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Sickness behaviour and its relevance to animal welfare assessment at the group level

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Abstract

The inflammatory response evokes changes in behaviour including increased thermoregulatory activities and sleep, reduced social exploration and appetite, and altered food preferences. This sickness response also includes feelings of lethargy, depression, and pain, collectively referred to as 'malaise'. Recent experiments involving laboratory rodents reveal information about proximate mechanisms of sickness behaviour, but scant information exists about how sickness behaviour is expressed by farmed species or within social environments. The behavioural needs of ill individuals differ from those of conspecifics, and failure to accommodate the needs of ill individuals may exacerbate suffering. Policy makers, industry and animal welfare certification programs recommend hospital pens to address the housing and handling needs of ill livestock and to reduce risks of disease transmission. However, a survey of swine farms in Ontario, Canada revealed deficiencies in the use of hospital pens and gaps in knowledge about best management practices for this vulnerable population. There is considerable scope to improve the welfare and husbandry of ill and at risk animals through effective use of hospital pens and supportive therapies.

Keywords: *animal welfare, health management, hospital pens, motivation, pain, sickness behaviour*

Introduction

During the 2003 UFAW International Symposium on *Science in the Service of Animal Welfare*, Dr Marion Dawkins suggested that, in spite of the variety of animal welfare measures available, there are only two basic questions that one needs to answer: "Are the animals healthy?" and "Do the animals have what they want?" (Dawkins 2004). There is general agreement that poor health significantly impairs animal welfare (Algers 2004), and research that identifies risk factors and therapeutic interventions are clearly important for prevention and treatment of disease and injury. However, there has been little scientific attention directed at understanding what animals want and need during states of acute illness and convalescence. The feeling of being sick (ie malaise) includes negative affective states of pain, depression, lethargy and anhedonia. At the group level, ill and injured individuals represent a vulnerable population with unique needs and preferences. Housing and management of livestock are designed for healthy animal populations, whereas suffering of compromised individuals may be exacerbated by the inadequacies of the standard commercial environments where behavioural responses may be thwarted and where bullying may occur. Furthermore, management of ill and injured animals on commercial farms has implications for public health, potentially affecting prevalence of zoonotic pathogens and development of antimicrobial resistance. In this paper, opportunities to improve the care of ill farmed animals will be discussed, drawing from emerging knowledge about behaviour as a component of the immune system.

Sickness behaviour

During acute stages of illness, animals alter their behaviour such that activity, social interaction, feeding and drinking are reduced, whereas huddling, shivering and resting increase. In a pivotal review, Hart (1988) pointed out that these changes in behaviour occur across a wide range of mammalian and non-mammalian species in response to a wide range of bacterial, viral and parasitic infections. Since evolution favours diversity, preservation of such a consistent response is unusual and suggestive of strong underlying biological advantage. Hart postulated that this "sickness behaviour" is a component of a highly organised evolved strategy to combat infection, involving behavioural, immune and endocrine systems. Subsequent research in the interdisciplinary field of psychoneuroimmunology reveals that sickness behaviour is mediated by pro-inflammatory cytokines, in particular interleukin-1 (IL-1), interleukin-6 (IL-6) and tumour necrosis factor-α (TNF α), within specific sites of the central nervous system (Dantzer 2003). Cytokines produced by activated immune cells, such as macrophages, cross the blood-brain barrier, but are also produced directly by glial cells in response to neural stimulation (Maier & Watkins 2003). Plasma levels of IL-1 tend to return to baseline levels within a few hours after an acute

immune challenge, but remain elevated in stress-responsive structures including hypothalamus, hippocampus, pituitary and adrenals for 24-48 hours, resulting in sensitisation of the stress response (Deak *et al* 2005). Similarly, pro-inflammatory cytokines acting on the spinal cord prime the pain sensory system, causing hyperalgesia or exaggerated pain responses (Maier & Watkins 2003).

Fever is an important component of the immune response, reducing pathogen proliferation (Kluger *et al* 1975). However, mounting a fever is energetically expensive, requiring a 13% increase in metabolic rate for mammals to increase body temperature by 1°C (Hart 1988). Hence, fever is maintained by drawing from the animal's energy reserves through glycogen and protein catabolism, but cannot be sustained without changes in behaviour that reduce energy demands for other functions. Sleep increases in association with the onset of the febrile response, and is positively associated with less severe clinical signs during bacterial infections (Toth *et al* 1993). Reductions in activity and social interactions may make ill individuals less conspicuous to predators and conspecifics (Meddis 1975). Sleep may also provide a buffer against negative feelings of malaise that accompany illness.

