The Veterinary Journal 234 (2018) 96–101

Contents lists available at ScienceDirect

The Veterinary Journal

journal homepage: www.elsevier.com/locate/tvjl

Original Article

Respiratory rate of clinically healthy cats measured in veterinary consultation rooms

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ARTICLE INFO

Article history:
Accepted 21 February 2018

Keywords:
Breathing
Feline
Physiologic
Reference
Video

ABSTRACT

Respiratory rate is commonly recorded during physical examinations. However, reference intervals are only available for resting and sleeping respiratory rates in cats at home. This observational study aimed to establish reference intervals for the respiratory rate in clinically healthy adult cats at primary-care veterinary clinics. Respiratory rates were recorded from 131 cats, in 6 primary-care veterinary clinics, by observation under four circumstances: by the investigator in the consultation room prior to and during a physical examination, by the owner at home when the cat was resting or sleeping, and by the investigator when watching a video-film of the cat recorded by the owner at home.

The respiratory rate of the 88 clinically healthy adult (≥12 months) cats in the consultation room ranged 28–176 breaths/min (median 64) with a calculated reference interval of 32–135 breaths/min. Based on video-recordings, the resting ($n = 32$) and sleeping ($n = 38$) respiratory rates of the same cats were determined: median 27 (range 16–60) breaths/min and median 20 (range 9–28) breaths/min, respectively, which were lower than the respiratory rates recorded in the consultation room (both $P < 0.0001$). We conclude that the reference intervals proposed for cats in textbooks reflect the resting respiratory rate at home. These values are inappropriate for using in the veterinary consultation room, because based on such reference intervals, many cats would erroneously be categorized as having tachypnea. Since the resting and sleeping respiratory rates at home show less variation, owners should be encouraged to film their pets before they visit their veterinarian.

Introduction

Respiratory rate is one of the most commonly assessed physiologic parameters taken by veterinarians on a daily basis, in each species, including cats. Increased respiratory rate can be caused by numerous physiologic and pathologic disorders, such as stress, hyperthermia, pain and diseases of several organ systems (Sigrist et al., 2011). Identifying a respiratory rate as increased (i.e. tachypnea) requires a reference interval, derived from a large cohort of healthy cats. Two studies have reported the respiratory rates of cats with subclinical and clinical heart disease in the home environment (Ljungvall et al., 2014; Porciello et al., 2016). Additionally, one study describes the effect of hospital visits on the respiratory rate and other physiologic variables in 30 apparently healthy cats (Quimby et al., 2011). However, a reference interval for respiratory rates of cats in veterinary consultation rooms is lacking. Our impression is that the reference intervals recommended in textbooks (20–40 breaths/min) is inappropriate for use in outside home environments (Rijnberk and Stokhof, 2008).

Therefore, we sought to establish reference intervals for the respiratory rate in cats outside the home environment. We counted the respiratory rates of apparently clinically healthy, client-owned cats brought to primary-care veterinary clinics in the consultation room and had owners count and video-record respiratory rates at home. We hypothesized that respiratory rates of clinically healthy cats at home would be lower than in the consultation room during a veterinary examination.

Materials and methods

Animals and inclusion criteria

Healthy client-owned cats were enrolled in this prospective descriptive field study. Cats were considered to be clinically healthy based on their medical files, medical history, general appearance and physical examination. If cats did not have a physical examination at the time of respiratory rate evaluation, we considered them as *assumed healthy* based on their medical files, general appearance and their owners' opinion. Physical examination consisted of evaluation of the respiratory rate, respiratory type and respiratory effort, assessment of the femoral pulse

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https://doi.org/10.1016/j.tvjl.2018.02.014
1090-0233/

(quality, rhythm and frequency), the hair-coat, the skin, the mucous membranes and the lymph nodes. In addition, abdominal palpation and thoracic auscultation were carried out in each animal. Rectal temperature was measured only in some cats. The respiratory rate was measured by inspection only (hands-off), without restraint or manipulation, prior to the onset of physical examination, when the cat was still in its carrier in the consultation room. Examination of the hair-coat and the skin included screening for flea infestation using a flea comb in each cat.

Exclusion criteria were the presence of a known disease, pregnancy, lactation, abnormalities found during the physical examination, and purring while taking the respiratory rate. The respiratory rate of cats that underwent surgery (e.g. neutering) and/or anesthesia were taken at home at least 2.5 weeks after the event to minimize the effect of any factors on the respiratory rate, such as pain and discomfort.

