

# Estimate of the annual economic impact of treatment of cranial cruciate ligament injury in dogs in the United States

Vicki L. Wilke, DVM, DACVS, Duane A. Robinson, DVM; Rich B. Evans, PhD;  
Max F. Rothschild, PhD; Michael G. Conzemius, DVM, PhD, DACVS

**Objective**—To estimate the economic impact to veterinary clients for the medical and surgical treatment of rupture of the cranial cruciate ligament (RCCL) in dogs for the year 2003.

**Design**—Economic impact survey.

**Sample Population**—501 diplomates of the American College of Veterinary Surgeons (ACVS) indicating that their area of surgical emphasis was small animal orthopedic surgery or small animal general and orthopedic surgery and 4,000 veterinarians indicating to the AVMA that their professional area was small animal practice exclusive or mixed animal practice (at least 80% small animal).

**Procedure**—Veterinarians were surveyed concerning the cost for medical and surgical treatment of RCCL for 2003. The economic impact was calculated by multiplying the number of RCCL surgeries performed by the mean cost of surgery. This was added to the number of RCCL cases managed medically multiplied by the mean cost of medical management. This estimate for survey responders was extrapolated to the total number of veterinarians in the study population for the ACVS or AVMA.

**Results**—Estimates for the total cost of surgery were \$171,730,134.72 and \$1,020,167,907 for veterinarians in the ACVS and AVMA populations, respectively. The cost of medical management was \$2,885,687.86 and \$126,558,155.16 for veterinarians in the ACVS and AVMA populations, respectively. After combining the ACVS and AVMA populations, we estimated that owners spent \$1.32 billion for the treatment of RCCL in the United States in 2003.

**Conclusions and Clinical Relevance**—RCCL is a prevalent, costly injury. Results may motivate veterinary and consumer agencies to prioritize funding for a better understanding of the injury. (*J Am Vet Med Assoc* 2005; 227:1604–1607)

inflammation, and lameness. Although treatment options include surgical and nonsurgical management, surgery is generally recommended for dogs > 15 kg (33 lb) because it provides for an improved prognosis.<sup>2</sup> This contributes to the increased cost for RCCL management because the breeds of dogs that are most predisposed to RCCL are comparatively large in size.<sup>3,4</sup> Veterinarians have dozens of surgical techniques to choose from to treat RCCL, and the cost to the owner depends on several factors. Expertise of the surgeon, surgical technique performed, and region of the country would also be expected to factor heavily into cost comparisons. Unfortunately, even with surgical management, osteoarthritis develops in most patients.<sup>5-7</sup> Although the severity of osteoarthritis of the stifle joint does not correlate with the severity of lameness,<sup>8</sup> many patients do require treatment for osteoarthritis and this treatment may be required for the duration of the patient's life. **Nonsteroidal anti-inflammatory drugs (NSAIDs)** in combination with weight management, physical therapy, and disease-modifying drugs are all nonsurgical treatments commonly used for osteoarthritis in dogs.

Although RCCL is an exceedingly prevalent disease, particularly in some breeds of dogs,<sup>9</sup> only a limited amount of research funding is available for investigators to explore the cause of RCCL and establish the best treatment options for patients. This limitation in funding may be attributable, in part, to the fact that the economic impact of RCCL is not considered substantial and funding agencies prioritize research in this field comparatively low or that the economic impact of RCCL is high and agencies are not aware of the economic impact. Therefore, we hypothesized that RCCL treatment is costly. The purpose of the study reported here was to estimate the economic impact to veterinary clients for the medical and surgical treatment of RCCL in dogs for the year 2003.

## Materials and Methods

**Survey**—Two groups of veterinarians were surveyed. First, all diplomates of the American College of Veterinary Surgeons (ACVS) indicating that their area of surgical emphasis was small animal orthopedic surgery or small animal general and orthopedic surgery (n = 501) were surveyed. This mailing list was purchased from the ACVS after they had approved both the cover letter and survey. The cover letter and survey were mailed directly by the authors. Second, 4,000 veterinarians that had indicated to the AVMA that their professional area was small animal practice exclusive or mixed practice (at least 80% small animal) were randomly chosen. This mailing list was purchased from the AVMA, through the list manager<sup>b</sup> for the AVMA, after the AVMA

**R**upture of the cranial cruciate ligament (RCCL) is the most common cause of lameness in dogs.<sup>1</sup> Rupture of the CCL causes stifle joint instability, joint

From the Department of Animal Sciences and Center for Integrated Animal Genomics (Wilke, Rothschild), and the Department of Veterinary Clinical Sciences, College of Veterinary Medicine (Wilke, Robinson, Evans, Conzemius), Iowa State University, Ames, IA 50011-1250.

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Address correspondence to Dr. Wilke.

approved both the cover letter and survey. The list manager mailed the letter and survey.

