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A narrative review of occupational scheduling that impacts fatigue and recovery relevant to veterinarian well-being

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Abstract

Background

Sleep insufficiency is a worldwide affliction with serious implications for mental and physical health. Occupational factors play a large role in determining sleep habits. Healthcare workers are particularly susceptible to job-mediated sleep insufficiency and inadequate rest in general. Little is published on sleep practices among veterinarians, and overall recognition of the impacts of inadequate rest within the veterinary profession is poor.

Objectives and procedures

This review describes occupational factors affecting sufficiency of rest and recovery, reviews veterinary-specific and relevant adjacent literature pertaining to sleep patterns, and discusses potential solutions for addressing occupational schedules contributing to sleep insufficiency and inadequate rest. Online databases were searched to extract contemporary literature pertaining to sleep, insufficient rest, and occupational factors, with a focus on veterinary medicine and other healthcare sectors.

Results

Occupational factors leading to inadequate rest among healthcare workers include excessive workloads, extended workdays, cumulative days of heavy work hours, and after-hours on-call duty. These factors are prevalent within the veterinary profession and may contribute to widespread insufficient rest and the resulting negative impacts on health and well-being among veterinarians.

Conclusion and clinical relevance

Sufficient sleep quantity and quality are critical to physical and mental health and are negatively affected by many aspects of the veterinary profession. Critical review of current strategies

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employed in clinical practice is essential to promote professional fulfillment, health, and well-being among veterinarians.

Introduction

An increasing body of evidence (1,2), together with much anecdotal data, are raising awareness of and concerns with the rates of chronic occupational stress, burnout, and suicide in the veterinary profession. Therefore, there is an urgent need to identify and develop means to mitigate factors that contribute to workplace stress and barriers to well-being. Occupational factors that lead to insufficient rest in healthcare include extended workdays, cumulative days of extended work hours, night shifts, and after-hours on-call. These factors are commonly exacerbated by insufficient staffing and unreasonable workloads. Sleep-related impairment is an occupational hazard, and the veterinary profession has long been characterized by long and uncertain work hours. Furthermore, those that choose to enter this profession commonly do so for altruistic reasons and with little initial consideration of long-term work sustainability and quality of life (*e.g.*, financial stability, family planning).

Sleep insufficiency (both acute and chronic) encompasses inadequate quantity or quality of sleep and is particularly prevalent among healthcare workers (3). The 2018 National Health Interview Survey of more than 14 000 households administered by the Centers for Disease Control and Prevention and the US Census Bureau documented that 36% (95% CI: 32.9 to 40.0%) of healthcare workers and 45% (95% CI: 39.9 to 51.0%) of healthcare support workers nationwide do not obtain consistently sufficient sleep of 7 to 8 h per night (4). Although many aspects of personal and professional life can affect sleep quantity, quality, or both, occupational and structural factors may not be appropriately considered by healthcare workers and

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administrators who may be blinded by the fatigue paradox, which is the expressed assumption by an individual that they themselves are unaffected by fatigue, despite observations by the same individuals that identify troubling manifestations of workplace fatigue as common (5). In a meta-analysis of 228 studies on occupational impacts to individual health, Goh *et al* reported that various workplace stressors generally increased the odds of poor health outcomes to approximately the same extent that exposure to secondhand smoke affects physical health (physical health OR: 1.47, mental health OR: 1.49), and noted that the health effects of secondhand smoke exposure are widely viewed as sufficiently large to warrant regulatory intervention (6). They reported increased risks of mortality associated with long working hours for men (OR: 1.17, 95% CI: 1.01 to 1.35) and women (OR: 1.41, 95% CI: 0.89 to 2.24) (6).

In this narrative review, we present the existing evidence regarding the impacts of occupational factors on adequate rest, with a targeted review of literature relevant to common veterinary practice logistics. A secondary objective is to suggest considerations for change to mitigate some of the all-too-common occupational pressures for unhealthy lifestyles within the veterinary profession. Insufficient rest also has the effect of reducing team dynamics, work performance, and patient safety in human and veterinary healthcare; however, these topics are covered elsewhere (7). The pathophysiology of sleep deprivation and inadequate rest is reviewed in a companion article (8).

