Exploring the Bond

Use of a number-needed-to-ban calculation to illustrate limitations of breed-specific legislation in decreasing the risk of dog bite–related injury

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According to recent estimates, approximately 72 million dogs live in the United States, with 37% of all US households, or approximately 43 million homes, owning at least 1 dog.[1] Exposure to dogs, therefore, is almost ubiquitous in today's society. Not surprisingly, dog bites are relatively common in the United States, with 157 of 9,672 adults participating in a national, random-digit-dial survey reporting having been bitten by a dog.[2] Dog bite–related fatalities, however, appear to be extremely rare, occurring at a rate of approximately 27/y from 1999 through 2006 in a human population of just below 300 million,[a] or approximately 3 fatal bites/10 million dogs/y. Although there is widespread agreement that every effort should be made to reduce the incidence of dog bite–related injuries, how to best accomplish this is a subject of considerable debate.

One commonly suggested method for reducing the incidence of dog bite–related injuries is BSL, which bans, restricts, or imposes conditions on ownership of specific breeds of dogs presumed to pose greater risk of biting people.[3] The AVMA, American Kennel Club, and major animal protection and animal control groups in the United States have all strongly discouraged the use of BSL as a means of reducing the incidence of dog bite–related injuries,[4–7] contending that it is an ineffective method of dealing with this problem. Nevertheless, BSL continues to be a popular response to perceived concerns about dangerous dogs, particularly following a serious dog bite–related injury or fatality in a community.

In the present manuscript, we discuss factors influencing public perception of the risks associated with dog bites, particularly with respect to particular dog breeds, and examine how these factors result in promotion of BSL. In addition, we describe a novel method of demonstrating the implausibility of improving public safety via BSL through calculation of a risk-based statistic, the NNB, which is similar to the NNT statistic used in evidence-based medicine.[8,9]

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Abbreviations

BSL	Breed-specific legislation
NNB	Number needed to ban
NNT	Number needed to treat

The Appeal of BSL

Enthusiasm for BSL persists despite the lack of empirical evidence that legislation of this type reduces the risk of injury from dog bites or reduces associated costs to communities or insurers. Why is this so? We believe that BSL is appealing for 3 reasons: misperception of risk, misinformation and stereotyping, and erroneous beliefs about efficacy.

Misperception of risk—Risk is defined statistically as the probability that an event, either beneficial or harmful, will occur.[10] In essence, risk is a numeric estimate of how likely it is that individuals in a population will experience a particular event within a given time frame. For dog bites, risk is typically described as the number of dog bites per person in the population of interest per year. Desire to prevent serious bites is what appears to drive BSL. However, quantifying the risk of a serious injury arising from a dog bite is challenging. For example, estimates vary with respect to the number of dog bites during any given year that require medical attention. One study[11] estimated that there were 365,846 visits to emergency departments because of dog bites during 2000, or approximately 130 emergency department visits/100,000 people/y. This estimate was derived from data reported to the National Electronic Injury Surveillance System All Injury Program by only 66 emergency departments across the United States and was somewhat at odds with results of the Second Injury Control and Risk Survey,[2] which estimated, on the basis of results of a random-digit-dial telephone survey, that approximately 885,000 dog bites require medical attention each year (ie, 320 bites requiring medical attention/100,000 people/y). One possible explanation for the difference between these 2 estimates of the risk of dog bites could be that many dog bites are cared for by primary care physicians, rather than in emergency departments.

Accurate assessment of the risk of dog bites is further complicated by the lack of information on severity of injury, even for dog bites treated in an emergency de-

partment. People who have sustained a dog bite–related injury may seek emergency care for a variety of reasons, ranging from a desire to have immediate examination even for a minor scratch or scrape to consultation about the need for postexposure rabies or tetanus prophylaxis to treatment for extensive trauma. Weiss et al[12] have reported that most (ie, 99%) emergency department visits involving dog bites were assigned an injury severity score of 1, which is the lowest possible score. However, the injury severity score system was designed for assessing threats to life following blunt trauma and may not be well suited to assessing injury from other sources, such as dog bites.[13] Furthermore, dog bite injuries may be considered serious for reasons other than the extent of tissue trauma, such as the likelihood of secondary infection.