**Survey design**—Similar surveys were designed for each group with a goal to ascertain the combined cost of surgical and medical treatment for RCCL for each veterinarian surveyed. Survey questions were specific for the year 2003 and cases of RCCL treated at the veterinarian's hospital by that veterinarian. Estimates of costs for cases referred for treatment at a different hospital were specifically addressed in the survey and not included in the overall economic estimate. Questions included the average number of RCCL cases evaluated each month, the number of cases managed surgically and medically, cost range for surgical and medical management, and mean cost of surgical and medical management. We did not ask what type of surgical or medical treatment was offered. To determine normality of responses between responders and nonresponders, 25 nonresponders from the ACVS study population were randomly chosen and their survey response was obtained via telephone.

**Calculation of economic impact**—A 1-way ANOVA was performed to compare responses that were mailed with responses obtained via telephone. If no significant difference was detected between these response groups, data were then pooled. An economic calculation was performed for each group of veterinarians, and their data were added to estimate the overall economic impact of RCCL. To calculate the economic impact from responders, the number of RCCL surgeries performed was multiplied by mean cost of surgery. This was added to the number of RCCL cases managed medically, multiplied by the mean cost of medical management. This estimate for responders was then extrapolated to the total number of veterinarians reported in the study population by the ACVS ( $n = 501$ ) or AVMA (4,000). The equation used for the ACVS group was as follows:

$$\begin{aligned} & ([\text{No. of RCCL surgical cases}] \times [\text{mean cost}]) + \\ & ([\text{No. of RCCL medical cases}] \times [\text{mean cost}]) = \text{ACVS}^{\text{T1}} \\ & \frac{\text{ACVS}^{\text{T1}}}{\text{No. of responders}} \times \text{ACVS study population} = \text{ACVS}^{\text{T2}} \end{aligned}$$

where  $\text{ACVS}^{\text{T1}}$  was the total cost of management reported from responders and  $\text{ACVS}^{\text{T2}}$  was the total cost of management estimated from all potential responders.

In addition to economic data, the reported year of graduation from veterinary school, gender, and state in which a veterinarian practiced were collected from each veterinarian in the AVMA population. These data were examined for associations with the mean cost for surgery and evaluated by use of a Pearson product moment correlation. When appropriate, data are expressed as mean  $\pm$  SEM with  $P < 0.05$  considered significant.

## Results

Of 501 surveys mailed to the ACVS study population, 231 responded. In addition, 25 (9.3%) nonresponders from the ACVS study population were contacted via telephone for data collection. No significant difference was detected between these 2 groups for any survey response, and these data were pooled. In effect, data were collected from 256 of 501 (51.1%) members of the ACVS study population. Included in this group were 9 (3.5%) responders that did not treat RCCL cases. Of the 38,959 veterinarians listed by the AVMA as practicing small animal practice exclusively or mixed practice (at least 80% small animal), 4,000 sur-

veys were mailed and 1,083 (27.1%) responses were returned. Included in this group were 111 (10.3%) responders that did not treat RCCL cases.

In the ACVS response group, the mean number of RCCL cases managed surgically per year was 186.24 (range, 0 to 720; median, 156) and the mean number of cases managed medically per year was 23.88 (range, 0 to 120; median, 12.0). In the AVMA response group, the mean number of RCCL cases managed surgically per year was 29.16 (range, 0 to 480; median, 24.0) and the mean number of cases managed medically per year was 12.24 (range, 0 to 180; median, 12.0).

The mean cost for a single surgery reported by veterinarians in the ACVS response group was \$1,840.50 (range, \$0 to \$5,000; median, \$1,900.00), and the mean cost for medical management was \$241.20 (range, \$0 to \$1,000; median, \$225.00). The mean cost for surgery reported by veterinarians in the AVMA response group was \$898.00 (range, \$0 to \$5,000; median, \$875.00), and the mean cost for medical management was \$265.40 (range, \$0 to \$1,000; median, \$225.00).

The estimate for the total cost of surgery (by use of the mean) reported by the ACVS response group was \$87,750,328.32. When multiplied by the total number of veterinarians that fit the ACVS inclusion requirements (indicated that their area of surgical emphasis was small animal orthopedic surgery or small animal general and orthopedic surgery;  $n = 501$ ), the estimate was \$171,730,134.72. The cost of medical management reported by the ACVS response group was \$1,474,523.14. When multiplied by the total number of veterinarians that fit the ACVS inclusion population, the estimate was \$2,885,687.86. Similarly, the estimate for the cost of surgery (by use of the mean) reported by the AVMA response group was \$28,359,091.44. When multiplied by the total number of veterinarians that fit the AVMA inclusion population (indicated to the AVMA that their professional area was small animal practice exclusive or mixed animal practice with at least 80% small animal;  $n = 4,000$ ), the estimate was \$1,020,167,907. The cost of medical management reported by the AVMA response group was \$3,518,121.17. When multiplied by the total number of veterinarians that fit the AVMA inclusion population, the estimate was \$126,558,155.16. After combining the ACVS and AVMA populations, we estimated that owners spent \$1.32 billion for the treatment of RCCL in the United States in the year 2003. Similarly, calculation of the economic estimate by use of the median reported for surgical and medical management would have resulted in a total  $>$  \$1.28 billion.