Methods: Search strategy

Studies examining the relationship between occupational factors and sleep insufficiency were obtained using a previously described search strategy (8). Two search procedures were followed: One author (MS) searched the online databases PubMed and Google Scholar using combinations

of the term "veterinarian" with the terms "sleep deprivation," "sleep loss," "sleep insufficiency," "fatigue," "occupational," "work schedule," "duty hours," "on call," and "night shift," to find publications that informed the review goals. Because awareness and investigation of veterinarian well-being topics have grown only recently, we restricted the search to the past 5 years (2017 to 2022) to identify contemporary evidence. There is little existing veterinary-specific knowledge in this area, so we expanded the search to include the terms "physician," "healthcare," and "resident," and incorporated fundamental research and data from other professions that we obtained by manual scoping of cited studies from articles identified in the initial searches. Eligibility criteria included manuscripts examining occupational causes of sleep insufficiency and their impacts on individual health, and peer-reviewed, full-text articles written in the English language. Manuscripts that focused on topics of non-occupational stressors that might impact sleep, work performance, medical errors, general insomnia, non-occupational circadian rhythm disorders, parasomnias, hypersomnias, sleep-related breathing disorders, and sleep-related movement disorders were excluded.

Occupational health impacts to rest and recovery

Circadian misalignment

The number and distribution of work hours in a work week can affect sleep, productivity, and safety by affecting an individual's circadian rhythm (9). Circadian misalignment describes the incongruity between natural sleep-wake cycles and clock-regulated physiology. Sleep insufficiency induces a circadian misalignment that effectively contributes to the development of a variety of serious disease processes, including cardiovascular diseases and those associated with metabolic syndrome, such as obesity and diabetes (10-13). Circadian disruption also impairs

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cognitive performance, including inhibitory control, working memory, task-switching, and psychomotor vigilance (14,15). Wakefulness, poor sleep quality or interrupted sleep, and irregularities in the timing of sleep can all impede circadian adaptation to work-rest schedules and result in a state of insufficient rest, even if an individual has access to sufficient total sleep time (13,14).

Influence of extended duty hours

In general, overtime, extended shifts, or extended work availability all have negative effects on recovery processes and impair functioning, contributing to chronic fatigue and reducing the restorative value of rest periods (16,17). Numerous studies have associated long working hours with sleep deficits, and this appears to be true whether long working hours are spread over the week or performed more acutely as overnight extended duty shifts (14,18,19). Physicians with long (> 48) weekly work hours had higher odds for insufficient sleep than physicians with short (< 40) weekly work hours (OR: 1.78, 95% CI: 1.15 to 2.76) (18).

With chronicity, incomplete recovery from work associated with long working hours impacts all major body systems (8,20-26). A meta-analysis reported a 40% increased risk for coronary artery disease with long work hours (> 10 h/d, or > 40 to > 65 h/wk) (27). Long working hours exhibit a dose-responsive association with prediabetes and diabetes: Compared to working 35 to 40 h/wk, hazard ratios were 1.28 (1.17 to 1.40) for working 41 to 52 h/wk, and 2.80 (2.54 to 3.09) for working > 52 h/wk (24,28). Working long hours has been associated with obesity (29). Psychological distress among physicians (as measured by a General Health Questionnaire score > 8) was associated with both long work hours and engaging in night duty (30). Among physicians, disrupted and insufficient sleep has been associated with high burnout rates (31,32). Risk of depression in physicians was predicted by sleep and work hours, with the

highest rates of depression (32.7%) associated with poor quality, short duration sleep (≤ 6 h nightly; OR: 2.33, 95% CI: 1.52 to 3.57; $P < 0.001$) (33). Sleep insufficiency among physicians suffering from depression also led to a chronic course for depression (OR: 1.55, 95% CI: 1.01 to 2.36; $P = 0.04$), and each hour of lost sleep corresponded to a 55% increase in odds for remaining depressed (33).

