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ARTICLE *in* ANIMAL WELFARE (SOUTH MIMMS, ENGLAND) · AUGUST 2007

Impact Factor: 1.31

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Animal Welfare 2007, 16: 361-367
ISSN 0962-7286

Factors that can be used to predict release rates for wildlife casualties

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Abstract

Of the wildlife casualties admitted to rehabilitation centres in England, less than half are subsequently released back into the wild. If the factors associated with survival within rehabilitation centres can be determined, they may be used to focus efforts on individuals with high chances of successful recovery, and thus improve welfare by devoting resources to those animals that are more likely to benefit. We analysed the medical record cards of eight species admitted to four wildlife rehabilitation centres run by the Royal Society for the Prevention of Cruelty to Animals between 2000-2004 to determine those factors that affected the chance of survival in care until release, and whether trends in predictive factors occurred across taxonomic groups. We found that the most important predictive factor, across all species, was the severity of the symptoms of injury or illness. Factors commonly used as important indicators of rehabilitation success in published practice guidelines, such as mass and age, were not found to affect survival significantly. Our results highlight the importance of triage based on clinical diagnosis as soon as a wildlife casualty is admitted, and indicate that although the ethos of many rehabilitation centres is to attempt the treatment of all wildlife casualties, the attempted treatment of those with severe injuries may be adversely affecting welfare by prolonging suffering.

Keywords: *animal welfare, predictive factors, rehabilitation, survival, triage, wildlife casualties*

Introduction

Wildlife rehabilitation, "the managed process whereby a displaced, sick, injured or orphaned wild animal regains the health and skills it requires to function normally and live self-sufficiently" (International Wildlife Rehabilitation Council 2005), is an internationally large and growing practice. In Britain, 30,000–40,000 casualties are taken into wildlife hospitals each year (Stocker personal communication 2006). Improving rehabilitation protocols, therefore, has the potential to make significant advances in animal welfare.

Assessment of the rehabilitation process to date has largely focused on post-release survival rates (eg Robertson & Harris 1995a; Fajardo *et al* 2000; Molony *et al* 2006), or veterinary techniques for particular species (eg Blackmer *et al* 1997; Cousquer 2005; Stocker 2005). Conversely, survival rates in care have rarely been investigated, despite indications that < 45% of wildlife casualties survive to be released (Kirkwood 2003).

During their period in captivity, individuals may suffer mortality either because their injury or illness is too severe to attempt treatment, or because they do not respond to the treatment given. In both instances, euthanasia may be used as a humane solution. In addition, other factors may also be important in affecting survival whilst in care. Age and body condition can affect individual survival in the wild (eg Ringsby *et al* 1998; Overskuag *et al* 1999), and thus younger individuals and those in poorer body condition may have lower chances of surviving the rehabilitation process. Length of time in care may affect survival given that captivity involves novel stimuli and close proximity to humans, both of which are likely to induce stress in wild animals (McArthur *et al* 1986; Boissy 1995; Wingfield *et al* 1997), and chronic stress is known to have deleterious immunological consequences (Carlstead 1996) that may affect the recovery process. Finally, there are a number of extrinsic factors that may affect an individual's chances of survival, such as: the time of admission, given that not all rehabilitation centres are open 24 h; the season of admission and the speciality skills of the rehabilitation centre.

The role of such factors in affecting survival in captivity, however, remains speculative, and no comprehensive analysis has been conducted to clarify their relative importance. If the factors that are important in predicting whether an individual will survive to be released can be determined, they can then be used by rehabilitation centres to focus efforts on individuals with a high chance of survival. The welfare of wildlife casualties may be improved, therefore, if the chances of release can be established at an early stage (Kirkwood & Best 1998), because: 1) suffering will not be prolonged; 2) prospects of survival to release may be associated with post-release survival chances and 3) more resources can be devoted to those animals that will benefit most (Kirkwood & Sainsbury 1996).

Current advice offered to wildlife rehabilitators to assist in making the decision about the future of a wildlife casualty, across species, lists the following criteria as important: the natural history of the species; age; sex; body condition (measured as body mass); health status and prognosis (Best & Mullineaux 2003). However, the selection of these criteria has been based on perceived levels of importance rather than data. The aim of this study was to determine whether the currently recommended indicators are, in fact, the best predictors of release likelihood for eight species commonly admitted to rehabilitation centres in England, and to determine whether trends in these predictive factors occur across taxonomic groups.

