unremarkable at that point. The rabbit remained free of the previous clinical signs for 18 months after stent placement.

**Discussion**

Kidney disease is common in pet rabbits, with renal lesions identified in > 70% of geriatric rabbits at necropsy. This high prevalence may be related to conditions such as infectious nephritis caused by *Encephalitozoon cuniculi* or nephrolithiasis secondary to metabolic imbalances, such as those resulting from a high dietary calcium intake or insufficient water provision. Although less commonly identified in pet rabbits, primary or secondary renal neoplasia, congenital defects, and other conditions such as pyelonephritis and amyloidosis can also develop.

One rabbit in the present report had a diagnosis of nephroblastoma, and the other had a diagnosis of ureterolithiasis. Although cytologic evaluation of a fine-needle aspirate sample is useful for the assessment of retroperitoneal lesions in humans, cytophologic discrepancies can occur when there is loss of architectural organization, which can explain why nephroblastoma may first be diagnosed as renal cell carcinoma. Regardless of the cause, primary kidney diseases generally progress insidiously to chronic renal failure, with nonspecific signs such as weight loss and lethargy developing in affected animals once 50% to 70% of the nephrons lose function.

Evaluation of renal function is fundamental in the diagnosis and management of renal diseases. However, ancillary testing used routinely for cats and dogs may be of limited value for rabbits. Results of urinalysis can be difficult to interpret because color and turbidity of urine vary more in healthy rabbits than in healthy cats and dogs because of the unique calcium metabolism of rabbits. Urine specific gravity is naturally lower in rabbits than in other mammals because the kidneys of rabbits have poor concentrating ability, making isosthenuria a normal finding in this species. Moreover, proteinuria can be a normal finding after physical exercise or stress, and glucosuria is generally not considered abnormal in rabbits and other species with signs of distress or pain. The high susceptibility of rabbits to stress can therefore hide urinary changes associated with earlier stages of kidney dysfunction to a greater degree than in cats and dogs.

Measurement of routine biochemical analytes is fairly insensitive for the diagnosis of kidney disorders in rabbits, as it is in other mammals. The limited ability of rabbits to concentrate urea requires the excretion of greater volume of urine to remove the same amount of nitrogenous waste as in other mammals. As a consequence, when a rabbit is dehydrated, urine volume will decrease and it may not be able to excrete as much nitrogenous waste as a dehydrated cat or dog. Therefore, prerenal azotemia will develop more readily in rabbits. In addition, plasma urea concentration is influenced by variables such as circadian rhythm, cecal urea activity, or nutritional status, and small fluctuations in this analyte are difficult to interpret. As a consequence, routine hematologic testing in rabbits is less informative in the diagnosis of early intrinsic kidney dysfunction than in cats and dogs. Imaging techniques such as radiography, ultrasonography, or excretory urography can be helpful to identify morphologic modification of the urinary tract but are of limited value regarding evaluation of kidney function.

As in other mammals, determination of GFR is considered the most important indicator of renal function because it is directly proportional to the number of functioning nephrons. All validated methods of GFR estimation rely on clearance of a plasma marker. Any substance that is freely filtered by the glomeruli, not bound to plasma proteins, and not reabsorbed, secreted, or metabolized by the tubules may be used as a marker of GFR.

Various markers and techniques have been developed for GFR estimation, including plasma clearance of creatinine and urinary clearance of inulin. Measurement of inulin clearance is considered the reference (gold) standard. However, such techniques are expensive and time-consuming to perform and require collection of multiple and large amounts of urine or blood, precluding their use for small exotic pets or animals not adapted to frequent handling.

Other techniques, such as quantitative renal scintigraphy involving pharmaceutical radionuclides or clearance of gadolinium-based contrast medium monitored via MRI, have been described for rabbits but are expensive and require isolation of subjects or prolonged anesthesia of potentially unstable subjects.

Iopamidol is an iodinated x-ray contrast medium similar to iohexol, with pharmacokinetic properties that meet the requirements of a GFR marker. Historically, measurement of plasma iohexol clearance rate involved repeated blood sample collection. However, functional imaging techniques such as CT can be used to monitor plasma clearance of x-ray contrast markers because of the linear relationship between tissue x-ray attenuation
(measured in Hounsfield units) and plasma iodine concentration. This technique was developed in human medicine in the 1990s and has since been adapted for use in other species, including dogs, cats, horses, and pigs. Physiologic aspects of glomerular filtration in rabbits are similar to those in other species. Therefore, GFR measurement by means of CT-GFR is likely possible in rabbits. The technique is rapid and relatively noninvasive, requiring no blood sample collection, and is less expensive than MRI. With some minor adaptations, CT-GFR techniques described for other mammals meet the technical constraints associated with small exotic animal practice. To the authors’ knowledge, the present report represents the first in which the clinical use of CT-GFR in rabbits has been described.