Age, gender, breed and the reason for visiting the veterinarian were recorded. The gender at the time of the first respiratory rate collection was used. Cats were classified either as adult (≥12 months of age) or as young (<12 months).

Data collection

Data collection took place in 6 primary-care veterinary clinics, in the cities and outskirts of Amsterdam and Utrecht in the Netherlands over a period of 3 months between May and August 2016. All clinics had one waiting room and 1–2 consultation rooms with ongoing consultations. Patients included dogs, cats and small exotic animals. None of the veterinary clinics took special measures to comfort their feline patients (e.g. by using feline facial pheromones, a separate waiting room or feline consultation hours).

Data collection on each individual cat occurred in two locations (in the veterinary clinic and at home) and in both locations under two circumstances. In the veterinary clinic, the respiratory rate was obtained by a single investigator (ED) before any handling (such as physical examination) of the cat took place (1st measurement, referred to hereafter as 'ambulatory' rate). During this measurement the cat was still in its carrier or transporter and had not been handled. Thereafter, each cat was examined by the attending veterinarian. If the circumstances allowed (e.g. no sniffing by the cat or no handling by the veterinarian/technician blocking the investigator's view), counting the respiratory rate was repeated during this examination (2nd measurement). This second measurement took place always before measuring rectal temperature or performing additional investigations (such as blood pressure measurement or blood sampling).

Ambulatory respiratory rates were recorded only if counted for at least 15 s. If the investigator could repeat the respiratory rate counting under the same circumstances, the two measurements were averaged.

Immediately after completing the veterinary visit, the investigator asked each pet owner to record a video-film of at least 15 s of their cat using their mobile phone at home when the cat was sleeping (or resting) in sternal or lateral recumbency (3rd measurement), and to count the respiratory rate for 30 s immediately after filming while the cats were still sleeping or resting (4th measurement). Owners were asked to count the respiratory rate without touching their cats (i.e. the same way as it was done at the veterinary clinics), preferably when the cats were sleeping. Owners who had difficulties observing their cats sleeping were allowed to record resting respiratory rates. Owners were asked to avoid collecting data when the cat was obviously purring. Additionally, each owner received a one-page printed letter with instructions about how and when to record and count the respiratory rate of her/his cat, and where to send the video-recording (electronically) and the data. The owners were specifically asked to note whether the measurement was of a sleeping or a resting cat.

This study was purely observational and required no extra handling of the cats than already planned for the original consult, therefore no institutional approval was acquired. All owners signed an informed consent.

Statistical methods

All statistical analyses in this study were performed with commercially available statistical software (SPSS v23.0; IBM Statistics, IBM and MedCalc Statistical Software version 18, MedCalc Software bvba). P values < 0.05 were considered statistically significant.

D'Agostino-Pearson tests were used to investigate whether the data were normally distributed. If the data showed no normal distribution, logarithmic transformation was done, and the same test was run again to evaluate normal distribution of the transformed data. Data are presented as median and range. Comparisons between measurements was performed using a Wilcoxon signed rank test.

Effects of age and gender on the respiratory rate were analyzed with regression analysis (general linear regression) on the log-transformed data. MedCalc statistical software was used to investigate if reference intervals could be modelled for different age groups, based on the method described by Altman (Altman, 1993).

Table 1
Characteristics of the study population.

	Adult cats clinically healthy ($n = 88$)	Adult cats assumed healthy ($n = 18$)	Young cats clinically healthy ($n = 24$)	Young cats assumed healthy ($n = 1$)
Age	Median (range)	Median (range)	Median (range)	
	5.1 (1.0–17.0) years	3.2 (1.1–17.1) years	4.0 (3.0–11.4) months	10.6 months
Sex				
Female neutered	41	10	4	
Male neutered	41	7	2	
Female intact	5		9	
Male intact	1	1	9	1
Breed				
Domestic shorthair	71	12	7	1
British shorthair	2	2	3	
Siamese	2			
Bengal	1		4	
Maine coon	1		1	
Ragdoll		1	1	
Persian shorthair	1			
Norwegian forest	1			
Birman	1			
Oriental shorthair	1		1	
Savannah			1	
Mixed breed	8	3	6	
Reason for consultation				
Vaccination	75		14	
Dental examination		14		1
General health check	4			
Neutering	1		4	
Dental cleaning	3			
Removal of sutures	1		1	
Deworming		1		
Tick removal		1		
Nail clipping			1	
Grooming	1			
Microchip placement		1		
Recheck appointments	3	1	4	