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Significance of respiratory diseases in the health management of sheep

D. Lacasta[a*], J.M. González[ac], T. Navarro[a], F. Saura[a], C. Acín[a], N.G.C. Vasileiou[b]

[a] *Animal Pathology Department. Instituto Agroalimentario de Aragón-IA2 (Universidad de Zaragoza-CITA). Veterinary Faculty of Zaragoza. C/Miguel Servet 177. 50013 Zaragoza. Spain.*

[b] *Veterinary Faculty, University of Thessaly, 43100 Karditsa. Greece.*

[c] *Gabinete Técnico Veterinario S.L. C/ Isla Conejera sn. 50013 Zaragoza. Spain.*

* Corresponding author; e-mail: dlacasta@unizar.es

HIGHLIGHTS

- Respiratory diseases of sheep produce a relevant economic impact in ovine industry.
- In lambs, the principal adverse effects are related to mortality and poor quality of lambs produced.
- In adults, financial losses are related to reduced production of affected sheep, need for early culling and death.
- These are multi-faceted diseases and prevention is based on management practices.
- Appropriate health measures that improve animal immune response also will help control of the diseases.

ABSTRACT

Objectives of the present article are to review the financial significance of respiratory diseases and to indicate their relevance within the health management of sheep. In lambs, the principal adverse effects of the diseases are related to mortality, reduced carcass quality, veterinary expenses, decrease of average daily bodyweight gain and poor quality of lambs produced. In adult animals, financial losses are related to reduced production of affected sheep, need for early culling and death. Given the multi-faceted nature of these diseases, management practices (e.g., housing improvements, implementation of biosecurity provisions) need to be considered for their prevention; as environmental conditions also play a role in development of these diseases, they should be taken

into account. Appropriate health measures (e.g., vaccinations) that improve animal immune response also will help control of the diseases.

Keywords: bacterial pneumonia, carcass, condemnation, growth rate, ovine respiratory complex, *Small Ruminant Lentivirus*, Maedi-Visna, vaccination

1. Introduction

Respiratory diseases have been reported as important disorders in most livestock species around the world. These diseases also contribute to significant financial losses in sheep flocks. The financial significance of respiratory disorders in the sheep industry is varying and includes a wide array of adverse effects. Hence, there is a clear relevance for health management against respiratory diseases in sheep. Objectives of the present article are to review the financial significance of respiratory diseases and to indicate their relevance for and within the health management of sheep.

2. Financial significance of respiratory diseases

2.1. Significance in lambs

In sheep, bacterial pneumonia and the associated economic losses have been mostly studied in meat production systems, primarily in lambs. Several studies have been performed in order to quantify financial losses related to respiratory disorders.

A study performed in New Zealand by Goodwin-Ray et al. (2008) has estimated the annual cost of bacterial pneumonia in lambs to the industry to be 1.36 NZD per lamb. However, this may be a conservative estimate, as the study did not include costs associated with mortalities related to pneumonia in the farms. In Spain, González (2000) separated direct losses, associated with mortality and carcass condemnations, and indirect losses, related to treatments, decrease of average daily growth and poor quality of lambs produced. He concluded that final cost of pneumonia in Rasa Aragonesa lambs was 7% of their value. This was close to findings previously published by Luzón (1999), who mentioned that losses could sum up to 6.5% of lamb value.

In lambs, several authors have demonstrated that frequency of mortality caused by ovine respiratory complex increased with age (Lacasta et al., 2008; Mearns, 2009a; b) and have indicated

that this disorder was the main cause of death in feedlots farms. In a survey carried out in Spain by González (2015) in 5,394 feedlot lambs examined post-mortem, the author concluded that 78.5% of the lambs had died as the result of respiratory problems. The disorder was the main cause of death regardless of geographical area, bodyweight, animal breed or season of the year (González, 2015).