Research has demonstrated that a mild sleep reduction of just 30 min/night may result in acute performance decrements, such as a slower reaction time and reduced vigilance over time (34), which has safety impacts. Physicians driving home after working extended duration shifts were more likely to report a motor vehicle crash (OR: 2.3, 95% CI: 1.6 to 3.3) or near-miss incident (OR: 5.9, 95% CI: 5.4 to 6.3) compared with those working standard shifts (35). Safety impacts are seen with longer workdays even without obvious sleep deficiency: Compared with working 8-hour shifts in industrial settings, working a 10-hour shift has a 13% higher risk of incident or injury, and working a 12-hour shift increases this risk by 27% (36). The "dose-response" nature of occupational health impacts has been highlighted in both industrial and healthcare settings, with increased injury rates corresponding to both increased hours per day and total hours per week and on-call status (37,38). Disordered sleep and mood disorders in healthcare workers were independently associated with adverse outcomes relative to post-shift motor vehicle crashes, near-miss crashes, occupational exposures, and medical errors; and when occurring together, they contributed additively to risk (39). A survey by the American Nurses Association determined that 1 in 10 nurses reported a motor vehicle crash that they believed was related to fatigue or shift work (26).C

Influence of on-call

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Nighttime on-call is associated with deteriorations in neuropsychological and cognitive function, mental health, and physical health (40,41). An assessment of physician stress associated with being on call for 24 h demonstrated significant deterioration in all physiological, performance, and mood indicators in comparison with working a normal workday but not being on call (42). Significant reduction in heart rate variability (a useful tool for monitoring the autonomic nervous system) was observed in the on-call group compared to the control group ($F = 28.19$; $P < 0.001$) indicating that the stress was intense enough to inhibit the vagal modulation of the autonomic nervous system (42). Physicians with on-call duties also exhibited elevated biomarkers of systemic inflammation, at a level associated with increased cardiovascular risk and mortality, compared to those without on-call duties (43).

One or more nights on call per week has been associated with lower mood and with anxiety and depression in physicians in a myriad of studies (44-50) and correlated highly with various stress symptoms such as exhaustion, irritation, sleep disturbances, memory disturbances, and headaches (51). Notably, stress symptoms increased with increasing on-call workload and disappeared during vacation (51). This is unsurprising, given that physicians typically receive 2 to 3 phone calls during the night when carrying out at-home on-call work (similar to the rate reported in a recent study of veterinary residents) and even 1 shift/mo of at-home, on-call work was associated with increased risk of sleep difficulties (52-54). Partial sleep deprivation (sleep restriction to < 7 h in a 24-hour period) associated with on-call duties has been demonstrated to affect a variety of aspects of mood in physicians, with reports of increased irritability, sleepiness, and feeling jittery; and decreased energy, confidence, and talkativeness (55). In healthy adults, partial sleep loss from sleep continuity disruption was shown to be more detrimental to positive mood and affect than was partial sleep loss from delayed bedtime, and individuals with sleep

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continuity disruption had significantly less slow-wave sleep after the first night of sleep deprivation (56). High call burden (when called in ≥ 3 times/wk on nights or weekends) predicted physician risks for sleeping at the wheel (OR: 3.36, 95% CI: 1.51 to 7.86; $P = 0.004$) and motor vehicle crashes (OR: 3.07, 95% CI: 1.17 to 8.80; $P = 0.03$), and generally resulted in distress, job dissatisfaction and reduced work ability (44). These findings are not surprising, as being on-call from home demonstrably and adversely affects sleep quantity and, in most cases, sleep quality (51,53,57).

