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Guest Editorial

Longevity in pet dogs: Understanding what's missing

Being a scientist is a bit like being a detective – always looking for clues. Logically then, investigators who seek to understand the factors that have an impact on canine longevity ask: 'Where can the most reliable clues be found?' Fresh approaches generate new evidence and, as the pieces of the puzzle come together, new sets of questions arise. Our ability to make sure progress – to shake loose from the tyranny of old ideas – will depend upon our ability to uncover the most reliable clues. Our challenge is always to separate the genuine from the spurious.

In the most recent issue of *The Veterinary Journal*, Dr. Dan O'Neill and colleagues of the Royal Veterinary College, London, UK, and the University of Sydney, Australia, present the results of a canine longevity study conducted in England (O'Neill et al., 2013). The authors begin their paper: '*Improved understanding of longevity represents a significant welfare opportunity for the domestic dog.*' They are undoubtedly correct in making this assertion. And, as their work draws attention to the need to better understand aging, it also points out the need to carve out a research habitat that will nurture progress – an informed interplay of complementary approaches so that new discoveries can enhance the precision of our predictions. To better understand what we are learning about canine longevity, we should examine longevity research in dogs more closely. It is detective work of this sort that just might surrender the most important clue of all – *an understanding of what is missing*.

Where shall we look for what is missing? It would seem logical that indicators of the well-being of any investigative enterprise might fall within three domains of critical self-assessment. First, we might reflect upon who we are as investigators. Exploring the biology and epidemiology of longevity and successful aging will be challenging, demanding interdisciplinary expertise and the commitment of teams. Furthermore, the training and experience of investigators in any field of inquiry establishes constraints – the preconceived notions and boundaries that will steer the direction and emphasis of the research. Veterinarians educated in North America do not receive training in the biology of aging as part of their Doctor of Veterinary Medicine (DVM) curriculum. As a consequence, it is justifiable to question whether their educational experience renders DVMs well-prepared to critically evaluate or effectively debate new research on the biology of successful aging and healthy longevity. At the very least, this educational shortfall – what is missing – translates into a missed opportunity to inspire a critical mass of veterinary professionals to dedicate themselves to investigating canine longevity.

As a second step toward evaluating what is missing from canine longevity research, we might consider the individuals that we are investigating. Just what are the origins of the canine populations we are counting on to offer up clues about successful aging? If we are to make reliable inferences about which factors are associated with longevity, it would seem prudent to choose study populations in which the processes of natural aging and aging-related diseases can be evaluated. This can be seen as one of the strengths of the work by O'Neill et al. (2013), which reports data from primary care veterinary practices. In contrast, data from dogs that die in veterinary teaching hospitals are not likely to satisfy this criterion. This is because a source such as the Veterinary Medical Data Base (VMDB) tells a story of animals referred to veterinary teaching hospitals with difficult diagnoses, concurrent morbidities and complicated treatments – a strongly biased population in which life expectancies have been cut short by particular diseases. This can manufacture misleading extrapolations about aging and overall longevity. A quick comparison of breed-specific median age at death in the study by O'Neill et al. (2013) to VMDB data indicates a 1.7–2.3-fold longer life expectancy in pet dogs seen in primary care practices (Table 1). This calls into doubt the suitability of using VMDB data to make inferences about aging, emphasizing the need for careful scrutiny of studies reporting populations with truncated life histories.

With few exceptions, canine longevity studies have tended to report findings based on an assemblage of data from multiple breeds, rather than to communicate observations focused on a particular breed. The attractiveness of using an approach not limited to a particular breed is that it enables investigators to attempt an impartial comparison of many different breeds and to maximize sample size. O'Neill et al. (2013) adhere to this approach. They begin their discussion: '*The current study reports an overall median longevity for dogs of 12.0 years*.' One might wonder what is to be done with this result for 'the average dog'. Investigators should consider the tangible advantages of conducting breed-specific inquiries. By studying a single breed, the influence of factors such as obesity and lifetime duration of gonad exposure on longevity, including the incidence and age at onset of particular age-related diseases, might come into clearer view and allow sounder interpretations to be drawn. Such associations could be disguised or distorted in studies that homogenize results from multiple breeds. As the goal of pet owners and veterinarians becomes focused more on personalizing healthy wellness strategies for individuals, rather than for the average dog, we will need to de-emphasize our preoccupation with the mean. Instead, we will look to combine medical histories and life-style characteristics with biological readouts to predict those individuals that will benefit from particular life choices or interventions.

The third and final facet of canine longevity research that deserves consideration is the set of approaches that we use in our investigations. I contend that the two concepts most underutilized in canine longevity research are *life course perspective* and *whole organism thinking*. Life course perspective is the concept that

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Table 1
Comparison of longevity in dogs seen at primary care practices vs. dogs seen at veterinary teaching hospitals.

