IMPLICATIONS OF EXCESSIVE HEAT LOAD TO THE WELFARE OF CATTLE IN FEEDLOTS.

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SUMMARY

Environmental heat when combined with the high metabolic heat production of cattle in feedlots can have a negative impact on production. The syndrome causing this negative effect and at times potential distress for animals is excessive heat load. It is characterised by high body core and peripheral temperatures and severe disruptions in physiological functions. Animals are able to cope in most situations although they may show significant behavioural and physiological responses. Only in extreme cases does the animal fail to cope and if the process is not reversed the animal will suffer and possibly die. This paper reviews the physiological basis of excessive heat load, provides practical means for identifying potential problems and suggests means for avoiding unacceptable situations. While the paper takes the approach of trying to provide solutions, it must be recognised that our knowledge on the subject is far from complete and there is need for caution in interpretation. More scientific and on farm research is needed on the excessive heat load syndrome to optimise conditions for the welfare of animals and to reduce any potential negative effects on animals and the feedlot industries in Australia.

INTRODUCTION

The emerging dairy and beef feedlot industries which rely on close confinement of cattle and high grain feeding are facing issues not previously encountered by the grazing industries in Australia. Public perceptions of the feedlot industries and the associated animal welfare issues are concerns that will grow as the relatively new intensive systems become of increasing importance in animal production. The high solar radiation and temperatures of much of Australia's agricultural regions, when combined with close confinement of grain-fed cattle, predispose the development of an excessive heat load. Furthermore, heat load is a problem that will likely increase as intensification and production levels increase. As production increases so is hindered the ability of cattle to cope with heat. Excessive heat load is a disease of high production where the top producing animals are usually the first to show symptoms. Fortunately, there are precautions that can be taken to reduce the risk and avoid detrimental effects. This paper reviews current understanding of the excessive heat load syndrome and suggests ways to minimise negative consequences and maintain quality animal welfare practices.

BACKGROUND AND TERMINOLOGY

The term "excessive heat load" describes a syndrome that animals may show during periods of hot weather. Excessive heat load is descriptive and allows affected animals to be assessed quantitatively and differences between animals and situations to be distinguished. In contrast, the often used generic term "heat stress" lacks clear quantitative definition, causes confusion and is difficult to assess objectively. Furthermore, the term "stress" carries with it negative emotional implications which often have no scientific relevance.

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Body heat content is a function of body mass, specific heat of tissues and tissue temperatures, and varies in the short term mainly with changes in tissue temperatures (McLean et al. 1983). Excessive heat load occurs when the body heat content exceeds the upper end of the normal physiological range and is evidenced by high body temperatures. Recognition of the nature of the physiological changes associated with excessive heat load and the use of objective analyses provide scientific rationale for study of the syndrome. Quantitative objective measurements allow for appreciation of the range of levels of the syndrome from the subclinical through to extremely distressful conditions.

A rigorous scientific approach takes the syndrome out of the emotional arena of the public media. For the rapidly developing feedlot industries in Australia, the emotive and perceived animal welfare issues seem, at times, to be even more important than the syndrome itself. Television ratings and sales of newspapers are dependent upon conflict and sensational news. Well managed, efficient animal production systems that provide quality food to Australians and generate export dollars rarely make headline news. Why should they? They are common place!

Scientists, veterinarians and the feedlot dairy and beef industries are encouraged to consider excessive heat load in animals as a "non-infectious disease", one that can be combated by targeting its causes, especially the environmental factors. However, this disease does not have a single simple cause but arises from a complex of compounding factors , not all of which are present at any one time. Identifying and determining the relative importance of the key factors contributing to excessive heat load is paramount in the research that needs to be done. Below an analyses is made of excessive heat load using a diagnostic approach.

EXCESSIVE HEAT LOAD: A NON-INFECTIOUS DISEASE

Cause

Excessive heat load syndrome in grain-fed feedlot cattle occurs in warmer climates where a combination of local environmental conditions and animal factors leads to an increase in body heat content beyond the normal physiological range. With high body temperatures there may be changes in body metabolism and tissue damage, and, if extreme, animal deaths (Ansell 1981; Young and Hall 1993). Evidence to date excludes infectious organisms, dietary deficiencies or toxic compounds as direct contributing factors to excessive heat load in feedlot cattle (Young et al. 1992).