Only 23% of 164 surveyed physicians reported obtaining 6 to 8 h of sleep during on-call nights, compared to 88% when not on call (58). When nightly duration of uninterrupted sleep was specified, only 10% of on-call physicians achieved 6 to 8 h, compared to 80% of those not on call (58). When asked to rate the quality of sleep during a call night, 91% of physicians reported "fair" to "poor" sleep quality, and 75% relayed that they needed a daytime nap due to on-call-related fatigue (58). Sleep is affected by the on-call condition beyond the mere sleep time lost while being out of bed (and in bed while falling asleep again). Those working on call have greater difficulty falling asleep and staying asleep while on call compared to when they are not on call (58). Studies have repeatedly shown that on-call employees experience disrupted and poor-quality rest and sleep regardless of whether or not a call is actually received (42,59,60). Both non-rapid eye movement (NREM) and rapid eye movement (REM) sleep were strongly reduced in physicians on overnight call, and research clearly shows that night on-call duty caused a sizeable overall sleep reduction (57,61). The on-call condition itself appears to involve transient insomnia and indirect effects that lengthen the period of sleep loss in addition to the direct sleep deficit acquired when called to work (61). The disturbed recovery inherent to time

spent on call is demonstrably not equivalent to rest time and is of substantially reduced restorative value (62).

Influence of overnight shift work

It is well-recognized that overnight shift work has a negative impact on well-being, with potential effects on metabolic health, cancer risks, heart health, and mental health (63). The primary mechanism whereby this occurs is circadian misalignment and disruption of the circadian rhythm (63). Overnight shiftwork commonly results in sleep displacement and reduced overall sleep quality. Daytime sleep after night work is commonly 2 to 4 h shorter than night sleep (63-65). With regular (fixed-shift) scheduling, some adjustment to night work at a rate of ~1 h/d can occur (66), although daylight exposure during early morning hours can inhibit full adjustment, commonly maintaining at least partial day orientation and leading to social jet lag (64,67).

Available evidence indicates that prior sleep-wake history, including exposure to acute and chronic sleep restriction and irregular sleep-wake schedules, may greatly affect an individual's resilience in the face of subsequent sleep loss (14). This can be mitigated by circadian adaptation; however, this is a gradual process requiring extended, consistent exposure to the altered work-rest cycle, and there is a high degree of variability in the capacity of night-shift workers to do so (60). Without specific interventions, it is estimated that only ~25% of workers show circadian adaptation to night work (68). Meta-analysis showed that average sleep times varied among permanent day-shift workers (7.0 h/d), permanent and rotating evening-shift workers (7.6 to 8.1 h/d), permanent night-shift workers (6.6 h/d), and rotating night-shift workers (5.9 h/d) (69), although differences in schedule design details will impact these outcomes.

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Sleep and alertness of shift workers can be affected by the design of shift systems, including fixed or rotating schedule design, speed and direction of shift rotation, time of changeovers, and duration of time between changeovers, and studies support optimizing shift schedule design to minimize chronic sleep deficiencies (9,64,70). Short-term compensatory efforts such as caffeine use and napping that are directed at alertness and cognitive parameters may improve functionality and safety over the shift but, without adjustment, likely do not ameliorate chronic metabolic dysregulation and its subsequent impacts (63). From an occupational health perspective, it has been suggested that adapting shift schedules where possible to account for the impact of individual chronotype (the behavioral manifestation of one's underlying circadian rhythm as a propensity to sleep at particular times) on sleep duration and timing may also mediate some of the adverse health effects associated with overnight work (11,71,72). Aligning work hours and chronotype is associated with longer sleep duration across the work schedule (72,73). This is more easily accomplished with fixed shifts, where employees may self-select for different shift types. Regardless of time of day, the duration of breaks between successive work shifts was shown to be important, with quick returns (< 11 h off between shifts) associated with insomnia, excessive sleepiness, and shift work disorder (74,75). Early day shift start times and quick-return evening-to-day shift transitions should be avoided within safety-sensitive environments such as healthcare due to associations with impaired performance (76).

