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The causes and prognoses of different types of fractures in wild koalas submitted to wildlife hospitals

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ABSTRACT

Fractures are a major problem in wild koalas of great veterinary and conservation importance as their occurrence in different locations of the body might result in varying healing success. The aim of this study was to determine the fracture types (defined by location of the fracture) occurring in wild koalas, temporal patterns, possible causes and risk factors of fracture types, and the prognosis for successfully releasing kolas with healed fracture types into the wild. Data from a total of 2031 wild koalas submitted to wildlife hospitals in South-East Queensland, Australia, over a period of 13 years were analysed. Approximately 56.7% of koalas experienced head fractures, 13.4% had torso fractures, 14.9% had limb fractures and 15% had combination fractures. A total of 84.1% of fractures were caused by vehicle collisions, 9.1% by dog attacks, 3.3% by falls from trees, 1.3% by train collisions, 0.2% by livestock trampling and 1.8% due to unknown causes. Multinominal logistic regression was used to identify risk factors (cause of fracture, age category, sex, year, three-year admission period and season of fracture event) by fracture type. The type of fracture was associated with both the cause of the fracture and the season when it occurred: for example torso fractures (compared to combination fractures) were associated with dog attacks (OR = 10.98; 95% CI 6.03, 20.01) and falls from trees (OR = 4.79; 95% CI 2.26, 10.19) relative to vehicle collisions. More submissions of koalas with head fractures due to vehicle collisions occurred in spring compared to autumn and winter, coinciding with the breeding season of koalas and increased animal movement. Prognosis for koalas with fractures was poor, with approximately 63.8% of koalas admitted dead on arrival, 34.2% euthanised, and only 2.0% of koalas able to be released. Given this data, further research into mitigation strategies to decrease the risk of fractures and to increase the observed low recovery rate should be considered.

1. Introduction

The koala, *Phascolarctos cinereus*, a tree-dwelling, medium-sized marsupial, is an iconic wildlife species in Australia. Koalas are currently experiencing a drastic population decline in South-East Queensland and were listed of vulnerable conservation status by the Queensland State Government in June 2015. Their decline estimated at 54%, from greater than 10,000 animals in the South-East Queensland region in 1995 to less than 5000 by 2011, is driven by the consequences of koala habitat loss and diseases such as Chlamydia infection (Department of Environment, Australian Government, 2011; de Oliveira et al., 2014; Dique et al., 2003; McAlpine et al., 2006; Rhodes et al., 2014). Habitat loss or its fragmentation through the establishment of new roads are a result of urban expansion for both residential and commercial development, associated with rapid population increases in South-East Queensland (Department of Environment and Heritage Protection, Queensland Government 2011; McAlpine et al., 2006; Rhodes et al., 2014). Major threats to koalas associated with this infrastructure changes and increased human activity are vehicle collisions and dog attacks. (Department of Environment and Heritage Protection, Queensland Government 2014; Griffith et al., 2013; McAlpine et al., 2006; Preece, 2007; Rhodes et al., 2014). A 1983 study of wild southern koalas admitted for hospital treatment in Victoria reported traumatic injury as 'the most common presentation', with motor vehicle collisions as the leading cause (Obendorf, 1983). However, the types or locations of traumatic injuries in koalas have not yet been described in detail. Understanding fractures types and their risk factors may aid

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veterinarians in the clinical management of these cases and guide the use of limited rehabilitation resources towards animals with a more favourable prognosis. Previous research has shown that where the fracture is located has a great bearing on whether wild animals coming into care will be successfully released—for example humerus fractures in wild birds resulted only in the release of 1.3% of cases, while radius fractures had release rates of 20% (Mason, 2004; Frowler, 2014). However, release rates of fracture cases in koalas have never been formally investigated. As the survival of individual koalas of breeding potential is of ever-growing significance, the rehabilitation of fracture cases plays an important role in conservation efforts.

Given the impact of traumatic injury on the koala population, the objectives of this study were to (1) describe fracture types occurring in wild koalas and determine their prognosis, (2) describe seasonal and temporal patterns of fractures (3) summarize the causes of fractures, (4) examine if variables, such as cause of fracture, age category, sex, year, three-year admission period and season were associated with fracture types.

