Aetiology and consequences of reproductive tract diseases in dairy cows

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Abstract

Reproductive tract diseases of dairy cows are common world-wide and results in a decrease in reproductive performance. The research presented in this thesis evaluates the available diagnostic methods for reproductive tract diseases, including the quality of published reports describing these methods in dairy cows. To improve the accuracy of cow-side diagnostic tests for reproductive tract diseases more research is needed, specifically to establish optimal cut-points, timing of examination and test variability (i.e. intra- and interobserver agreement). Moreover, future manuscripts reporting on diagnostic methods for reproductive tract diseases could be improved by using checklists for quality of design and reporting as a guideline.

Research was also done to assess the presence of intrauterine bacteria in early postpartum New Zealand dairy cows and their association with the subsequent reproductive tract infection, inflammation and reproductive performance. The isolation of intrauterine bacteria, irrespective of type, at 23 days postpartum was associated with a decrease in pregnancy within three weeks for the start of the seasonal breeding programme (planned start of mating; PSM; P = 0.05). *Escherichia coli* isolated at 23 days postpartum tended to increase the time to pregnancy (P = 0.09). However, the presence of *E. coli* within the first week postpartum was not significantly associated with isolation of *Trueperella pyogenes* three weeks later (P = 0.53). An interesting finding was the positive association between the elevated recruitment of polymorphonuclear cells in the early postpartum period and a decreased time to pregnancy (P = 0.05).

Susceptibility data, based on minimum inhibitory concentration (MIC), was generated for a range of antimicrobials against *E. coli* and *T. pyogenes* from intrauterine origin. Between-herd and between age-

group differences in MIC were detected ($P \leq 0.05$). Cows diagnosed with intrauterine *E. coli* with an MIC of ≥8 μg/mL at 23 days postpartum tended to be at lower risk of pregnancy within six weeks of PSM relative to an MIC of <8 μg/mL ($P = 0.09$). No interpretative criteria are available for MIC data of antimicrobials against uterine isolates. Hence, more research is required on pharmacokinetic and pharmacodynamic profiles for veterinary antimicrobials.

This thesis describes the first isolation of apparent antibodies to bovine herpesvirus type 4 and the DNA of bovine lymphotropic herpesvirus in New Zealand dairy cattle, both of which may play an important role in the pathogenesis of reproductive tract diseases. Further studies are required to investigate the true impact of these viruses.

The research presented in this thesis provided data useful for further improvement of diagnosis and treatment of reproductive tract diseases in dairy cows.

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As I'm sitting here surrounded by piles of paper collected over the last number of years, notes, draft versions of manuscripts, and multiple printouts of peer-reviewed manuscripts I'm reflecting on the last few years that have been entirely dedicated towards the creation of this thesis. Returning to New Zealand to start this PhD project was life-changing in many ways. I am pleased to have this opportunity to thank a large number of people. Without them this demanding journey would have been an ordeal.

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Abbreviations

AI	Artificial insemination
BCS	Body condition score
BHBA	β-hydroxybutyric acid
BHI	Brain heart infusion
BLAST	Basic local alignment search tool
BLHV	Bovine lymphotropic herpesvirus
BoHV-4	Bovine herpesvirus type 4
bp	Base pair
BUN	Blood urea nitrogen
CCFA	Ceftiofur crystalline free acid
CFU	Colony forming unit
CL	Corpus luteum
CLSI	Clinical and Laboratory Standards Institute
DIM	Days in milk
ELISA	Enzyme-linked immunosorbent assay
EnPEC	Endometrial pathogenic *Escherichia coli*
EUCAST	European Committee on Antimicrobial Susceptibility Testing
MAC	Macrophages
MIC	Minimum inhibitory concentration
MIC_{50}	The antimicrobial concentration that inhibits 50% of the bacterial isolates
MIC_{90}	The antimicrobial concentration that inhibits 90% of the bacterial isolates

NEFA	Non-esterified fatty acid
OD	Optical densities
ONPG	An enzymatic test for Ortho-nitrophenyl-β-galactosidase
OUMI	ONPG, urase, motility, indol agar tests
PBMC	Peripheral blood mononuclear cells
PGE_2	Prostaglandin E_2
$PGF_{2\alpha}$	Prostaglandin $F_{2\alpha}$
PMN	Polymorphonuclear cells
PSM	Planned start of mating (the seasonal start of the breeding season)
PVD	Purulent vaginal discharge
RFM	Retained foetal membranes
ROC	Receiver-operating characteristic analysis
Se	Sensitivity (the proportion of diseased animals that test positive)
Sp	Specificity (the proportion of non-diseased animals that test negative)
TAGS	Tests in absence of a gold standard
TSI	Triple sugar iron agar test
VDS	Vaginal discharge score

List of publications

2014

MW de Boer, SJ LeBlanc, J Dubuc, S Meier, W Heuwieser, S Arlt, RO Gilbert, S McDougall. 2014. *Invited review*: Systematic review of diagnostic tests for reproductive-tract infection and inflammation in dairy cows. Journal of Dairy Science 97:3983-3999.

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