While the current understanding of optimal shift scheduling is not comprehensive and long term-data are lacking, some research indicates that a rapid forward rotation schedule (2 morning shifts, 2 evening shifts, and 2 night shifts, followed by 3 d off**)** may be most conducive to night shift tolerance and minimization of individual health impacts; however, this must be

balanced against operational logistics and worker willingness to participate in rotating shift designs (77-79). This type of schedule may not be viable for workers with young families, for example, due to the challenging impacts on home logistics. General recommendations for rotating shift schedules include using forward rotation (morning-evening-night) and frequency of rotation ≤ 3 d, and allowing ≥ 3 d recovery after the last night shift (70,80,81).

Within healthcare, a variety of shift designs are described (70,82,83). Research supports shift lengths of ≤ 12 h, with shifts of 8 to 10 h recommended (70,80,81). Twelve-hour shifts have been associated with high rates of multiple poor health behaviors: short sleep duration, smoking, obesity, low physical activity, and higher alcohol use (84). Nurses were 3× more likely to make an error when working ≥ 12-hour compared to 8.5-hour shifts (85). Nursing shifts > 13 h were linked to patient dissatisfaction (86). Due to workflow differences, operational considerations for nurses are often different than for physicians (83). A simulated scheduling model suggested that overlapping shift scheduling for emergency physicians with policies that restrict physicians from taking new patients during the end of their shift could provide a variety of benefits, and the authors encouraged institution-specific cost-benefit analyses (87). Benefits included reducing patient handoffs by 41% and reducing patient time in the emergency department by 14% while accommodating a 10 to 15% increase in patient volume (87).

Factors affecting individual vulnerability to sleep loss

Work-related fatigue is an important occupational safety and health problem, and because of this, some of the working population experiences disproportionate risks of injury and illness (88,89). Occupational circadian misalignment affects individuals differently. It has been reported that almost 20% of overnight workers cannot tolerate night work, about 10% enjoy it, and the rest

exhibit variable tolerance (90). Factors associated with better adaptation to night work are being young; being male; having late chronotype, low languidity score (tendency to become tired or sleepy upon losing sleep), and low neuroticism score (tendency to experience the world as stressful); and having high scores on extraversion, internal locus of control (belief that one is in control of one's life and environment), and sleep flexibility (77). Individual chronotype impacts circadian adaptation to night work (77). Individuals with an evening-oriented chronotype exhibit less rigid sleep timing and higher shift work tolerance compared to morning-oriented chronotypes, and late sleepers appear to suffer less from night shifts (77).

Aging has been associated with decreased ability to make circadian adjustments (91). For many, the ability to adapt to shift work is more difficult over the age of 40, as older shift workers experience a reduction in the ability of circadian rhythms to readjust to new schedules (92). During a simulated shift rotation of 2 12-hour day shifts followed by 2 12-hour night shifts, all study participants exhibited performance decrements during the night shifts; however, younger workers (average age 21 y) were better able to maintain performance across day and night shifts while older workers (average age 44 y) were more prone to sleep-disruption impacts (93). Based on these results and the correlation between sleep deprivation effects and alcohol intoxication effects (94), the study authors hypothesized that it may take fewer hours of wakefulness in older subjects to reach a performance decrement equivalent to a blood alcohol concentration of 0.1% (93). As older adults have greater difficulty obtaining daytime recovery sleep, they are commonly more vulnerable to the sleep-loss effects of a sequence of extended duty or night shifts (95-97). However, after a single night of acute sleep deprivation, young adults may show comparatively more pronounced impacts of acute sleep deprivation than adults over 55 y of age (97). In general, younger workers have better shift work tolerance in terms of subjective

sleepiness, performance tests, recovery after work, and sleep time; older workers have a higher need for recovery after work (98,99).