The Health Care Utilization Project National Inpatient Sample database[b] covers approximately 90% of the US population and currently is the most reliable source of information about reasons for hospitalization. Data for 2006 indicate that, nationwide, there were approximately 8,387 hospitalizations (approx 3/100,000 people/y) because of dog bites. However, the number of reconstructive procedures following dog bites (31,089 in 2007 and 28,232 in 2008) and the reconstructive procedure rate (approx 9 to 10/100,000 people/y) were higher,[14] suggesting that roughly two-thirds of these procedures are done without the need for hospitalization.

Given these inconsistencies and uncertainties, not only is the overall rate of dog bites difficult to define, but the severity of dog bites that do occur is impossible to quantify. This makes it difficult for the public to appreciate the true risk associated with dog bites and may lead to perceptions that serious dog bites are common, that all dog bites are equally serious, or that all emergency department visits following a dog bite represent serious injuries. The wide range of estimates from different sources of data describing different categories of injuries also makes it difficult for the public to put the risk of dog bites in context with risks of other types of injuries (**Figure 1**).

Stereotyping and misinformation—Three published studies[15–17] are inappropriately used to implicate specific breeds, particularly pit bull–type dogs, as being more likely than other breeds to be involved in human fatalities resulting from dog bites. Misinterpretations of these data persist, despite disclaimers cautioning that these reports cannot be used to infer any breed-specific risk.[18,19,c] Media portrayals of certain dog breeds as being particularly aggressive, along with persistent popular myths that physical and behavioral characteristics can distinguish certain breeds from other dogs of a similar size (eg, greater bite force or more unpredictable behavior), have also contributed to the erroneous belief that certain breeds of dogs have a propensity to bite people. Such stereotypes reinforce the belief that BSL will de-