Respiratory diseases also lead in a large number of condemnations in abattoirs. McRae et al. (2016) performed a 6-year long survey in the frequency of lung lesions and pleurisy in 11,471 lambs at abattoirs and has reported an overall incidence of 28%. In a previous year-long study, Godwin et al. (2004) had reported a respective figure of 22%. In several studies performed in Spain, high frequency of lung lesions in slaughtered lambs has been shown. Luzón (1999) has found that 30% out 1,285 examined lambs had lung lesions and González (2015) has concluded that, even among lambs with no clinical evidence of respiratory signs, proportion of lungs condemned was 34%. Besides, lambs with clinical respiratory signs had a 3.1 times greater risk for condemnation of affected lungs than lambs with no clinical signs (González, 2015). Further, appearance of lung lesions varied according to climatic and micro-environment changes (Lacasta et al., 2008) and differed among regions (McRae et al., 2016). Moreover, McRae et al. (2016) have suggested that lambs with increased growth rate were more susceptible to pneumonia. These authors also have indicated a possibility for genetic background in respiratory diseases in New Zealand sheep breeds (McRae et al., 2016), a hypothesis that was originally suggested by Gama et al. (1991).

In this sense, Goodwin et al. (2004) investigated association between severity of pneumonia and growth during the month prior to slaughter. They have found that, when over 20% of lung surface area had been affected by pneumonia, lamb bodyweight gain decreased from 136 to 65 g daily. In this sense, Alley (1987) have found a significant linear relationship between liveweight gain and the extent of the pneumonic lesions in experimentally infected lambs, which indicated that a reduction of nearly 1 kg/month could be expected for every 10% of the lung surface area affected. The same correlation was noted by Jones et al. in 1982. In Spain, several surveys conducted in feedlots showed that lung lesions had also consequences in growth, feed conversion ratio and carcass quality (González et al., 2016) and specified an average loss of 36 g daily in affected Rasa Aragonesa lambs. This can result in up to 10% delay in time for lambs to reaching proper slaughter bodyweight. To note that, although there are many contributing factors to the differences observed between studies, including differences in production systems, bodyweight and age of lambs at slaughter, and environmental conditions, all studies confirmed the adverse effects of respiratory diseases in production characteristics of lambs.

Decreased growth leads to an increase in time needed for lambs to reach appropriate bodyweight for slaughter. Green et al. (1995), in an investigation performed in English lambs weaned at the age of 45 days and thereafter fattened intensively to a bodyweight of 33 kg (to be reached at an approximate age of 14 weeks), found differences of up to 14 days longer needed for lambs to reach bodyweight for slaughter (14% longer) in animals with lung lesions and up to 33 days (34% longer) in animals with pleural adhesions. Jones et al. (1982) found that experimentally infected pneumonic

lambs required 25% more feed and 9 weeks longer than the controls to reach similar live (42kg) and carcase weights. In abattoir studies, González et al. (2001) reported differences of up to 7 days in lambs with average age 73 days at slaughter, with increases of up to 10% longer time for animals with lung lesions compared to animals with no lesions. The extended days to slaughter increase amount of required investment, as duration of fattening is prolonged, which leads in delayed returns; higher cost of labour and increased risk of death from other causes occur additionally (González, 2015). Further, respiratory diseases in lambs can lead to reduced quality of final product, due to reduction in fatness that hinders sales and results in smaller price of carcasses (González, 2015).

Within the context of controlling antibiotic resistance, it is also important to highlight problems associated with antibiotic treatments for respiratory diseases. It is well established that the main use of antibiotics in lambs is related to ovine respiratory complex (Gay et al., 2012; González, 2015). Nevertheless, although use of antibiotics may be useful in an outbreak (Scott, 2011) or as a metaphylactic treatment (Mavrogianni and Fthenakis, 2005), in only 25% of affected lambs, lung lesions would be fully restored before slaughter (Luzán, 1999). This findings is in sharp contrast with results of controlled efficacy trials of various antimicrobials, in which even up to 100% restoration of lung lesions has been reported (Politis et al., 2018) and indicates that possibly fully effective treatments are not always performed during field studies. In the United States, in a survey carried out in calves, it has been found that 72% of *Mannheimia haemolytica* and 50% of *Pasteurella multocida* isolates were resistant to more than one antibiotic (Klima et al., 2014). Further, in France, in a survey that compared susceptibilities of recently recovered *Mycoplasma bovis* isolates to those of isolates recovered 30 years ago, found that the former isolates showed resistance against eight more families of antimicrobial agents (Gautier-Bouchardon et al., 2014).

In general, economic losses associated with respiratory diseases have an added inconvenience, which relates to the difficulty in farmers detecting the problems and veterinarians reaching an aetiological diagnosis (Scott, 2011). Acute processes are more easily diagnosed, but hyperacute or chronic processes usually remain underdiagnosed. This fact becomes clear when ones takes into account that frequency of calls for veterinary assistance for cases of gastrointestinal disorders is double than that for cases of respiratory disorders (González, 2015).