Differences in the impacts of sleep disruption and insufficiency on health between men and women have been documented. Men report better sleep and less fatigue and sleepiness with on-call work than women (98). Women with family and domestic obligations are more vulnerable to poor night shift adaptation, which may be explained by societal gender differences in these roles (100). Female physicians often experience higher levels of work-related stress and lower job control than male physicians, which could impact individual perceptions of on-call effects rather than indicating the existence of a truly sex-linked physiologic difference in sleep needs and non-reproductive impacts (58,101). However, female shift workers have a higher risk of developing metabolic syndrome and diabetes mellitus compared to male shift workers (102-104). A growing body of literature has examined the effects of shift work on reproductive outcomes such as fertility, endometriosis risks, premenstrual impacts, and menstrual function with variable effects; these outcomes are dependent on hormones with cyclic rhythms that can be affected by circadian disruption associated with night work (105-107). Working nights or on call can lead to increased risk for pregnancy complications including miscarriage, preterm labor, and preeclampsia (108,109). Compared with working standard workweeks of < 40 hours, working longer hours was associated with increased odds of miscarriage (OR: 1.38, 95% CI: 1.08 to 1.77), preterm delivery (OR: 1.21, 95% CI: 1.11 to 1.33), and low-birthweight infants (OR: 1.43, 95% CI: 1.11 to 1.84) (110). Women prone to earlier menopause may further truncate their reproductive lifetime by working schedules that combine day and night shifts (111).

Veterinary literature

The veterinary-specific literature on topics related to occupational impacts on fatigue and sleep is very limited, but in general, what reported data do exist are very similar to those reported in physician populations (48,54,112,113). In a single institution in the USA, 66% of exiting veterinary house officers (post-graduate apprentice trainees that may include interns, residents and clinical fellows) reported that they had insufficient time in a typical week to meet their own personal needs, 62% felt neutral or were dissatisfied with their physical well-being, and 57% felt neutral or were dissatisfied with their emotional well-being (114). In 2021, veterinary house officers in corporate and private practice internships and residencies in the USA reported receiving 2 to 3 more d/mo off and 3 to 4 h more sleep in the 48 h before the survey than those in academic institutions (115). Veterinary house officers (comprising 303 individuals from 9 institutions in the USA) responding to an online survey reported less sleep per night when on clinic duty compared to off-clinic assignment, averaging only 6 h of sleep per night when on clinics compared to 7.5 h when off clinics ($P < 0.01$) (54). Working hours were significantly negatively related to sleep quantity (54). Respondents reported going to the clinic an average of 5 d (33%), 6 d (34%), or 7 d (32%) weekly (54). Respondents described spending 8 to 10 h (25%), 11 to 13 h (58%), or ≥ 14 h (15%) in the clinic on an average weekday, and 2 to 5 h (48%), 6 to 8 h (15%), and > 8 h (13%) on an average weekend day (54). Forty-five percent of respondents reported being on call for 8 to 14 d/mo, with on-call blocks of ≤ 2 consecutive d (24%), 3 to 4 consecutive d (21%), and 7 consecutive d (49%) (54). Perceived sleep quality was much poorer when on call than when not on call (OR: 36.20, 95% CI: 13.08 to 100.16; $P < 0.001$) (54). Forty percent of respondents reported that fatigue interfered "extremely" or "quite a bit" with their ability to empathize (54).

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In an online survey of general practice veterinarians, offsite on-call shifts were reported to have a negative impact on veterinarian job satisfaction, well-being, and personal relationships (112). Sixty-six percent of responding veterinarians identified on-call duties as being a minor (11.5%), moderate (21.9%), or important (33.2%) factor in the decision to leave a prior job (112). Seventy-eight percent of these responders indicated that lack of on-call duties had influenced their acceptance of a job previously, and 94% indicated that on-call duty requirements would have a role in their acceptance of a future job (112). Female associate veterinarians were also more likely to agree with the statement "I have thought about leaving my current job due to my on-call responsibilities" and with the statement "I would take a job for less money if it did not include on-call duties" (112).