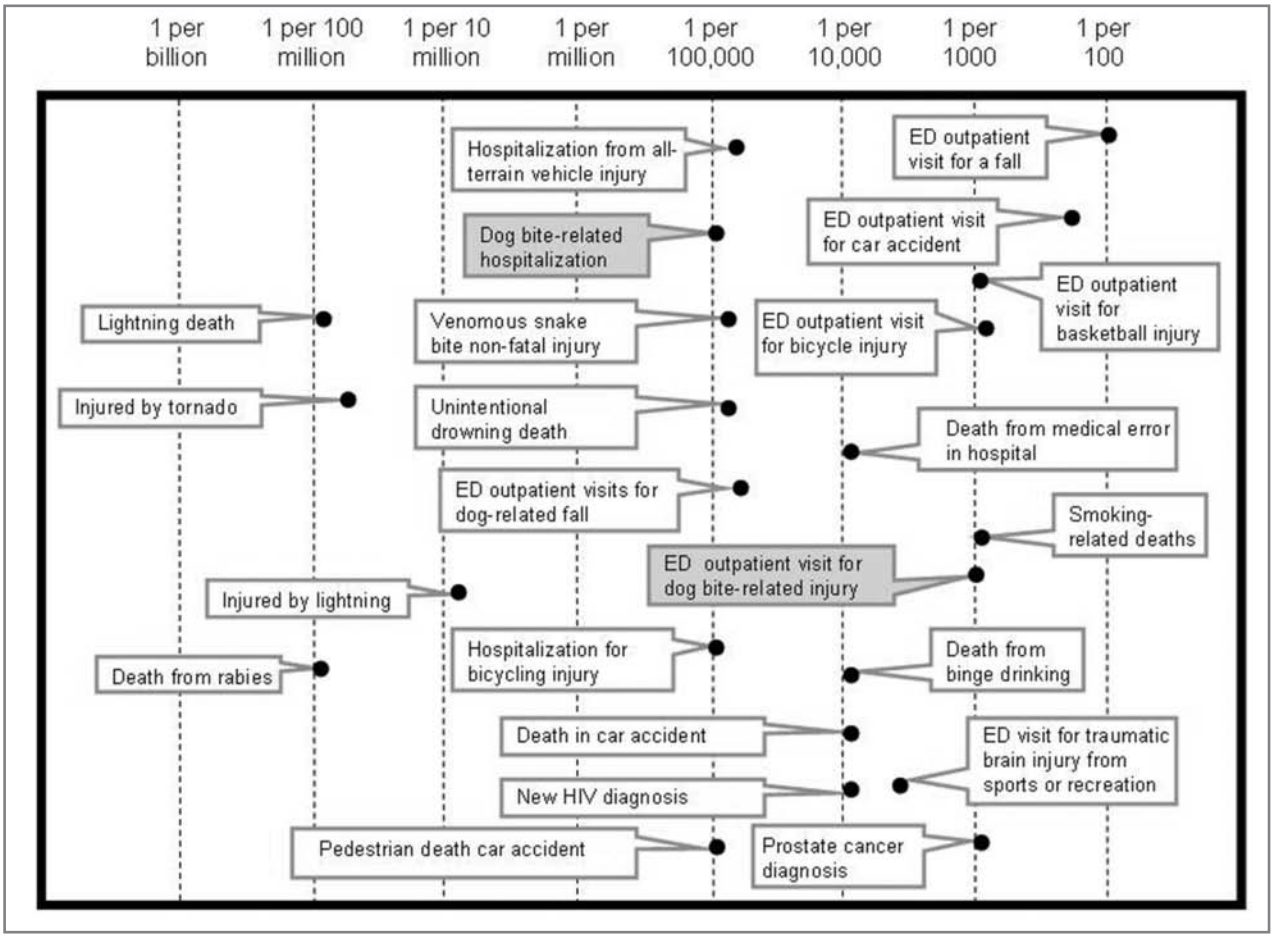

Figure 1—Reported risks of various types of injuries for people living in the United States. ED = Emergency department.

crease the incidence of dog bite–related injury. Tellingly, a study[20] from Germany in which a standardized temperament test was used to compare the behavior of 415 dogs representing banned breeds with the behavior of 70 Golden Retrievers did not find any significant differences between the 2 groups. However, even if behavior could be reliably predicted from breed, heredity is only 1 of 5 factors, in addition to early experience, early socialization and training, behavioral and medical health, and victim behavior, that may influence a dog's propensity to bite in a given situation.[21] A study[22] has shown that even people who work with dogs on a daily basis in an expert capacity cannot reliably identify breed mixtures, and some dogs whose appearance suggests a particular breed may in fact have little to no genetic evidence of that breed.

Erroneous beliefs about efficacy of BSL—To our knowledge, there currently is no published evidence supporting claims that BSL is efficacious, whereas evidence does exist suggesting that BSL is not effective or does not improve public safety. For example, an analysis of medically attended dog bites before (1995 through 1999) and after (2000 through 2004) addition of a list of dangerous breeds to existing dangerous-dog legislation in Aragon, Spain, did not indicate any changes in frequency of bites.[23] Similarly, The Netherlands repealed a national ban on pit bull–type dogs after 15 years because the ban did not lead to a decrease in dog bites,[24] and Italy has repealed BSL, replacing it with a law making owners more responsible for their dogs' training and behavior.[25,26]

Using NNB to Reframe the Perception of Risk

Given the misperception of risk and stereotyping of dog breeds, the question becomes how to best dispel the notion that BSL could be efficacious. An important statistic in evidence-based assessments of the efficacy of various preventive measures in medicine is the NNT. Mathematically, the NNT is the inverse of the difference between the absolute risk before treatment and the absolute risk after treatment.[9] In essence, the NNT represents the average number of patients who would need to be treated to prevent 1 patient from developing the outcome of interest (eg, illness, injury, or death). In human medicine, values for the NNT are typically in the range of tens or at most hundreds of patients for medical or surgical interventions.[9]

The NNT statistic is advocated in evidence-based medical practice as a concise, clinically useful presentation of the effect of an intervention[27] and is used to communicate the potential costs and benefits of treatments to patients or to justify costs of a pharmaceutical or medical or surgical intervention to insurers. As indicated,[8] the NNT is suitable for assessing active interventions and treatments as well as risk-reduction and prevention efforts. This approach allows both economic and human costs to be weighed when considering an intervention. If BSL were viewed as an intervention (ie, removal of a dog from the population) to prevent an adverse event (ie, dog bite), then an NNT could be calculated for BSL. This value would be calculated as the inverse of the risk of a dog bite before BSL was implemented minus the risk of a dog bite after BSL was implemented and, in essence, would represent the number of dogs that would have to be removed from the population (ie, the number of dogs that would have to be banned) to prevent a single dog bite. Because the treatment in this instance involves banning dogs, we believe this should be referred to as the NNB, rather than the NNT.