Not only suitable for use in small mammals, the CT-GFR technique provides clinically relevant information. The entire urinary tract is imaged with and without contrast medium administration, allowing for a complete structural evaluation with better spatial resolution than achieved with scintigraphy. In addition, this technique allows evaluation of the GFR in each kidney, which is not possible with conventional plasma clearance or biochemical methods of measurement. As a consequence, the main indication for use of the CT-GFR technique is for patients in which evaluation of GFR in individual kidneys is necessary, such as when nephrectomy is considered or after renal transplantation.

Following nephrectomy, various renal modifications take place to maintain fluid and electrolyte balances, such as decreased angiotensin secretion and structural hypertrophy and hyperplasia of the remaining kidney. In rabbits, those functional adjustments develop within a month after nephrectomy to maintain a physiologically normal GFR, and this period can therefore be associated with transient kidney failure. However, these physiologic and structural adaptations lead to hyperfiltration and hypertension, resulting in nephron loss. Such adaptations have no clinical consequences when the remaining kidney is healthy but can accelerate the course of preexisting subclinical disease when the remaining kidney is diseased. The CT-GFR technique allows functional evaluation of individual kidneys and diagnosis of subclinical renal insufficiency, and it should be considered when attempting to minimize the risk of a rabbit developing true clinical renal failure following nephrectomy.

Although no studies have been performed in rabbits regarding factors associated with GFR, veterinary practitioners should be aware that GFR may be influenced, as in other species, by factors such as age, sex, circadian rhythm, hydration status, and dietary protein intake. Various methods have been used to measure GFR in rabbits. For example, measurement of inulin clearance rate by use of a single blood sample resulted in a mean ± SD GFR of 4.01 ± 0.14 mL/min/kg in healthy rabbits (n = 14) in 1 study. Contrast medium clearance rate has also been measured in healthy rabbits (n = 10) via MRI, revealing mean ± SD values of 0.68 ± 0.31 mL/min/kg with 1 protocol, 0.84 ± 0.37 mL/min/kg with a second protocol, and 3.19 ± 1.2 mL/min/kg with a third protocol. These variations emphasize the fact that GFR value is highly dependent on the method used for determination. Therefore, caution must be used when comparing GFR values measured with different techniques and protocols.

Caution should also be applied when using the CT-GFR technique, given that this approach reportedly results in underestimation of GFR. Although reasons for this underestimation are unclear, several factors are believed to be involved. By the Farheus effect, which is a physiologic phenomenon in microvessels, the Hct in smaller blood vessels is less than that in larger blood vessels. Therefore, the CT-GFR technique could lead to underestimation of plasma clearance rates calculated from the blood clearance and Hct values. The nephrotoxic effect of iodinated contrast medium could also result in a temporary reduction in renal blood flow and GFR. Use of high doses of iohexol has been associated with contrast medium–induced nephrotoxic effects in healthy rabbits. Although other factors that may contribute to contrast medium–induced renal injury in rabbits are poorly understood, the consequences of administration of iodinated contrast medium to patients with renal failure must be considered. Use of a low dose of iodinated contrast medium and provision of adequate hydration are therefore recommended. Another consideration is that the CT-GFR technique requires that subjects be anesthetized or sedated, which can impair cardiovascular function and GFR. An anesthetic protocol that minimizes cardiovascular effects should be therefore used.

Considering on one hand the potential for physiologic, iatrogenic, and technical variations in GFR values and, on the other hand, the paucity of reference values for rabbits, great care must be taken when interpreting results of CT-GFR. Cautious analysis of CT-GFR findings in rabbits should therefore involve consideration of the proportion of GFR contributed by each kidney and interpretation of the resulting time-attenuation curves (eg, width and height of vascular peaks and speed of contrast medium accumulation in the renal parenchyma). A time-attenuation curve, also called a renogram, represents the pattern of renal enhancement over time. The first phase is a vascular peak corresponding to the arrival of the contrast medium before it becomes diluted by the circulatory system. Evaluation of the size and width of the vascular peak yields information on the renal blood supply, and changes can be observed when vasoconstriction, stenosis, or interstitial edema exists. The second phase is related to migration of contrast medium...
from the bloodstream to the nephrons, and the slope of the ascending part of the renal peak is correlated with the GFR. Additional studies are necessary to establish reference values for rabbits for specific protocols.29