Materials and methods

Medical records of eight species admitted between 2000 and 2004 were obtained from the four wildlife rehabilitation centres run by the Royal Society for the Prevention of Cruelty to Animals (RSPCA) in England. The eight species were selected because 1) they are commonly admitted for rehabilitation and 2) they cover a range of taxonomic groups. They were: badger (*Meles meles*); blackbird (*Turdus merula*); hedgehog (*Erinaceus europaeus*); red fox (*Vulpes vulpes*); tawny owl (*Strix aluco*); starling (*Sturnus vulgaris*) and house sparrow (*Passer domesticus*). Pipistrelle bats were also included but few rehabilitation centres identify the species of pipistrelle. Since *Pipistrellus pipistrellus*, *P. pygmaeus* and possibly *P. nathusii* could have been included, this group is referred to as *Pipistrellus* spp hereafter.

The following data were extracted from the record cards for individuals within each species: age class (adult/juvenile); sex; time and season of admission; rehabilitation centre; mass on admission; reason for admission; clinical diagnosis, if given, or the symptoms of injury or illness; time in captivity and whether the individual was released or died in care. Individuals were classed as either adult (> 1 year) or juvenile (< 1 year and/or still dependent, eg fledgling birds). The following categories were used as reasons for admission: road traffic accident; cat/dog attack; orphan; injured; sick; grounded (for *Pipistrellus* spp); and 'other' (eg trapped inside building, caught in netting). By using four different rehabilitation centres across several years, the clinical assessment of individuals on admission had been conducted by different veterinary surgeons/veterinary nurses. Therefore, to standardise the data, broad categories were used to describe the severity of the symptoms of injury or illness: 1) no apparent damage; 2) weak and/or thin – where the assessment was recorded as 'weak' or 'thin' and no other damage reported; 3) superficial tissue wound(s) only; 4) deep tissue wound(s) and/or emaciated and/or bone fracture; 5) moribund, and/or blind and/or fractured pelvis; and 6) ocular injuries were also included as an additional category for tawny owls. In the case of bone fractures, inconsistencies occurred between different rehabilitation centres in the level of detail given regarding the position and type of fracture, and therefore, all bone fractures (with the exception of pelvis fractures) were defined as category 4). Symptoms of injury or illness in category 1 were considered least severe and category 5 (or 6 for tawny owls) the most severe.

Statistical methods

Statistical analyses were performed with SPSS 12.0. Binary logistic regression was used to analyse the data, with the dependent variable being 'released from rehabilitation centre or died in care'. Ten independent variables were potentially available for each species (Table 1). Initially, each independent variable was tested separately with the dependent variable and selected for inclusion in the model if $P < 0.05$. The standard threshold probability of 0.5 was used in all binary logistic models. In order to test the variable 'time in care', orphans were removed because they confounded the analysis: orphaned animals spent the longest time in care and had higher probabilities of release. Adults and juveniles were tested separately for the effect of body mass on the dependent variable, in order to remove the potentially confounding affect of age on body mass.

Preliminarily selected variables were tested for colinearity using χ^2 or Spearman's rank order correlation. Where independent variables were significantly associated with each other, the variable most significantly associated with the dependent variable in the univariate tests was selected for inclusion in the final model. Interaction terms between variables were also included. The selection of variables for inclusion in the final model was identified by comparison of the difference of the –2 log likelihood values of the full and reduced models (Quinn & Keough 2002). The adequacy of the final models was assessed with Hosmer-Lemeshow, Cox and Snell and Nagelkerke statistics. The Hosmer-Lemeshow test corrects for the use of continuous independent variables, and Cox and Snell and Nagelkerke tests are pseudo r-squared statistics that have been developed for logistic regression. In all cases there were no significant differences between the fitted model and the data, and the percentage of variation explained by the included parameters was high (Table 2). Effect sizes are expressed as odds ratios (the ratio of P [released] to P [died in care]). Odds ratios were calculated for each category within a variable by using one category as a reference, eg for the variable 'rehabilitation centre', centre A was used as the reference category for centres B, C and D. Odds ratio values of less than one indicate that the animal was more likely to die in care than survive to be released.

Since this paper is concerned with the welfare of animals that are treated in rehabilitation centres, the casualties that died or that were euthanased within 48 hours of arrival at the centre were removed from the data. The initial 48 hours after admission is a practically acceptable time for a clinical assessment to be made, and removing the animals that were immediately euthanised avoided biasing the results towards a 'poor' prognosis.

Table 1 Summary of the variables potentially available for each model.