Key Data and Assumptions for Calculating NNB

Because of the uncertainties regarding the risks of dog bites, certain assumptions have to be made to calculate the NNB associated with BSL. To obtain the most conservative estimates of NNB, we assume that BSL would be 100% effective in removing dogs of the target breed from the region or in isolating such dogs from the human population. We also assume that dogs obtained as replacements for banned dogs would have a propensity to bite equal to that for dogs in the general canine population and not equal to the higher propensity to bite attributed to the target breed. It is unlikely that in the real world any legislative effort would be 100% effective or that no owners would choose to replace dogs of the banned breed with other dogs with an equal or greater propensity for aggression. Thus, including these 2 assumptions in calculations of the NNB would provide a conservative estimate of the minimum number of dogs that would need to be banned to prevent a single dog bite.

Two important values are needed to calculate the NNB: the risk that a person will be bitten by a dog and the proportion of dog bites attributable to the target breed. Examples of data for the former include reported bites, emergency department visits, hospitalizations for dog bites, or insurance claims for dog bites. The proportion of dog bites attributable to the target breed is needed to estimate the reduction in number of dog bites after removal of dogs representing the banned breed following implementation of BSL. Some rough estimates can be made for the maximum frequency of a single breed on the basis of data that follow. In a study[28] from Colorado for which breed information was provided for > 2,000 dog bites reported during 2007 and 2008, the largest proportion of bites was attributed to dogs for which the primary breed was listed as Labrador Retriever (13.3%), followed by bites attributed to dogs identified as pit bull–type dogs (8.4%). In a study[29] of 5,497 dog bites in Prince Georges County, Md, the largest proportions of dogs for which breed was identified were German Shepherd Dogs (12%) and pit bull–type dogs (12%); Labrador Retrievers represented about 6% of all dogs. In a report[30] from Multonomah County, Ore, involving reported bites by licensed dogs, the largest proportion of bites was from dogs in the terrier group (23.8% of all bites). However, the American Kennel Club defines this group as containing 27 breeds, suggesting that any single breed would likely have been only a fraction of this proportion. The next largest proportion of bites (23.1%) was from dogs in the sporting group, which also contains 27 breeds. In a review[31] of pediatric dog bites handled at a single inner-city tertiary-care hospital, it was reported that pit bull–type dogs accounted for approximately 56% of bites for which a breed was reported; however, over half of the records contained no information about breed, and it was not reported how breed was determined for those breeds for which a notation was made. In addition, it

seems likely that patients were not representative of the city as a whole.

Using these data about bite prevalence and breed to calculate NNB for dog bites in general, we conservatively assumed that a maximum of 15% of all dog bites would be attributable to any particular individual breed. However, for purposes of calculating NNB for more serious injuries (ie, dog bites requiring corrective surgery or hospitalization) and for insurance claims, we assumed that up to 35% of all dog bites could be attributable to a particular breed. For all calculations, we also assumed that a dog that bites injures only a single person and that dogs removed from a community would not be replaced.

On the basis of these assumptions, an NNB can be calculated for any particular outcome of interest. For example, a previous study[11] of emergency department visits due to dog bites estimated that there were 365,846 visits to emergency departments because of dog bites during the year 2000 out of a population of 281,421,906 people, or approximately 130 emergency department visits/100,000 people/y. If the targeted breed was assumed to represent 15% of all dog bites, then removing these dogs through BSL would decrease the number of bites by 15% after the ban was in effect. Thus, the estimated risk of emergency department visits due to dog bites after the ban was in effect would be 85% of the risk prior to the ban being enacted, or approximately 110.5 emergency department visits/100,000 people/y (ie, 130 × 0.85), and the estimated reduction in risk attributable to the ban would be 19.5 emergency department visits/100,000 people/y (ie, 130 – 110.5). The NNB is the inverse of this number (100,000/19.5). Thus, the number of dogs of the target breed that would have to be banned to prevent a single emergency department visit each year would be 5,128 dogs.

Similar calculations can be done for other published dog bite rates. For example, a study[32] from Kansas City reported a rate of 157 emergency department visits because of dog bites/100,000 people/y. With the same calculations and same assumptions, 4,255 dogs would need to be banned to prevent a single emergency department visit each year. Similarly, for a study[28] of dog bites in Colorado that reported a rate of 80 dog bites/100,000 people/y, the NNB to prevent a single dog bite each year would be 8,333 dogs.