Suggested solutions

Suggested occupational solutions for the serious and complex problems of inadequate rest and circadian misalignment caused by the healthcare workplace vary. At an individual level, early and structured professional education on the impacts of sleep deprivation and sleep disorders on performance and health and safety is imperative. This education should include information regarding i) the tendency to underestimate sleep needs, ii) established guidelines for sleep targets, and iii) optimizing sleep hygiene (8). Veterinarians need to be aware of the serious impacts of both acute and chronic sleep insufficiency on their psychological and physical health and cognitive function. At an organizational level, re-evaluation of systems to ensure that they are not limiting clinician sleep is crucial. Suggestions for healthcare organizations to reduce occupational risks from fatigue from the 2011 US Joint Commission on Sleep Health (Centers for Disease Control and National Institute for Occupational Safety and Health) included the

following: examine and improve work schedules, staffing, and hand-off process, and consider fatigue in all adverse events; involve staff in the design of their schedules; create and implement a fatigue management plan; educate staff about sleep and fatigue; support staff who work long shifts; and for organizations who allow sleep breaks during the work shift, provide a good sleep environment and adequate release from work responsibilities (26). Most studies among physicians and veterinarians support reducing clinician work hours overall, inclusive of trainees and experienced clinicians (116-119).

On-call schedules and prolonged or extended work hours are common in veterinary medicine. Having employees on call is perceived to be less expensive than providing off-peak shift coverage, but while this type of scheduling may be cost saving for the business, it has human costs (46). Reassessment of systems of at-home on-call is overdue and must recognize that this duty should be categorized as work time. Research clearly supports that non-work hours during which employees are required to remain available for work cannot be considered leisure time (62). Similar trends are seen in both human and veterinary medicine, with falling proportions of veterinarians and physicians that are willing to take on-call duty as part of employment (112,113). Healthcare workers who work extended overnight shifts or have on-call duty following a regular workday cannot compensate by sleeping either in advance or after the night duty (14). At a minimum, planning for catch-up sleep before or after the on-call shift is imperative, although it should be noted that true short-term "recovery" from acute sleep deprivation is unlikely to be feasible even with provisions for recovery sleep (8). To improve clinicians' working conditions and stress levels and to ensure stable cognition, logistics should provide an opportunity to compensate for the sleep loss of an overnight on-call shift with the

post-call day off, as the standard work-hour regulations for physicians currently dictate in Europe (19).

Unlike individuals working extended shifts or on call, it is common for overnight shift workers to preface a night shift with a nap, allowing those individuals to better compensate with early sleep loading (64). While shift work is not physiologically benign (63), circadian adaptation to a night-oriented schedule can occur, suggesting that appropriately scheduled overnight shift work is physiologically preferable to on-call duties. Superficially minor details can profoundly influence adaptation to shift work, and sleep needs and responses to deficits are individualized. Not all clinicians may be physiologically capable of circadian adaptation or disposed to effective night work, and hiring practices that are aimed at overnight staffing should be targeted rather than generalized (8,68). Several studies have suggested that allowing personal choice regarding shift preference and allowing healthcare workers to plan their own work schedules may decrease fatigue-related stress (120,121). However, it should be noted that even those individuals who do not show notable performance deficits under conditions of sleep insufficiency are still at risk for other physiologic and mental health ramifications of chronically insufficient sleep, so actions to minimize accumulating sleep debt are important for all.

Work-hour limitation policies do not exist in veterinary medicine. In extrapolating from human literature, it should be noted that the evidence upon which physician house officer work-hour policy limits were developed was largely derived from laboratory studies of healthy subjects who passed physical examinations and volunteered to participate in relatively brief sleep restriction or deprivation (7,122,123). If one considers the era in which resident physician duty-hour policies were initially constructed, there are also likely some intrinsic assumptions about a "typical" resident physician (young, healthy, male, single or with a wife managing the household