Variable	Variable type	Description
Result	Categorical	Dependent variable: 1 = released, 0 = died in care
Centre	Categorical	A, B, C, D
Year	Categorical	2000-2004
Age	Categorical	Adult or juvenile (see text)
Sex	Categorical	Male or female
Mass	Continuous	Mass on admission (g)
Time	Categorical	Time of admission: 0800-1400h; 1400-2000h; 2000-0800h
Season	Categorical	Season of admission: spring, summer, autumn, winter
Reason	Categorical	Reason for admission (see text)
Symptoms	Categorical	Severity of the symptoms of injury or illness (see text)
Period	Continuous	Time in care (days)

Table 2 Summary of the fit of each statistical model.

Species	n	% surviving to release	Hosmer-Lemeshow	Cox & Snell	Nagelkerke	% variation explained by model
Badger	548	32	$\chi^2_3 < 0.000$, $P = 1.000$	0.205	0.318	80.9
Fox	780	43	$\chi^2_3 < 0.000$, $P = 1.000$	0.221	0.357	82.8
Hedgehog	754	53	$\chi^2_2 < 0.000$, $P = 1.000$	0.182	0.287	81.4
Pipistrellus spp	666	29	$\chi^2_3 < 0.000$, $P = 1.000$	0.341	0.474	83.5
Blackbird	680	37	$\chi^2_3 < 0.000$, $P = 1.000$	0.221	0.324	80.1
House sparrow	543	33	$\chi^2_6 < 8.134$, $P = 0.228$	0.192	0.267	73.3
Starling	629	36	$\chi^2_2 < 0.000$, $P = 1.000$	0.189	0.292	84.0
Tawny owl	587	45	$\chi^2_3 < 0.000$, $P = 1.000$	0.330	0.501	79.8

Table 3 Summary of variables in the final statistics.

Species	Variable(s) in final model	Additional variables associated with variables in the final model
Badger	Severity of symptoms	Reason
Fox	Severity of symptoms	Reason
Hedgehog	Severity of symptoms	Reason
Pipistrellus spp	Severity of symptoms	Age, reason
Blackbird	Severity of symptoms	Reason
House sparrow	Centre, severity of symptoms	Reason
Starling	Severity of symptoms	Reason
Tawny owl	Severity of symptoms	Reason

Results

Severity of injury or illness symptoms

For all species, the severity of the injury or illness symptom(s) was a significant predictor of whether an individual survived to be released or not (Tables 3 and 4). The more severe the injury or illness, the less likely the individual was to be released (eg odds ratios were lower for more severe categories of symptoms). *Pipistrellus* spp, for example, admitted with puncture wounds were less likely (odds ratio [P (released) to P (died in care] 0.291) to be released than those admitted with no apparent damage. Individuals that did not survive to be released were found to have spent varying lengths of time in captivity, despite the severity of injury/illness (Table 5).

Rehabilitation centre

There was a difference in the probability of release between the four rehabilitation centres only for house sparrows. Individuals of this species admitted to centre C and centre D were significantly less likely (odds ratios 0.238 and 0.251, respectively) to be released than sparrows admitted to centre A.

Table 4 Summary of the binary logistic models for each species.

