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Review Article

Particulate Matter in Equestrian Stables and Riding Arenas

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ABSTRACT

Equine respiratory disorders in horses have shown a marked increase in incidence and severity during the last years. This is mainly because of the widespread practice of keeping horses in individual stalls in enclosed stables and riding them in enclosed riding arenas, leading to continuous exposure to high concentrations of airborne particulate matter (APM). Correct management and treatment of horses suffering from airway diseases are of vital importance. However, the prevention of airway diseases is also becoming increasingly important. Apart from the living environment (pasture, open stables, stalls with close-by paddocks, and stalls with exterior and interior windows), special attention has to be given to the quality of forage, concentrated feed, and bedding materials as well as maintenance of the surfaces in riding arenas to protect horses from high concentrations of APM. Since most horses are kept in stables, it is of cardinal importance to ensure that activities causing high levels of APM such as mucking out, cleaning the stable corridors, etc. are only carried out when the horses are not present in the stables. Because of the significantly lower sedimentation rate of fine particles (which are a major factor fostering the occurrence of airway diseases), they can still be found in high concentrations in the stalls hours after these activities. To reduce APM in stables, it is possible to use bedding material and forage with low contents of particulate matter such as straw pellets, wood shavings, haylage, and silage. These are (without requiring prior treatment) especially suitable for horses suffering from chronic and allergic equine respiratory disorders. Alternatively, specific treatments may be applied. Beside the use of fluid additives to concentrated feeds, it is possible to treat forage by steaming or soaking. The concentration of APM in the air of a riding arena is mainly dependent on the location (free standing or attached to the stables), the type of footing material, the humidity of the footing material, and the number of horses being trained at the same time. Because the riding arena is an important location for equestrian sports, its relevance for respiratory health of horses is very high.

1. Introduction

A large number of horses are afflicted by airway diseases. Most common are inflammatory airway disease (IAD) and recurrent airway obstruction (RAO), which are usually subsumed under the term “equine asthma,” because of the similarity of some of their symptoms of asthma in humans [1].

Inflammatory airway disease (mild-to-moderate equine asthma) occurs in horses of every age, but is predominantly found in young or middle aged animals, whereas RAO is a severe form of the ailment mainly found in horses of 7 or more years of age [1].

Symptoms such as occasional coughing, no increased respiratory effort while the horse is at rest, and an observable decrease in performance [1], as well as mucus and a neutrophilic inflammatory response in the distal

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airways [2] are characteristics for IAD. Typical symptoms of RAO, on the other hand, are regular to frequent coughing, heavy breathing while the horse is at rest, and a general intolerance to exertion [1]. The observed symptoms and their severity typically vary significantly in RAO [1].

Recurrent airway obstruction differs from IAD insofar as it is a chronic disease. The symptoms can be mitigated, but a complete cure is not possible.

The etiology of IAD is probably multifactorial. Not only exposure to stable environments [1,3], but also bacteria [2,4] and viruses [4,5] have been discussed as possible causes of IAD.

Exposure to dust and allergens in stalls and on pastures have been held responsible for RAO, but a genetic predisposition has also been seen as a potential cause [1].

The composition of ambient air, especially of the air in the stables, is an important factor in minimizing the pathogenic effects of the environment in horse husbandry.

In contrast to outside air composition, horse stable air contains considerable amounts of inorganic (dust) and organic particles (bacterial endotoxins, >50 species of molds, plant debris, and large numbers of forage mites) of various origins [3,6]. These stable airborne particles are potential airway allergens and irritants [6]. Depending on the concentration and the biological, chemical, and physical properties of the respirable airborne particulate matter (APM) [7], it shows different potential degrees of harmfulness for human and equine health.

Equine respiratory disorders are responsible for high economic losses due to performance issues, veterinary and management costs, and restrictions in use [8].

Although IAD can usually be cured by veterinarian medical care and management of the environment quality [1], the method of choice in case of horses chronically afflicted by respiratory health problems is low-dust management [9]. Because of the increasing incidence of horses with chronic equine respiratory disorders, a large number of studies focusing on the quality of stable air have been published in the last years.

Factors influencing the release of APM as well as its reduction that have been investigated include stable management, materials used for bedding (e.g., paper, wheat straw, straw pellets, wood shavings), feed (e.g., hay, haylage, oats, commercially formulated ready-prepared mix, pellets), and riding surfaces.

1.1. Definition of APM and Its Characteristics

In the vernacular, the expression “dust” is used for every kind of APM [10]. However, scientific literature distinguishes between different types of APM and uses the following categories according to source and properties: aerosols, bioaerosols, and dusts.

Bioaerosols are defined as complex APM of biological (microbial, plant, or animal) origin; they are also often referred to as organic dusts [10,11].

Furthermore, bioaerosols are characterized by their composition (an agglomeration of animate and inanimate components), biological activity, and the potential for causing health issues (allergies, toxicity, infections, or pharmacological effects on the organism) [10].

Animate components of bioaerosols are microorganisms such as bacteria, fungi, viruses, mites, the inanimate components are the so-called dusts [10], which are defined as solid matter dispersed in gases [12].

Airborne particulate matter can be classified according to different criteria. Beside a classification according to the size of the APM [13], a classification can be made on the basis of its microscopic anatomy (i.e., form, size, surface character) [10] or its respiratory penetration ability in human and animal lungs [14]. With regard to health of horses and humans, the latter classification of APM is the most relevant one. In this context, the Comité Européen de Normalisation (CEN) norm 481 [14] classifies APM into the following four fractions: inhalable fraction (aerodynamic diameter size [ADS] < 100 μm; particulate matter [PM] 100), thoracic fraction (ADS < 10 μm, PM 10), tracheobronchial fraction (ADS: 4–10 μm, PM 4–10), and alveolar permeable fraction (ADS < 4 μm, PM 4). In addition, particles ≤0.1 μm (PM 0.1) are often classified as ultrafine particles [6].

According to Mehlhorn [13], APM has a potentially harmful effect on the sensitive airways of animals and humans.

The significance of APM for animal and human health depends on the amount inhaled (mass of dust or number of airborne particles per unit volume of air), the proportion of nonrespirable and respirable fractions, and the composition (microorganisms, endotoxins, aeroallergens, and proteinases) [15].

Airborne particulate matter penetrates the airways of horses and humans to different depths according to its size (aerodynamic diameter), nature (hydrophobic or hydrophilic), and form (elongated, spiral, cubic, etc.) [15].

Inertial impaction in the upper airways (nasal turbinates, pharynx, and bifurcation of the large airways) prevents APM of larger size (≥PM 5) from entering the lower airways. However, smaller APM (≥PM 0.5 to ≤PM 5) is mainly held back by gravitational sedimentation in the lower airways (terminal and respiratory bronchioles). If the APM is <PM 0.1, it diffuses into the small airways and alveoli [15].

Airborne particulate matter concentration (PM 10 and PM 2.5) in the breathing zone of horses in different stalls and stables are significantly associated with the presence of mucus accumulations of tracheal mucus as well as the occurrence of large numbers of inflammatory cells (20% or more neutrophils) [16]. A comparison of the PM 10 concentration in the breathing zone of healthy horses and ones with airway diseases from the same stable shows that animals with larger amounts of mucus in the trachea are exposed to significantly higher PM 10 concentrations at busy times during the day as well as at night [17].

Measurements of APM can be divided into two categories. Pilot-plant testing measures the generation of APM by materials such as litter or roughage, whereas measurements in stables and/or stalls examine the dispersion of APM in the ambient air of the stalls under practical conditions. In the following, we will, therefore, differentiate between the generation of APM and the effects of APM dispersed in the air.