2.2. Significance in adult animals

The economic impact that respiratory diseases have in adult sheep has been studied in detail only for *Small Ruminant Lentivirus* respiratory infections. In this disorder, indirect economic impact in flock productivity has been addressed in studies, in which seropositive ewes had been found with smaller conception rates than seronegative animals within the same flocks (Dohoo et al., 1987), or in which weaning weights of lambs of seropositive ewes were smaller than those of lambs of seronegative ones (Pekelder et al., 1994; Keen et al., 1996; Arsenault et al., 2003). The disease also

has a well-documented adverse effect in milk production (Snowder et al., 1990; Ploumi et al., 2001; Gelasakis et al., 2015). A survey performed in the United Kingdom has estimated that losses associated with *Small Ruminant Lentivirus* infections could be as high as 40% (Ritchie and Hosie, 2010). Further, in a study performed in intensively-managed dairy flocks in Spain, it has been concluded that moderate to severe pathological findings associated with the disease were present in 52% or 80% of animals that died or were culled, and which had affected the lungs, the brain and/or the mammary glands, thus highlighting this disease as a major cause of animal loss (Benavides et al., 2013).

In a survey performed in the largest dairy sheep farm in Spain, with over 13,000 Lacaune sheep managed under an intensive system, all animals that died over a period of 2.5 months were examined in detail. In total, 175 post-mortem examinations were performed in adult animals, which revealed that the ovine respiratory complex was the second most frequent reason of death (23% of all cases), following reproductive problems (27%) and preceding pregnancy toxaemia (20%). *Small Ruminant Lentivirus* infections and ovine pulmonary adenocarcinoma were responsible for 4.5% of cases, thus contributing to respiratory diseases collectively being the most frequent reason of death of adult animals (27.5% of all deaths) (Navarro et al., 2016). To a large extent, similar findings have also been reported in dairy sheep in Argentina (Suarez and Busetti, 2009).

Further, in a study carried out in a large meat-production flock managed under a semi-extensive system in Spain, average mortality rate in adult animals was found to be 8%, with the main reason for death over a four-year period being the ovine respiratory complex, accounting for 50%, 68% and 88% of deaths in ewes, rams and replacement animals, respectively (own data).

Finally, in a survey of 195 culled sheep, for which detailed clinical and post-mortem findings have been available, in 118 (60%) animals lung lesions were detected. Suppurative pneumonia lesions were evident in 32 animals and lesions associated with *Small Ruminant Lentivirus* infections (interstitial pneumonia) were detected in 29 animals (Fig. 1) (Saura Armelles, 2017). Suppurative or fibrinous lesions, both associated with ovine respiratory complex, accounted for 27.5% of total lung lesions found in the animals, findings similar to those previously reported by Lacasta et al. (2016). Of the animals with lesions associated with *Small Ruminant Lentivirus* infections, 62% had also lesions associated with lung disorders of other aetiology (Saura Armelles, 2017); this confirms the importance of co-infections in the respiratory system, especially as it has been repeatedly reported that *Small Ruminant Lentivirus* infections can predispose to infections by other organisms (Minguijón et al., 2015). Lung histopathological examination performed in 42 animals revealed that out of 34 animals with lesions, 17 (50%) had more than one type of lesions, more commonly combination of suppurative and interstitial bronchopneumonia (Table 1) (Saura Armelles, 2017), findings which coincided with those of post-mortem examination. Overall, during the study, sensitivity and specificity of macroscopic findings for diagnosis of respiratory diseases were 88% and 75%, respectively, although differences were seen among specific diseases, ovine pulmonary adenocarcinoma having a complete

concordance (*k* coefficient = 1) and interstitial pneumonia having the smallest concordance (*k* coefficient = 0.36). A variety of bacteria (*Bibersteinia trehalosi*, *Escherichia coli*, *Mannheimia haemolytica*, *Mycoplasma ovipneumoniae*, *Pasteurella multocida*, *Trueperella pyogenes*) was recovered from relevant samples (Figs 2 and 3) (Saura Armelles, 2017).