Species	Variable	B	SE	Wald	df	P-value	Odds ratio (95%)
Badger	Symptoms 1 (no apparent damage)	-	-	38.512	4	$P < 0.001$	-
	Symptoms 2 (weak, thin)	-0.795	1.274	0.361	1	$P = 0.548$	0.465 (0.038-5.650)
	Symptoms 3 (tissue wound)	-0.529	0.838	0.398	1	$P = 0.528$	0.589 (0.114-3.048)
	Symptoms 4 (fracture, deep tissue wound, emaciated)	-2.695	0.760	12.575	1	$P < 0.001$	0.068 (0.015-0.300)
	Symptoms 5 (moribund, fractured pelvis)	-4.049	0.991	16.701	1	$P < 0.001$	0.017 (0.003-0.122)
	Constant	3.068	0.723	17.989	1	$P < 0.001$	21.500
Fox	Symptoms 1 (no apparent damage)	-	-	83.106	4	$P < 0.001$	-
	Symptoms 2 (weak, thin)	0.217	1.073	0.041	1	$P = 0.839$	1.243 (0.152-10.18)
	Symptoms 3 (tissue wound)	-0.546	0.493	1.229	1	$P = 0.268$	0.579 (0.220-1.521)
	Symptoms 4 (fracture, deep tissue wound, emaciated)	-2.774	0.381	52.959	1	$P < 0.001$	0.062 (0.030-0.132)
	Symptoms 5 (moribund, fractured pelvis)	-3.749	0.624	36.133	1	$P < 0.001$	0.024 (0.007-0.080)
	Constant	2.874	0.325	78.158	1	$P < 0.001$	17.700
Hedgehog	Symptoms 1 (no apparent damage)	-	-	73.468	4	$P < 0.001$	-
	Symptoms 2 (weak, thin)	-1.144	0.393	8.491	1	$P = 0.004$	0.319 (0.148-0.688)
	Symptoms 3 (tissue wound)	-2.021	0.363	30.917	1	$P < 0.001$	0.133 (0.065-0.270)
	Symptoms 4 (fracture, deep tissue wound, emaciated)	-3.060	0.408	56.336	1	$P < 0.001$	0.047 (0.021-0.104)
	Symptoms 5 (moribund, fractured pelvis)	-5.026	1.095	21.058	1	$P < 0.001$	0.007 (0.001-0.056)
	Constant	2.828	0.297	90.634	1	$P < 0.001$	16.917
Pipistrellus	Symptoms 1 (no apparent damage)	-	-	88.939	3	$P < 0.001$	-
spp	Symptoms 2 (weak, thin)	-1.013	0.551	3.376	1	$P = 0.066$	0.363 (0.123-1.070)
	Symptoms 3 (bruising, puncture wound)	-1.234	0.517	5.690	1	$P = 0.017$	0.291 (0.106-0.802)
	Symptoms 4 (fracture, wing membrane tear, emaciated)	-3.725	0.459	65.728	1	$P < 0.001$	0.024 (0.010-0.059)
	Constant	2.597	0.392	43.952	1	$P < 0.001$	13.429
Blackbird	Symptoms 1 (no apparent damage)	-	-	64.345	4	$P < 0.001$	-
	Symptoms 2 (weak, thin)	-1.623	0.394	16.999	1	$P < 0.001$	0.197 (0.091-0.427)
	Symptoms 3 (bruising, puncture wound)	-0.140	0.449	0.097	1	$P = 0.755$	0.869 (0.360-2.098)
	Symptoms 4 (fracture, deep tissue wound, emaciated)	-2.551	0.346	54.490	1	$P < 0.001$	0.078 (0.040-0.154)
	Symptoms 5 (moribund, blind)	-23.289	16408.711	0.000	1	$P = 0.999$	0.000 (0.000)
	Constant	2.086	0.243	73.544	1	$P < 0.001$	8.053
House	Centre (A)	-	-	23.285	3	$P < 0.001$	-
sparrow	Centre (B)	0.098	0.472	0.043	1	$P = 0.836$	1.103 (0.437-2.782)
	Centre (C)	-1.435	0.405	12.549	1	$P < 0.001$	0.238 (0.108-0.527)
	Centre (D)	-1.381	0.466	8.794	1	$P = 0.003$	0.251 (0.101-0.626)
	Symptoms 1 (no apparent damage)	-	-	16.825	4	$P = 0.002$	-
	Symptoms 2 (weak, thin)	0.430	0.495	0.753	1	$P = 0.386$	1.537 (0.582-4.058)
	Symptoms 3 (bruising, puncture wound)	0.557	0.478	1.353	1	$P = 0.245$	1.745 (0.683-4.457)
	Symptoms 4 (fracture, deep tissue wound, emaciated)	-1.429	0.423	11.439	1	$P < 0.001$	0.239 (0.105-0.548)
	Symptoms 5 (moribund, blind)	-22.261	1921.505	0.000	1	$P = 0.999$	0.000 (0.000)
	Constant	1.543	0.363	18.045	1	$P < 0.001$	4.677
Starling	Symptoms 1 (no apparent damage)	-	-	58.563	4	$P < 0.001$	-
	Symptoms 2 (weak, thin)	-0.003	0.648	0.000	1	$P = 0.996$	0.997 (0.280-3.551)
	Symptoms 3 (bruising, puncture wound)	-1.394	0.427	10.672	1	$P < 0.001$	0.248 (0.108-0.573)
	Symptoms 4 (fracture, deep tissue wound, emaciated)	-3.010	0.411	53.643	1	$P < 0.001$	0.049 (0.022-0.110)
	Symptoms 5 (moribund, blind)	-2.040	1.429	2.037	1	$P = 0.154$	0.130 (0.008-2.142)
	Constant	2.040	0.208	95.774	1	$P < 0.001$	7.692
Tawny owl	Symptoms 1 (no apparent damage)	-	-	31.591	5	$P < 0.001$	-
	Symptoms 2 (disease, parasites)	-4.535	1.070	17.976	1	$P < 0.001$	0.011 (0.001-0.087)
	Symptoms 3 (ocular injury)	-5.108	1.039	24.160	1	$P < 0.001$	0.006 (0.001-0.046)
	Symptoms 4 (fracture, deep tissue wound)	-4.967	1.038	22.886	1	$P < 0.001$	0.007 (0.001-0.053)
	Symptoms 5 (both 3 and 4)	-6.057	1.135	28.465	1	$P < 0.001$	0.002 (0.000-0.022)
	Symptoms 6 (moribund, blind)	-6.280	1.529	16.864	1	$P < 0.001$	0.002 (0.000-0.038)
	Constant	5.182	1.003	26.701	1	$P < 0.001$	178.000