2. Materials and methods

2.1. Study design

The Queensland Government Department of Environment and Heritage Protection Moggill Koala Hospital (MKH) maintains a Microsoft Access 2007 database of koalas that are found injured or deceased and that are submitted to veterinary clinics and wildlife hospitals. The MKH database is made up of koala admissions to the MKH, the Australia Zoo Wildlife Hospital (AZWH), the Currumbin Sanctuary Wildlife Hospital (CSWH) and various other veterinary clinics in South-East Queensland. At admission, a mandatory koala paper record sheet is completed describing the signalment and general health of the koala, including sex, weight and cause of admission. Depending on the veterinary assessment, koalas are then retained for treatment, euthanised or instantly released. Cause of trauma is recorded as it was observed by the submitter, who is generally a member of the public (e.g. a member of the public might observe a koala being involved in a vehicle collision or dog attack), or is logically deduced from the presentation during clinical or post-mortem examination. For example, a koala found on the side of a road with massive blunt force trauma may be presumed to have been hit by a motor vehicle. Euthanised and dead-on-arrival koalas receive a postmortem examination. Additional information such as postmortem results are entered in a free text field in the database.

2.2. Statistical analysis

A search in the free-text field section of the MKH database for the words ‘fractured’, ‘crushed’ or ‘broken’ was performed to create the dataset used in this study. The dataset was further refined by removing cases that did not involve fractured bones or were duplicates. Only definite findings were included, and all potentially misleading descriptions were cross-checked (and corrected if necessary) by referring to the original paper records.

Clinical fracture outcomes were defined as dead-on-arrival, euthanased or released. Dead-on-arrival describes an individual that was found deceased, or died shortly after rescue, or in some cases shortly after the commencement of treatment. Fracture locations were cross tabulated with clinical fracture outcomes and the prevalence and the 95% Jeffrey’s confidence interval for the prevalence of fracture locations was calculated. Fracture locations were then summarized into four fracture types: (1) Head only, (2) Torso only, (3) Limbs only (including hindlimb, forelimb, or both), and (4) combination of fracture locations.

Fracture causes were summarised into the following categories: vehicle collisions, dog attacks, falls from trees, train collisions, livestock trampling and unknown. Koala age groups were defined by weight: adults >4 kg, young adults 2–4 kg, juvenile <2 kg. Season was coded in accordance with the Southern Hemisphere (spring: September–November; summer: December–February; autumn: March–May; winter: June–August). To analyse the long-term trend, years of admission between 1997 and 2008 were categorized into three-year intervals as these intervals largely represented the temporal increasing, decreasing or plateauing changes in admission numbers. The chi-square statistic for homogeneity of a sample was used to explore the pattern of seasonal fracture submissions and the frequency of clinical outcomes observed. Multinomial logistic regression was then used to analyse the association of clinical fracture outcomes and of fracture causes with the individual koala risk factors sex and age category.

Fractures caused by livestock trampling, train collisions or unknown causes were sparse and these cases were therefore excluded from further analysis. Multinomial logistic regression analysis was utilized to analyse univariable associations between risk factor variables (cause of fracture, age category, sex, year, three-year admission period and season) and the dependent variable, fracture type. Combination fractures were considered as the base category to which the other three categories of fracture types were compared to. For the explanatory risk factor variables we chose the following reference groups: spring for season, adult for age group, female for sex. A multiple Wald test was computed to evaluate the statistical significance of all categories together for any

Table 1
Fracture location by outcome of admission (dead-on-arrival, euthanised, released) for koalas with fractures submitted to wildlife hospitals in South-East Queensland between 1997 and 2010.

Fracture location	N Dead-on-arrival	N Euthanised	N Released	N Total	% (95% CI)
Head	855	292	4	1151	56.7 (54.5, 58.8)
Torso	123	142	8	273	13.4 (12.0, 15.0)
Hindlimb	108	65	16	189	9.3 (8.1, 10.6)
Forelimb	33	70	10	113	5.6 (4.6, 6.6)
Head torso	57	37	0	94	4.6 (3.8, 5.6)
Head forelimb	38	25	0	63	3.1 (2.4, 3.9)
Head hindlimb	40	8	2	50	2.5 (1.9, 3.2)
Torso hindlimb	9	21	0	30	1.5 (1.0, 2.1)
Torso forelimb	6	14	0	20	1.0 (0.6, 1.5)
Both limbs	6	10	0	16	0.8 (0.5, 1.3)
Head torso hindlimb	9	1	0	10	0.5 (0.3, 0.9)
Head both limbs	4	4	0	8	0.4 (0.2, 0.7)
Head torso forelimb	4	1	0	5	0.3 (0.1, 0.5)
Torso both limbs	2	3	0	5	0.3 (0.1, 0.5)
Head torso both limbs	2	2	0	4	0.2 (0.1, 0.5)