Environmental factors which may effect an animal's ability to maintain its thermal balance include thermal radiation, air temperature, humidity, and air movement (McDowell 1972). The factors of metabolic intensity, rate of thermal exchange and thermal insulation also contribute significantly to the heat balance of animals (Monteith and Mount 1974). A combination of these factors may tilt the balance to a state of continual net heat gain and consequential disruption of normal physiological functions. The tolerable duration and extent of thermal imbalance varies among animals, and is dependent upon body mass, specific heat of tissues, temperature distributions in the body and temperature sensitivity of tissues (McLean et al. 1983). The relative importance of the complex of interacting environmental and animal factors contributing to excessive heat load is not well understood, see Fig. 1. It should be appreciated that several factors are usually concurrently involved and must be taken into account when investigating the syndrome. Focus should not be placed on a single factor, such as solar radiation.

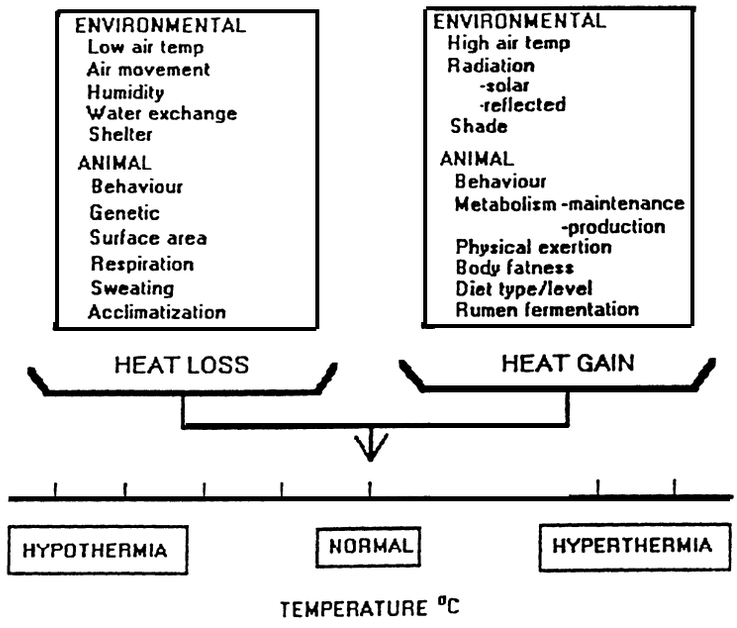

Figure 1. Factors contributing to the thermal balance of cattle (from Young & Hall 1993)

Diagnosis

Diagnosis needs knowledge and skill to judge the clinical symptoms and circumstances with diagnosis based on deviation from normal values. Such values may be behavioural, physiological or production parameters, and should take into consideration the immediate environment to which the animals are exposed (Young and Hall 1993).

This present paper does not review the many potential factors and physiological and productive consequences of excessive heat load. These are the topics of other reviews and the reader is referred to McDowell (1972); Monteith and Mount (1974); NRC (1981), Young et al. (1992) and Beede (1993) to obtain further information. Herein consideration will be given to behavioural symptoms that can be readily observed in practical feedlot situations and can be easily used to assist in the diagnosis of excessive heat load syndrome. Young and Hall (1993) compiled the following list of behavioural symptoms, in order of increasing severity, that could indicate the development of excessive heat load in feedlot cattle.

1. Body alignment with solar radiation
2. Shade seeking.
3. Refusal to lie down.
4. Reduced food intake.
5. Crowding over water trough.
6. Body splashing.
7. Agitation and restlessness.
8. Reduced or stopped rumination.
9. Grouping to seek shade from other animals.
10. Open-mouth and laboured breathing.
11. Excess salivation.
12. Ataxia/inability to move.
13. Collapse, convulsions, coma.
14. Physiological failure and death.