Table 5 Mean length of time in care prior to death for each injury/illness category.

Species	Mean (± SE) number of days in care for each category of injury/illness					
	1	2	3	4	5	6
Badger	40 ± 25	8 ± 0	7 ± 5	9 ± 15	19 ± 24*	-
Fox	42 ± 47	10 ± 13	23 ± 23	14 ± 21	13 ± 21*	-
Hedgehog	31 ± 28	14 ± 17	17 ± 22	9 ± 11	7 ± 9*	-
Pipistrellus spp	9 ± 9	19 ± 27	13 ± 14	13 ± 22*	-	-
Blackbird	15 ± 15	26 ± 20	15 ± 21	11 ± 14*	6 ± 6*	-
House sparrow	22 ± 26	13 ± 16	9 ± 14	18 ± 33*	5 ± 4*	-
Starling	15 ± 19	14 ± 13	13 ± 18	11 ± 18*	5 ± 0*	-
Tawny owl	17 ± 21	12 ± 13	8 ± 6	12 ± 16	23 ± 48*	5 ± 5*

Categories correspond with those in Table 4.
* Categories of injury/illness for which animals had < 10% chance of surviving to be released.

Other factors

Sex, age, time, year and season of admission, mass on admission, and length of time in care were not significant predictors in any of the final statistical models.

Reason for admission was excluded from statistical models because of its high colinearity with the severity of the injury/illness symptoms. Body mass and sex were not included in statistical models for blackbirds, house sparrows or starlings because these data were not available for these species.

Discussion

The four RSPCA centres used in this study appear representative of rehabilitation centres across the UK, exhibiting release rates and survival rates, for the eight species studied, that were within similar ranges to the 35 rehabilitation centres that take part in the British Wildlife Rehabilitation Council (BWRC) survey. For example, 39 (± 8%) of wildlife casualties admitted to RSPCA centres were subsequently released, in comparison to 42% from the BWRC survey, and 55% (± 8%) of wildlife casualties admitted to RSPCA centres survived the first 48 hours, in comparison to 60% from the BWRC survey (Kirkwood 2003). Whilst the latter figure was slightly lower in RSPCA centres, it is probable that more difficult cases of injured wildlife were admitted to the RSPCA. For example, more foxes with shot wounds were admitted to RSPCA centres between 1993-2003 than to five out of six other rehabilitation centres studied (AJ Bentley, PJ Baker and S Harris, unpublished data). Thus we believe the analyses presented here are applicable to other British wildlife rehabilitation centres.

Our study focused on those wildlife casualties where treatment was attempted: the individuals that survived the first 48 hours after being admitted. The most important predictive factor determining whether a wildlife casualty survived to be released from a rehabilitation centre, across all species, was the severity of the symptoms of injury or illness. Factors that were not found to be significant in affecting chances of survival for any species were time, season and year of admission, age, sex and mass on admission and length of time in care. Probabilities of release differed between rehabilitation centres only for house sparrows. The results of this study, therefore, highlight the importance of obtaining a clinical diagnosis early on in the admission procedure, and using this diagnosis to make the decision about the future treatment of the casualty.

