DISCONTOOLS

Environmental Mastitis
Summary

Introduction

1. This note provides a brief summary of the Disease and Product analysis prepared by a DISCONTOOLS group of experts on Environmental Mastitis. They reviewed the current knowledge on the disease, considered the existing disease control tools, identified current gaps in the availability and quality of the control tools and finally determined the research necessary to develop new or improved tools. Full details are available here.

Disease profile

2. Environmental mastitis is defined based on epidemiological criteria (environment as main source of the pathogen with transmission from the environment to individual cows) and contrasted to contagious mastitis (infected cow as main source of the pathogen with transmission from cow to cow). Many mastitis pathogens can originate from or be spread via the environment. They include gram-negative coliform species (*Escherichia coli*, *Klebsiella* spp., *Enterobacter* species), gram-negative non-coliform species (e.g. *Serratia* spp., *Pseudomonas* spp.), gram-positive catalase negative species (*Streptococcus* spp., *Enterococcus* spp., *Lactococcus* spp.), gram-positive catalase positive species (*Staphylococcus aureus* and non-aureus staphylococci, NAS) and non-bacterial species (e.g. yeast, *Prototheca* spp.). Many gram-positive species, including *Strep. uberis*, *Strep. dysgalactiae* and *Staph. aureus* may cause environmental mastitis as well as contagious mastitis, with mode of transmission rather than bacterial species being the distinguishing feature.

3. Species affected by environmental mastitis include cattle, sheep, goats, buffalo and camels. Many other species, including humans, pigs, poultry, dogs and cats, may also be a source of bacterial species that can cause environmental mastitis. Bacterial species that can cause mastitis may be gut commensals (e.g. *E. coli*, *Klebsiella*, *Strep. uberis*) or skin commensals (e.g. *Staph. aureus*, NAS) in dairy animals and other host species. As implied by the name, the environment is a major reservoir of environmental mastitis pathogens. This includes, but is not limited to, faeces, bedding material, pastures, water and the barn environment.

4. Many bacterial and some non-bacterial species can cause environmental mastitis. In addition, there is high heterogeneity within species. Within-species heterogeneity can be used as evidence of environmental transmission. Within-species homogeneity is usually considered indicative of contagious transmission but can also be the result of exposure to an environmental point source.

5. Environmental mastitis can manifest as subclinical mastitis (no visible abnormalities) or clinical mastitis which can be mild (abnormalities in milk only), moderate (abnormalities in milk and udder) or severe (systemic signs). Severe environmental mastitis may result in sepsis and may be fatal.

Risk

6. Morbidity and mortality are highly variable between herds, groups within herds (e.g. fresh cows vs. mid-lactation), seasons (e.g. country-specific impact of heat, housing, or humidity), farm types (e.g. free stall vs. tie-stall; open vs. closed floor), etc. Outbreaks, by definition, are short periods of unusually high morbidity or mortality, whereby more than 10% of a herd may be affected or killed in a few weeks to months. Note that morbidity (proportion affected) does not refer to severity. Losses to the dairy industry due to decreased milk production, culling or death may be significant.

7. With the exception of toxin-producing *Staph. aureus*, there is very little evidence that environmental mastitis pathogens in dairy cattle pose a risk to human health. The use of antimicrobials in mastitis treatment and control could contribute to selection for antimicrobial resistance in causative pathogens, which may also be infectious to humans.

Diagnostics

8. Mastitis, inflammation of the mammary gland, can be detected with a range of diagnostics, both on-farm and off-farm. Some diagnostic tests, e.g. detection of high somatic cell count (SCC) or abnormal temperature or colour of milk can be performed manually/visually or they can be automated. Other tests are primarily visual (e.g. swelling, pain, behaviour) or primarily automated (e.g. conductivity). Inflammation is the host's response to mechanical, bacterial or other damage.

9. Intramammary infection is the most common cause of mastitis and can be diagnosed by demonstrating presence of a pathogen (in non-contaminated samples). This can be done through

culture or through molecular methods, with polymerase chain reaction (PCR) as the only commercially available option to date. Culture has traditionally been performed on various agar plates in diagnostic laboratories, but a growing array of on-farm diagnostics has recently become available, including plates with selective or indicator media, petrifilms and semi-automated systems on-farm culture systems. Some systems may include detection of antimicrobial resistance in some bacterial species. The use of culture- vs. PCR-based detection and off-farm vs. on-farm detection differs between countries. On-farm culture can be used to support treatment decisions. Within the veterinary profession, some favour its use whereas others are opposed to it.

Vaccines

10. A growing range of vaccines has become available on the European market in recent years, including vaccines with label claims for protection against mastitis caused by *E. coli*, *Staph. aureus* or *Strep. uberis* in dairy cattle and against *Staph. aureus* and NAS in sheep and goats. Evidence for their efficacy from independent field studies is mixed and, for *Strep. uberis*, limited as of yet, with generally stronger evidence for prevention of losses due to *E. coli* than for other pathogens.
11. The role of the innate immune system in the host response to mastitis is poorly understood, including but not limited to the role of macrophages, lymphocytes and cytokines. This is a gap in our knowledge that must be addressed to develop improved vaccines.

Pharmaceuticals

12. Whilst there are numerous antimicrobial pharmaceuticals on the market for treatment of mastitis, societal concern about antimicrobial use and antimicrobial resistance is currently driving a shift in thinking about treatment, and restrictions on antimicrobial use are in place in a growing number of areas. In particular, compounds on the World Health Organisation's Highest Priority Critically Important Antimicrobial lists (e.g. 3rd and 4th generation cephalosporins, quinolones, macrolides and polymyxins) should not be used for mastitis treatment. Withdrawal of such compounds from use in large dairy farms and practices has not affected dairy cow welfare.
13. Selective dry cow treatment and targeted treatment of mastitis in lactation can reduce antimicrobial use. Prevention of environmental mastitis during the dry period can be achieved with teat sealants, and with improved hygiene and dry cow management. Mild to moderate clinical mastitis caused by gram-negative species does not benefit from antimicrobial treatment whereas cases caused by gram-positive species can be treated with narrow spectrum antimicrobials.
15. The need to reduce our reliance on antimicrobials reinforces the importance of mastitis prevention through animal husbandry, including nutrition, animal handling, bedding management and farm hygiene, and staff training. This is not captured in the tools-focussed approach of DISCONTOOLS but is essential for control of environmental mastitis in lactating and dry animals.
14. Non-steroidal anti-inflammatory drugs are available commercially for supportive treatment.

Knowledge

16. There is no standardised typing system to establish a likely environmental origin, mode of transmission or prognosis for mastitis cases. The impact of bedding management and nutrition on environmental pathogen loads is poorly understood and there are no routine tools for monitoring pathogen load in the environment. There is a gap in uptake of recent insights into environmental mastitis in veterinary practice and herd health management programs. The impact of climate change, labour shortages and reduced use of antimicrobials on mastitis incidence an animal welfare is unknown.

Conclusions

17. Environmental mastitis is a multi-factorial disease that can be caused by a wide range of pathogen species. This complexity is reflected by the fact that most currently available tools do not provide control or prevention of all relevant species. To manage environmental mastitis, the balance between bacterial exposure and host resistance must be tipped in favour of the host. Tools such as diagnostics, vaccines and pharmaceuticals contribute to this balance, but the importance of communication and implementation of farm management measures must be not be overlooked.