Determination of GFR by use of the protocol reported here depends on application of the Patlak plot approach, which would be inappropriate in some clinical situations. The Patlak approach is a 2-compartment model, and its use is contingent on several assumptions, such as homogeneous mixing of contrast medium in the bloodstream, unidirectional transfer of contrast medium across the glomerular membrane, and no loss from the second compartment (ie, the nephrons and collecting system). These assumptions are not valid in some situations, such as when a subject has pyelonephritis, possibly resulting in a third interstitial compartment. In the rabbits of the present report, imaging procedures ruled out the existence of a third compartment and the rabbits were believed to meet the prerequisites for evaluation of GFR by means of CT.

The CT-GFR technique was used to further evaluate renal function in the 2 rabbits of the present report, for which nephrectomy was being considered. In case 1, the neoplastic kidney made a poor contribution to the total GFR and was potentially responsible for polycythemia-related prerenal kidney failure. Therefore, the expected benefit resulting from the surgery was anticipated to exceed the nephron loss attributable to kidney removal. In the rabbit with ureterolithiasis, nephrectomy was preferred over ureteral stent placement because of the lack of information regarding stent placement in rabbits. However, CT-GFR revealed a nonnegligible contribution of the partially obstructed kidney as well as signs of subclinical renal failure in the contralateral kidney, precluding nephrectomy.

Single-slice dynamic CT-GFR was found to be a rapid, relatively noninvasive, and useful technique that provided clinically relevant information in the therapeutic management of the 2 rabbits with upper urinary tract disease. These preliminary findings suggested that CT-GFR would allow determination of unilateral and bilateral kidney function in rabbits. However, practitioners must consider the indications and limitations of this procedure, and additional studies are needed to establish reference values for rabbits.

Acknowledgments

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Footnotes

a. GE Light Speed 16, General Electric Healthcare Medical Systems, Mississauga, ON, Canada.
b. Isovue 300, ER Squibb & Sons, Princeton, NJ.
c. Advantage (AW) 4.0, General Electric, Milwaukee, Wis.

References

From this month’s AJVR

Pharmacokinetics and pharmacodynamics of buprenorphine and sustained-release buprenorphine after administration to adult alpacas
S. Bryce Dooley et al

OBJECTIVE
To determine pharmacokinetics and pharmacodynamics of buprenorphine after IV and SC administration and of sustained-release (SR) buprenorphine after SC administration to adult alpacas.

ANIMALS
6 alpacas.

PROCEDURES
Buprenorphine (0.02 mg/kg, IV and SC) and SR buprenorphine (0.12 mg/kg, SC) were administered to each alpaca, with a 14-day washout period between administrations. Twenty-one venous blood samples were collected over 96 hours and used to determine plasma concentrations of buprenorphine. Pharmacokinetic parameters were calculated by use of noncompartmental analysis. Pharmacodynamic parameters were assessed via sedation, heart and respiratory rates, and thermal and mechanical antinociception indices.

RESULTS
Mean ± SD maximum concentration after IV and SC administration of buprenorphine was 11.60 ± 4.50 ng/mL and 1.95 ± 0.80 ng/mL, respectively. Mean clearance was 3.00 ± 0.33 L/h/kg, and steady-state volume of distribution after IV administration was 3.8 ± 1.0 L/kg. Terminal elimination half-life was 1.0 ± 0.2 hours and 2.7 ± 2.8 hours after IV and SC administration, respectively. Mean residence time was 1.3 ± 0.3 hours and 3.6 ± 3.7 hours after IV and SC administration, respectively. Bioavailability was 64 ± 28%. Plasma concentrations after SC administration of SR buprenorphine were below the LLOQ in samples from 4 alpacas. There were no significant changes in pharmacodynamic parameters after buprenorphine administration. Alpacas exhibited mild behavioral changes after all treatments.

CONCLUSIONS AND CLINICAL RELEVANCE
Buprenorphine administration to healthy alpacas resulted in moderate bioavailability, rapid clearance, and a short half-life. Plasma concentrations were detectable in only 2 alpacas after SC administration of SR buprenorphine. (Am J Vet Res 2017;78:321–329)