3. Relevance of respiratory diseases in the health management of sheep

Due to their anatomical conformation, sheep are sensitive to respiratory processes. In addition, there are several different diseases that can affect the respiratory system, especially in adult animals, causing significant economic losses. Financial losses caused by the diseases are related to mortality, as well as associated with production losses. Therefore, for all these reasons, it is essential to adopt necessary health management measures to prevent development of these diseases as possible. Although many of these pathologies have particular and disease-specific control and prevention measures, there are also general procedures applicable to all of them. Given the multi-faceted nature of these diseases, management practices (e.g., housing improvements, biosecurity provisions) applied in flocks need to take into account the prevention of respiratory diseases. As part of the various practices and schemes, the significance of climatic and micro-environmental conditions should be taken into account, as these influence strongly development of respiratory diseases. Potentially also, the genetic background of animals should be considered, given that some references have indicated its importance as risk factor for the disorder.

Appropriate health measures (e.g., vaccinations) that improve animal immune response will help control of respiratory diseases. When implementing therapeutic or vaccination programs, the control of respiratory diseases should be taken into account and appropriate schemes and schedules should be established. That way, these practices can improve animal welfare standards in farms with respiratory problems.

Conflict of interest statement

The authors have nothing to disclose.

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Figure Legends

Figure 1. Number of animals, in which various types of lung lesions were found, during post-mortem examination in culled sheep in Spain (Saura Armelles, 2017).

Notes. OPA: ovine pulmonary adenocarcinoma. In some animals, presence of more than one type of lesions was evident.

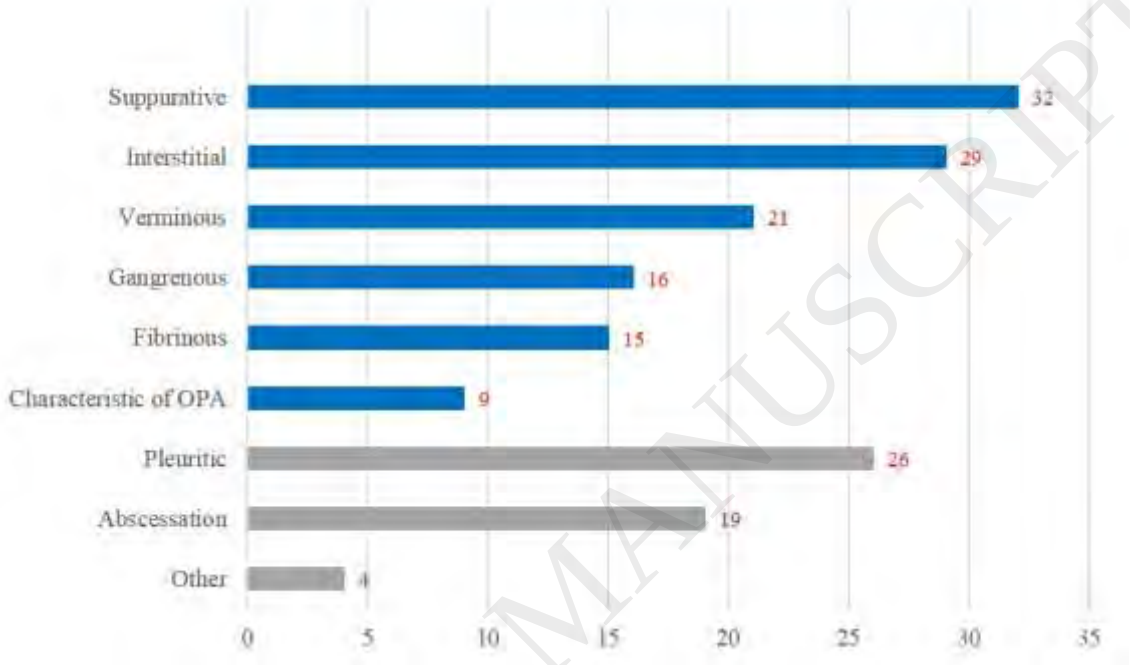

Figure 2. Proportion of bacteria isolated from samples from lungs with lesions, collected during post-mortem examination in culled sheep in Spain (Saura Armelles, 2017).

Note. Isolation of more than one organism from samples from the same animal has been recorded.