Within the AVMA response group, responders included 739 males and 344 females. The year of graduation from veterinary school ranged from 1945 to 2002, and no significant correlation was detected when year of graduation was compared with cost for surgical management, and no significant difference in cost for surgical management was detected among graduation dates between genders. However, when we compared the mean cost of surgery from veterinarians that reported that they performed RCCL surgery (ie, a zero dollar amount was not used for veterinarians that reported that they did not perform RCCL surgery), males reported a

mean  $\pm$  SE charge of \$1,023.43  $\pm$  18.54 and females reported a mean  $\pm$  SE charge of \$1,095.04  $\pm$  33.86. This difference was significant ( $P < 0.05$ ). At least 1 response was received from every state, and large differences in cost to the owner for RCCL surgery were detected. For example, there was a significant ( $P < 0.001$ ) difference in the mean cost for surgery between veterinarians practicing in Iowa (\$769.20) and those practicing in California (\$1,524.60).

## Discussion

Estimates provided by the ACVS population were expected because of the economic influence RCCL has at Iowa State University's Veterinary Teaching Hospital. The mean number of RCCL surgeries performed by the AVMA population (2.43 surgeries/mo) was unforeseen because we had no experience to draw from. The economic impact of RCCL reported may be unexpected by some; however, it parallels the financial burden of the rupture of the anterior cruciate ligament (RACL) in humans.<sup>9</sup> In the United States, it has been estimated that each year approximately 250,000 people, or 1 in 3,000, experience RACL.<sup>10</sup> Rupture of the ACL most commonly occurs in people  $< 40$  years old, and development of osteoarthritis is common. The economic burden to the health care industry for surgical care alone ranges from a mean of \$3,679 to a mean of \$17,000 with a total cost for surgery approaching \$2 billion.<sup>9,11,12</sup> This economic burden would be further increased if the cost of rehabilitation and medical management was added. Unfortunately, we were not able to find comparative reports that included estimated costs of veterinary treatment for other injuries or diseases in small animals.

This survey was designed with guidance from the Center for Survey Statistics and Methodology at Iowa State University. Like many surveys, questions were designed to maximize response rate (eg, concise, non-intrusive questions) and maximize estimate accuracy (eg, question clarity and duplication). In our study, the response rate was higher than expected. A response rate of 20% is typical for surveys similar to those used in the study reported here. By completion of our study,  $> 46\%$  of the ACVS and  $> 27\%$  of the AVMA study populations had responded via mail. This encouraging response rate may have been in reaction to the importance of the problem as perceived by the veterinary groups studied. Regardless, the high response rate increases the accuracy of our estimate. Even if the reported mean cost is overestimated by 25%, the economic impact of RCCL would approach \$1 billion. We would argue, however, that it is more likely that our estimate is below the actual financial burden. We surveyed only veterinarians that were active members of the AVMA and were classified by the AVMA as practicing exclusively small animal veterinary medicine or mixed animal practice (at least 80% small animal). We chose to study this group because the AVMA would be able to supply information necessary to perform the study and we believed that this group would have the greatest professional investment in the problem and thus would be more likely to participate. Many veterinarians who potentially treat dogs with RCCL did not participate because they either had a dif-

ferent classification from the AVMA and thus did not meet the study inclusion criteria or were not active members of the AVMA.

We recognize that there was a large range in the reported values for medical versus surgical management. One obvious difference in cost that we identified was explained by geographic location. The difference reported by veterinarians in the states of Iowa and California was expected because the authors are aware that similar differences exist between the mean costs of RCCL surgery performed by diplomates of the ACVS at our veterinary teaching hospital, compared with ACVS diplomates practicing in many metropolitan cities. Geographic location (and potential competition of veterinary services) would also affect the cost of nonsurgical management. However, the extent of nonsurgical management likely varies among veterinarians. Some veterinarians offer only traditional anti-inflammatory medications, and patients of others routinely participate in rehabilitation programs immediately after surgery or for treatment of osteoarthritis. The 7% difference in mean cost between genders of practicing veterinarians would contribute to the variation in the range of costs. In contrast, the year of graduation from veterinary school did not influence mean cost of surgery, which was not expected. We had expected that recent graduates would charge less because they had less experience. However, it could be argued that with the high frequency of RCCL, even recent graduates gain rapid experience performing this type of surgery. Another possible contribution to variation would be the responder's interpretation of the questions. For example, in the questionnaire, we specifically asked for the total cost of surgery (such as anesthesia, equipment, hospitalization, and supplies) to the client. Some responders may have only reported the surgical cost as opposed to the total cost. Other factors that would have contributed to variation in cost of surgical or nonsurgical management of RCCL would be the typical weight of the dog treated and type of treatment offered.

The objective of this survey was to provide an approximate calculation of the cost of RCCL to dog owners in the United States during 2003, thereby estimating the economic impact of this injury on the US economy. Rupture of the CCL is a prevalent, costly injury, and results of the study reported here may motivate veterinary and consumer agencies to prioritize funding for a better understanding of the injury.

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