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needs) that have been implicitly absorbed into ongoing healthcare culture regarding work hours and sleep expectations (7,124). General application of current resident physician work-hour expectations by employers would implicitly assume that the clinician population is entirely healthy and highly resistant to the effects of sleep deprivation themselves. However, a number of medical conditions common in the general population, including, but not limited to, sleep-related breathing disorders, insomnia, burnout, and mood disorders, are associated with varying sleep needs and tendencies among individuals. One example, obstructive sleep apnea, is estimated to affect a large portion of the general population, impacting means of 22% (range: 9 to 37%) of men and 17% (range: 4 to 50%) of women (125). Insufficient rest may negatively impact symptom management and disease progression of chronic disease in individuals, and medical conditions such as heart disease, high blood pressure, gastrointestinal disorders, sleep disorders, insulin-dependent diabetes, seizure disorders, asthma requiring medication, psychiatric diseases, and alcohol or drug abuse may worsen over time with overnight work (26). As there is no reason to expect that veterinarians as a subpopulation would differ substantially in rates of common medical conditions, it is likely that a significant fraction is at risk for impacts to baseline sleep needs, leaving reduced capability for any additional physiologic compensation required by occupational impacts to sleep. Policies also usually ignore the impacts of concurrent family responsibilities, such as child or elder care, that may also affect sleep quality or quantity and recovery from occupational sleep insufficiency. These oversights have the potential to inadvertently render some clinicians disproportionately vulnerable to sleep loss and its effects. Occupational schedules should permit reasonable and rational sleep management for all clinicians.

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Among physicians, generational differences in attitudes toward work have also been described, with younger workers placing a higher value on family, career flexibility, and work-life balance than their predecessors (126) that likely conflicts with willingness to participate in extended hours or on-call work. However, observed trends in minimizing work-life conflict are not wholly limited to the younger generation, reflecting concerns about personal health with aging, changing family needs, burnout, or other changes in personal expectations as physicians mature and age (126). These types of observed trends are likely to be similar in veterinary medicine. In order to ensure inpatient and emergency coverage during after-hours periods, creative incentivization in the forms of additional job perks and hazard pay rates might be considered. Such incentives might encourage those who are better able to tolerate night work to voluntarily accept these jobs at times in their lives that make reasonable sense for them, reducing the need to conscript clinicians who lack the physiologic tolerance or flexibility in personal responsibilities for after-hours work.

If practice logistics cannot be designed to permit appropriate clinician rest due to financial or scheduling constraints, one must consider whether the traditional veterinary practice business model that emphasizes breadth ("every practice offers/does all things") may no longer serve the profession well, and whether alternative options, organizational structures, and collaborative relationships should be explored. Changing the business model of veterinary practice to reduce occupational health impacts to individuals is necessary. However, it will require not only reconceiving roles and logistics at an individual and practice level, but also different approaches to managing public expectations and wider societal needs. For the latter, regional professional collaboration among veterinarians and targeted public education will likely be key (7,127).

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Conclusions

Veterinary profession-specific data on occupational impacts to rest and recovery processes are limited. However, what data exist demonstrate similar trends to those reported in other occupations, particularly human healthcare, and justify the idea that intervention to mitigate sleep-related impairment in veterinarians is important and warranted. Among factors affecting human health, sleep deprivation is among the most modifiable, and individuals experiencing chronic sleep losses should actively revise work and personal practices to improve sleep, including undergoing evaluation for relevant medical conditions where appropriate. In the workplace, in addition to re-evaluation of current practices for overnight duty scheduling, other cultural and logistical institutional issues that contribute to chronic sleep disruption or inadequate rest should be evaluated and addressed. Within veterinary academia, improved education on the contribution of sleep to health should be a prioritized part of veterinary and post-graduate training.

> *"The worst part of residency, he shared, is the round-the-clock non-urgent patient updates, nonclinical requests, and digital notifications…Every resident knows what it is like to be startled awake in the middle of the night by seemingly pointless notifications, a slightly higher than normal blood pressure reading, or a request to renew a routine order that has been in place for days…My friend explains, "Someone on the outside might think it's annoying and not a big deal, but multiply over years and countless hours of lost sleep…it's like psychological torture"* (128).

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