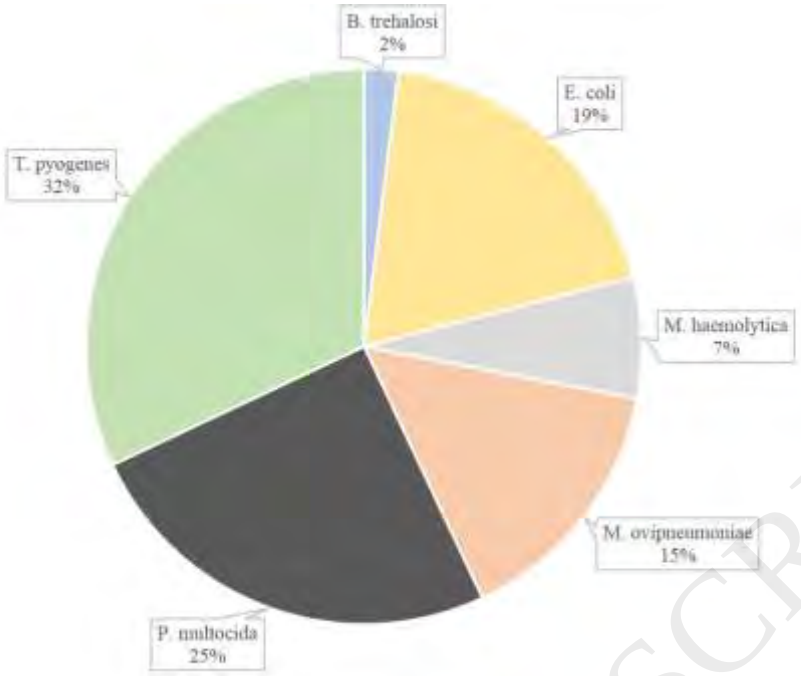

Figure 3. Numbers of bacterial isolates from samples from lungs with lesions, collected during post-mortem examination in culled sheep in Spain, according to type of main lesions evident in lungs (Saura Armelles, 2017).

Note. Isolation of more than one organism from samples from the same animal has been recorded.

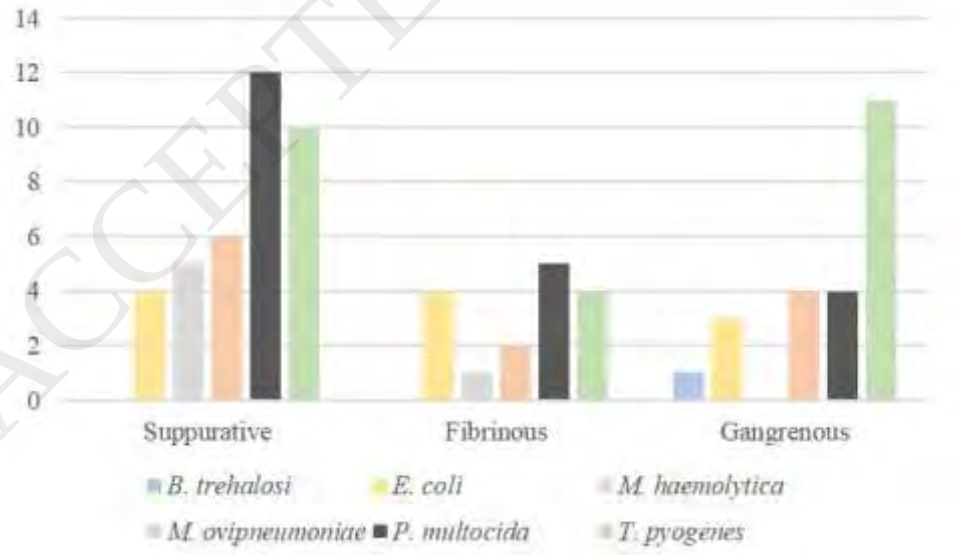

Table 1. Number of sheep detected concurrently with lesions additionally to interstitial pneumonia during post-mortem examination in culled sheep in Spain (Saura Armelles, 2017).

Type of lesions present additional to interstitial pneumonia	Number of sheep
Suppurative pneumonia	7
Pleurisy	2
Ovine pulmonary adenocarcinoma	1
Abscessation	1
Suppurative pneumonia and Gangrenous pneumonia	1
Suppurative pneumonia and Ovine pulmonary adenocarcinoma	1
Suppurative pneumonia and Pleurisy	1
Suppurative pneumonia and Abscessation	1
Gangrenous pneumonia and Pleurisy	1
Acute congestion and Oedema	1