Controlled experiments involving laboratory rodents indicate that sickness may be a specific motivational state that competes for expression with other motivational states. Administration of lipopolysaccharide (LPS) induces a characteristic pro-inflammatory cytokine cascade and sickness behaviour response. However, the way in which sickness behaviour is expressed is context-dependent, When LPS is administered to lactating mice, nest building behaviour is suppressed when environmental temperature is 24ºC, but not at 6ºC when pup survival is compromised (Aubert 1999). Similarly, LPS reduces food-hoarding behaviour in rats, but rats that are required to work for a portion of their daily food ration continue hoarding. This is interesting since hoarding is performed during anorexia, suggesting that rats anticipate future needs (Aubert 1999). Sickness suppresses sexual behaviour in female rats, but not in males (Yirmiya *et al* 1995). Sickness also impairs learning of new tasks, but not performance of tasks previously learned (Aubert 1999).

Managing sick animals

Proximate mechanisms of sickness behaviour have important implications for diagnosis, treatment and prevention of disease in domesticated and captive species. Elements of sickness behaviour are well-recognised clinical signs of disease and are commonly used for diagnosis. However, the fact that expression of sickness behaviour is context-dependent affects the likelihood of clinical signs being expressed in social environments. Livestock present subtle behavioural indicators of sickness and pain and are viewed as 'stoic' due to their evolutionary niche (Flecknell 2000). However, behavioural responses may be more readily expressed in familiar environments and amongst familiar conspecifics.

Researchers have explored effects of behaviour on immune function, particularly interactions between stress and social behaviour (Broom & Johnson 1993). Social stress significantly impacts disease transmission within groups, with shedding and transmission of *Salmonella* occurring within hours after unfamiliar finisher pigs are mixed at lairage (Gray *et al* 1996). However, few detailed studies have explored the effects on behavioural needs of domesticated species. It is reasonable to expect that the behavioural needs of ill pigs differ from their healthy penmates. Thwarting of highly motivated behaviour causes increased frustration and aggression (Duncan 1970), and these negative subjective states may exacerbate suffering of ill individuals.

Hospital pens provide opportunities to segregate ill individuals and to tailor husbandry to the needs of this vulnerable population. Policymakers, industry and animal welfare certification programs recommend hospital pens for the care of ill and injured swine. However, few technical reports, veterinary extension articles or peer-reviewed publications discuss hospital pens (BVAAWF 1991; Madec *et al* 2000; Cleveland-Nielsen *et al* 2004; Millman 2005). A survey of 108 Ontario swine producers was conducted in 2003 (Millman & Friendship, unpublished data). Producers reported using hospital pens on 70% of the farms. However, visual inspection by research technicians revealed discrepancies in terminology, since 'hospital pens' were often standard pens where sick pigs were at that time, or where pigs were separated prior to euthanasia. Few producers had designated infirmaries or standard operating procedures for the care of ill and injured pigs. Husbandry varied considerably, with inspection of hospital pens occurring once daily on one-third of the farms and twice daily on a further third of farms. Antimicrobial therapy was administered on 94% of the farms. On 5% of the farms, ill and injured pigs were simply segregated with no additional treatment or inspection. It is important to note that the majority of producers expressed interest in how management of ill populations could be improved, particularly during outbreaks of infectious diseases such as porcine reproductive and respiratory syndrome (PRRS). A small number of farms had well-planned management procedures for ill pigs.

Primary research is needed to understand the needs of ill animals and applied research for the design of effective hospital pens and appropriate ratios of hospital pens at different stages of production. Well-designed hospital pens that accommodate behavioural needs of ill animals may reduce suffering over and above the direct effects of illness or injury. These responses evolved as strategies for addressing extreme threats to survival, and may be unnecessary or even maladaptive in the face of veterinary therapy where interventions, such as antimicrobial therapy, are regularly administered. Behavioural responses during convalescence, such as anorexia and adipsia, can impair prognosis, particularly for neonatal animals. Supportive therapies, such as non-steroidal anti-inflammatory drugs, may provide opportunities to enhance welfare, and have

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been shown to improve recovery rates during antimicrobial therapy (Bednarek *et al* 2003).

Conclusions and animal welfare implications

Animal welfare assessments have focused on mechanisms to prevent illness and injury from occurring within animal populations. However, individuals suffering from disease or injury represent vulnerable populations with special needs that are at odds with the herd. Knowledge about the mechanisms of sickness behaviour provides opportunities to apply these concepts to managed animal populations. Determining how behavioural needs of ill individuals differ from their healthy pen-mates is critical for developing appropriate housing, animal care protocols, and decision-making about humane endpoints.

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