For more serious injuries, when 35% of injuries were assumed to be attributable to the target breed, NNB calculations yield even higher values. For example, a report[14] of the numbers of reconstructive procedures following dog bites reported a rate of 9.3 reconstructive procedures/100,000 people/y. If the targeted breed was assumed to represent 35% of all bites requiring reconstructive procedures, then removing these dogs through BSL would decrease the number of such procedures by 35%, and the estimated risk following implementation would be 6.1 reconstructive procedures/100,000 people/y, or an estimated reduction in risk of 3.2 reconstructive procedures/100,000 people/y and NNB of 30,663 dogs to prevent a single reconstructive procedure each year. With the same assumptions, the NNB would be 102,040 dogs (given a rate of 2.8 hospitalizations/100,000 people/y[b]) or 109,495 dogs (given a rate of 2.6 hospitalizations/100,000 people/y[33]) to prevent a single hospitalization secondary to a dog bite each year and 59,523 dogs to prevent a single insurance claim for a dog bite–related injury each year (given a rate of 4.8 claims/100,000 people/y[34]).

For all of the scenarios described above, it is important to recognize the NNB increases as the proportion of bites attributable to the target breed decreases (**Figure 2**). In addition, the NNB represents the number of dogs that would have to be banned to prevent a single bite each year. To prevent 2 bites, this figure would be doubled; to prevent 3 bites, this figure would be tripled. Finally, BSL that does not involve complete bans (eg, muzzle laws) would require considerably higher NNB because many dog bites occur in a home setting by a familiar dog, when a muzzle would not be required.[35]

Implications For BSL

The large values for NNB calculated as described point out the implausibility that BSL will substantially decrease the number of dog bite–related injuries in a community. In addition, the large number of dogs of a target breed that would have to be removed from the community to prevent even a single incident illustrates the high costs of BSL in terms of dog lives and effects on responsible owners whose pets would be banned.

What does this mean for policy makers struggling with real-world problems associated with dangerous dogs and reckless owners? Ropeik[36] has discussed how risk perception is often nonlinear and how there can be a large gap—a so-called perception gap—between public fears and the facts. Factors that would tend to widen this perception gap with respect to dog bites include a lack of control over a perceived threat (eg, having dangerous dogs living in one's neighborhood), a lack of information about the true nature of the threat (eg, a false perception that certain breeds are more dangerous or have a greater propensity to bite), and a lack of trust. In addition, highly publicized events create an availability bias, making people more fearful than they ought to be about a given risk.[37]

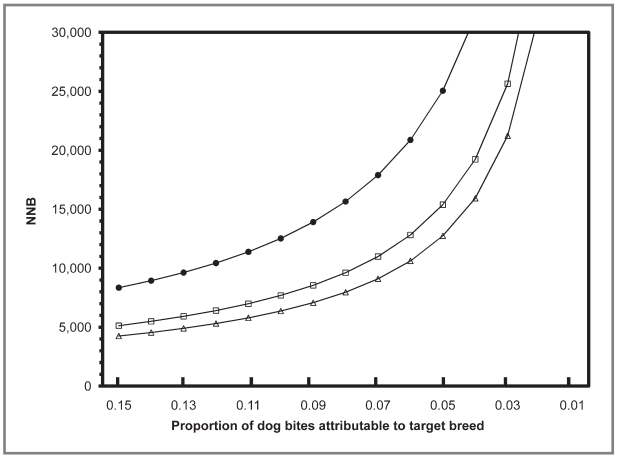

Figure 2—Number of dogs needed to be banned to prevent a single dog bite–related injury each year (ie, NNB) as a function of the proportion of dog bite–related injuries attributed to the target breed in BSL. Values were calculated on the basis of reported risk of dog bites in Colorado (estimated risk, 80 dog bites/100,000 people/y[28]; black circles), the risk of emergency department visits because of dog bites in the United States (estimated risk, 130 emergency department visits because of dog bites/100,000 people/y[11]; white squares), and risk of emergency department visits because of dog bites in Kansas City (estimated risk, 157 emergency department visits because of dog bites/100,000 people/y[32]; white triangles).

It is our belief that BSL is based largely on fear, and it has been emphasized that appeals to fear have their greatest influence only when coupled with messages about the high efficacy of proposed fear-based solutions.[38] Easily understood communication tools, such as NNB, can help put the lack of efficacy of BSL into perspective and narrow the perception gap. Veterinarians, animal behaviorists, and other scientists also need to be well-informed about the data available on this subject and must step forward to counteract media hyperbole and misinterpretations. A better understanding of the improbability of making communities safer through BSL can add to the arguments against discriminatory responses that are based on assumptions regarding dogs of a particular breed or with a particular physical appearance. This is essential if we are to turn the tide of public perception and encourage more rational, breed-neutral approaches to decrease human injury from dog bites.

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