Currently, there is no clear consensus over triage – the procedure of sorting casualties into categories of priority for treatment – in rehabilitation practice: guiding principles on whether or not to treat a casualty are often based on speculation regarding the chances of post-release survival for that individual (eg Mullineaux *et al* 2003), and the general ethos in many rehabilitation centres is that the treatment of all wildlife casualties should be attempted in order to give every individual a chance. Our results, however, point towards the importance of triage, given that individuals with greater severity of injuries/illness were found to have significantly lower chances of surviving the treatment process than individuals with less severe injuries/illness. Furthermore, we found that, across species, individuals that had severe injuries and failed to thrive (eg fractures or deep tissue wounds) were spending up to 18 (± 33 days) in care before mortality, and up to 23 (± 48 days) (Table 5) in care before mortality for the most severe category of symptoms (eg fractured pelvis). In these cases, the cause of death may have been natural or animals may have been euthanased after their condition deteriorated or treatment had not been successful. Therefore, the attempted treatment of casualties with severe injuries may be adversely affecting welfare, given that prolonged periods in captivity and the associated capture, handling, and treatment may be extremely stressful (Kirkwood & Sainsbury 1996).

Several other criteria perceived to be important by wildlife rehabilitators are cast in doubt by the results of this study. Practice guidelines suggest that mass is a strong indicator of an individual's chances of survival to release (eg Best & Mullineaux 2003) but it was not found to be an important predictor of survival for any of the species of raptor and mammal in this study. The importance of body mass in passerines could not be examined, as these data had not been collected. However, we suggest that mass is recorded for passerine birds in the future, in order to determine whether it is an indicator of survival for these species. In addition, it is often stated that juveniles may be more challenging to rehabilitate than adults and, therefore, rehabilitation may not be feasible (eg Simpson & King 2003), but our analysis did not find that juveniles have lower chances of survival up to release, or that age is a better indicator of survival chances than the severity of injury/illness. Finally, longer periods of time in captivity were not found to have a significant effect on the chances of survival to release for the species in this study, despite the detrimental impact that captivity can have on stress levels and, subsequently, immune function and health (eg Lander *et al* 2003; McKenzie & Deane 2005). This variable may have been confounded, however, by the fact that animals which survive to be released will have generally spent longer in captivity undergoing treatment than those for which treatment is unsuccessful. Furthermore, whilst longer periods of time in care allow animals successfully to recover, prolonged captivity may detrimentally affect their survival post-release, for example, by decreasing cautiousness to predators and hazards (eg Robertson & Harris 1995b; Ben-David *et al* 2002). Therefore, the impact of captivity on physiological stress levels and recovery time for wildlife casualties is one area that warrants further research.

In addition to the severity of injury, differences in the probability of release were also found between rehabilitation centres, but only for house sparrows. These differences may have arisen for a number of reasons, eg the specialist skills of the centre and its familiarity with treating this particular species, and/or the facilities and resources available. This may suggest that rehabilitation centres could improve the treatment success of particular species by sharing information on protocols and methods of best practice, or focusing on particular species.

Animal welfare implications

The findings of this study indicate that the chances of survival to release for a wildlife casualty can be predicted by the severity of its symptoms of injury or illness at admittance, and this is consistent across taxonomic groups. Based on the chances of survival found in this study, and the symptoms of injury or illness on admission, we propose a triage principle that will enable rehabilitators to decide whether or not to treat a wildlife casualty. Deciding on the cut-off point after which euthanasia would be the best welfare option should be based on the proportion of individuals that fail to thrive and the mean time spent in captivity before mortality, for each category of injury or illness symptoms (Table 5). If a lower limit of a 10% chance of survival is used (eg < 10% of individuals admitted with this category of injury/illness survive to be released), then our results indicate that it is better welfare not to attempt to treat injuries that are as severe as, or more severe than, the following for the species noted: 1) fractures, wing membrane tears and/or deep tissue wounds for bat and passerine species; 2) fractured pelvis and/or severe ocular damage for all species of mammal and 3) ocular damage in addition to fractures and/or deep tissue wounds in raptors

By following these guidelines, the welfare of wildlife casualties can be improved by devoting more resources to animals that will benefit most, and reducing the potentially prolonged suffering of animals that have low chances of surviving until release (Kirkwood & Sainsbury 1996). Focusing efforts on wildlife casualties with high chances of survival until release should also improve post-release survival rates. However, there remains a scarcity of information on survival rates post-release. Our study has investigated survival rates in rehabilitation centres, and this should be furthered by identifying the injuries that, even if treated successfully, have a significant impact on survival after the individual has left the rehabilitation centre.

Acknowledgments

We are grateful to the RSPCA for funding this study, and to A Charles, R Griffiths, A Kelly and R Thompson, the managers of the RSPCA Wildlife Centres, for allowing us to use the record cards. We thank three anonymous referees for comments on an earlier draft of the paper.

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