Cattle can usually cope physiologically up to symptom 9. The onset of 10, open-mouth and laboured breathing, is a clear sign of an animal failing to cope. With shallow rapid breathing an animal can efficiently evaporate moisture from its upper respiratory tract but the efficiency of evaporative capacity falls dramatically with open-mouth breathing (Hales and Finlay 1968). If this second-stage breathing persists, special attention must be given to animals to avoid unacceptable consequences.

While behavioural changes are useful for field identification of the thermal status of animals, they are in themselves not sufficient. Some of the behavioural changes listed above can arise from other causes, and additional information should be collected before making a definitive diagnosis of excessive heat load. Current work in my laboratory is attempting to identify and develop physiological and haematological tests that can be used to obtain more precise and reliable measures of heat load in feedlot cattle. Meteorological measurements provide valuable background data that assist in the diagnosis process. The monitoring of the weather should be a routine part of management of feedlots as it provides warnings of pending problems. Meteorological parameters that should be monitored include:-

air temperature
solar radiation
humidity
air movement
ground surface temperature,

Knowledge of the relative contributions of thermal acclimation of animals, their breed, sex and history, and feeding level and type of diet are also important to the understanding of excessive heat load, its risk of onset and severity. However, our information resource base in these areas is lacking and more research is urgently needed (Commonwealth of Australia 1992).

Treatment

The symptoms of a disease alert a manager or veterinarian to a problem and set in motion a course of treatment for the affected animal or animals. As with any disease, the appropriate treatment depends on the particular circumstances; no single treatment is always best. This is particularly the case with excessive heat load which may be caused by a number of different environmental, managerial or internal factors. Correctly identifying and overcoming the offending factor or factors is difficult, if not impossible. Thus, there is need for development of a number of strategies from which managers may select to avoid or overcome a potential disaster.

Possible treatments, not in any order of priority, for excessive heat load could include:

Exposure of cattle to increased air movement
Provision of cooled drinking water
Move animal to shaded area
Apply water sprays to animals
Change feeding type or level
Minimise physical exertion
Release animals from close confinement.

Some of the above are more practical, effective and/or costly than others. Circumstances will determine the choice. One of the objectives of current research is

identification of options available to managers and determination of their cost effectiveness in avoiding or stemming the severity of excessive heat load in feedlot cattle.

Prevention

Preventative precautions are applied before an animal shows symptoms and are aimed at avoiding the occurrence of a problem. Examples of possible preventive measures for excessive heat load include:

- Use of thermally resistant breeds
- Provision of solar shades
- Increased animal spacing
- Provision of cooled water source
- Use of water sprinklers
- Monitoring of meteorological parameters
- Increasing opportunity for thermoregulatory behaviour.

As with the evaluation of potential treatments for excessive heat load, there is need for evaluating the relative effectiveness of means for preventing or, at least reducing the risk of excessive heat load.

DISCUSSION

Diagnostic procedures can be applied to the excessive heat load syndrome in feedlot cattle. However, it is a complex syndrome which presently is not well understood and we need to investigate it in a systematic scientific way to find means of reducing potentially detrimental effects. Shade has been promoted, by some, as the solution to the problem. Unfortunately shade structures can be expensive and they are not very effective if components other than solar radiation are the offending factors. Young and Hall (1993) have identified key factors contributing to rapid rates of body heat gain by cattle in feedlots. These are air temperature, humidity, air movement, solar radiation and internal metabolic heat production by the animal itself. The relative contribution of each is likely to be highly dependent upon the characteristics of the cattle and conditions under which they are managed.

The net rate of gain of body heat depends upon the interaction and summation effects of factors. In extreme situations, the body temperature rises rapidly. With body temperatures above 42°C, the rate of cellular metabolism in cattle will accelerate and this will contribute to an even faster rate of heat gain and rise in body temperature. If uncontrolled, “run-a-way” hyperthermia concomitant with the rapid increase in cellular metabolism may occur. This can progress till the animal cannot cope with the heat load and death occurs.

CONCLUSION

While the basic principles of excessive heat load are identified, current understanding of causes, treatments and prevention are far from being adequate. Further research will provide a clearer picture of the relative importance of the various contributing factors. Ultimately, prevention of unacceptable situations will be possible through greater understanding of the circumstances associated with “run-a-way” hyperthermia and the development of strategies to circumvent the risk of excessive heat load.

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