Breed[a]	Median age at death in years (number of dogs)	
	Dogs seen at primary veterinary practices[b]	Dogs seen at veterinary teaching hospitals (VMDB)[c]
Cocker spaniel	11.5 (145)	5.6 (775)
German shepherd	11.0 (312)	6.8 (1793)
Golden retriever	12.5 (114)	6.6 (1088)
Labrador retriever	12.5 (418)	6.2 (1113)
Rottweiler	8.0 (105)	3.5 (185)
West Highland white terrier	13.5 (128)	8.2 (189)

[a] Represents the six breeds with 100 or more animals in both studies.
[b] O'Neill et al. (2013).
[c] Patronek et al. (1997); VMDB, Veterinary Medical Data Base.

early life events can significantly influence adult health outcomes, including longevity (Waters and Kariuki, 2013). By embracing life course perspective, we are more inclined to view organisms as *processes*, rather than things (Waters, 2012). We commit ourselves to understanding how early events – exposures and influences that are often missing at the time we examine the senior pet – can have an impact on longevity by triggering successful aging trajectories. Accordingly, the number of years of ovary exposure that a bitch experiences over her lifetime becomes an essential piece of the longevity puzzle, since removal of ovaries early in life disturbs endocrine output and re-sets the system. Under the sway of life course perspective, investigators will no longer be satisfied with using the common method of 'spayed' or 'intact' at the time of death as a substitute for lifetime gonad exposure (Waters et al., 2011). The rationale for this evolution in thinking is clear-cut: the status of being spayed or intact at the time of death *does not cause longevity*. However, a relationship between the number of years of endocrine organ exposure and longevity is causally plausible and therefore deserves further evaluation.

The concept of whole organism thinking helps to steer investigators away from their preoccupation with a favorite organ or favorite disease to consider something fundamental – *trade-offs*. Since longevity integrates both the incidence and mortality of every disease, as well as the rate of aging, whole organism thinking urges us to question whether significantly reducing the incidence of a single disease (for example, a late-onset disease with variable mortality, such as canine mammary cancer) should merit serious consideration as a core principle of any wellness program developed to achieve the goal of overall healthy longevity. Also, by embracing whole organism thinking, we experience a seismic shift in how we envision interventions – one no longer sees any intervention or life choice, such as taking antioxidant supplements, as 'good' or 'bad'. Instead, whole organism thinking teaches us to see all interventions as both good *and* bad (Waters, 2012).

To further illustrate the importance of whole organism thinking, it is instructive to consider more closely one of the potentially important biological trade-offs that biogerontologists are actively exploring, namely the possible longevity cost of investing in reproduction, especially for females (Gagnon et al., 2009). What are we learning about such trade-offs from canine longevity studies? Unfortunately, the report by O'Neill et al. (2013) can provide no insights here, since the study lacks information on reproductive histories. Likewise, investigators utilizing longevity data from the VMDB are also blind to the number of litters or offspring of their study population, bitches that die in veterinary teaching hospitals. Yet, a recent paper using VMDB data claims a relationship between 'reproductive capability' and longevity in dogs that died in veterinary teaching hospitals (Hoffman et al., 2013). In that study, 'reproductive capability' was assigned to bitches that were intact at the time of death (in contrast to those coded as spayed at the time of death). Without any knowledge of number of litters or offspring, and missing the information on just how long each female remained intact during their lifetime, it is difficult to understand how this work addresses the potential longevity cost of reproduction. In contrast, a detailed study of reproductive histories of pet dogs that captured both reproductive intensity (number of offspring) and tempo of reproductive effort (age at first and last reproduction) showed no evidence that a bitch's physiological investment in offspring was associated with disadvantaged longevity (Kengeri et al., 2013). Instead, independent of reproductive investment, longer duration of lifetime ovary exposure was significantly associated with highly successful aging.

Clearly, investigators will need to keep working to decipher the cryptic relationship between reproduction and longevity – attempting to sift through the competing factors that situate reproductive success as a physiological cost and at the same time an upsided surrogate of high maternal fitness. Add to this combatant context the fact that the timing and extent of reproductive effort are simultaneously the products of both biological signals and social inputs (i.e. the decision to breed is dictated by owners), and it is not surprising that ideas regarding the real relationship between reproduction and longevity escape consensus. Could it be that, in well-nourished, medically protected populations, the physiological cost of reproductive effort does not divert sufficient resources away from somatic maintenance to move females significantly closer to a threshold for age-related diseases or earlier mortality? This speculative line of reasoning is consistent with results reported on the impact of reproduction on longevity in protected zoo animal species (Ricklefs and Cadena, 2007).

To summarize, i believe the working appraisal developed in this invited editorial points to a fertile, opportunity-rich conclusion: *There is a lot of room for innovation in canine longevity research*. And, as we reflect on the content of new works describing canine longevity, such as those published by O'Neill et al. (2013), we should be reminded of anthropologist H.G. Barnett's insight from a half-century ago that how we react to new evidence is up to us:

> '...*the manner of treating this content, of grasping it, altering it, reordering it, is inevitably dictated by the potentialities and the liabilities of the machine which does the manipulating; namely, the individual mind.*' (Barnett, 1953)

Just how well prepared are our minds to do the necessary manipulating? Can we be open minded enough to effectively process the new findings that will advance our progress? I believe we can. For, although the biology of successful aging is unquestionably complicated, the mathematics of solid progress in this area is surprisingly simple: LCP + WOT = SA.[1] What is apparent now is that, without thoughtful attention to these two vital concepts, there is just too much that is missing.

[1] Life course perspective plus whole organism thinking equals successful aging.

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