

Copyright is owned by the Author of the thesis. Permission is given for a copy to be downloaded by an individual for the purpose of research and private study only. The thesis may not be reproduced elsewhere without the permission of the Author.

**THE SIGNIFICANCE OF "NAVEL ILL" AND OTHER LESIONS AT
POST-MORTEM INSPECTION OF BOBBY CALVES**

MONIQUE ELISABETH BISS

A Thesis presented in partial fulfilment (70%) of the requirements for the degree of
Master of Veterinary Science.

Massey University, New Zealand

1990

ABSTRACT

Calves slaughtered for bobby veal in New Zealand are considered a public health risk if "acute inflammation of the umbilicus" is present at slaughter, because it is believed that the consumption of veal derived from these calves may subsequently "cause food-poisoning" as a result of bacterial dissemination throughout the carcass. This belief, however, has not been fully validated.

During the 1989 season, 54 calves were condemned for "navel ill" (0.465% of the total slaughtered) at Waitaki International's Feilding export slaughterhouse. Carcasses from these calves, along with 31 normal carcasses, were examined for the presence of septicaemia (Part I). The study involved the detailed gross examination of the carcass and viscera, together with microbiological examination of umbilical vein, liver and muscle, and histopathological examination of the umbilical vein, liver, and kidney. The working definition of septicaemia for the purposes of this study was the presence of large numbers of bacteria in the general circulation, involving slight or absent clinical signs and with or without gross evidence of early systemic infection in the carcass. Bacteraemia was defined as the presence of smaller numbers of bacteria in the general circulation, with or without gross evidence of localisation in the carcass. Although differing from the several definitions, particularly of septicaemia, in the literature, these were proposed as appropriate definitions in the context of the slaughterhouse. The presence or absence of septicaemia was determined on the basis of the combined gross lesions in the carcass, histopathological lesions in the liver and kidney, and microbial isolates from the liver and carcass musculature. The presence of infection extending from the umbilicus was determined by histopathological and microbiological examination of the umbilical vein near the liver.

"Navel ill" could be sub-classified into three categories:

- (1) Umbilical vessel infection and carcass lesions indicative of systemic spread, with or without umbilical infection.
- (2) Umbilical vessel infection, with or without umbilical infection.
- (3) Umbilical infection alone.

Three carcasses condemned for "navel ill" had no abnormalities of the umbilicus or umbilical vessels. Of the remaining 51 carcasses, one (2%) had gross, histological and microbiological evidence of septicaemia, and seventeen (33%) had lesions indicative of bacteraemia or septicaemia. The proportion of condemned carcasses which were bacteraemic decreased as the condemnation criteria expanded to include all three categories of "navel ill". There was a significant risk of bacteraemia in carcasses from all sub-categories of "navel ill", except category (3), when compared with normal carcasses. Insufficient data were generated to allow assessment of the risk of septicaemia being present in carcasses from calves with "navel ill".

A second study was undertaken later in the 1989 season, and involved the detailed gross examination and description of 371 calves condemned for any reason at six export slaughterhouses; five in the North Island and one in the South Island. The major disease entities found in calves of this age and resulting in carcass condemnations were "navel ill" (197 (0.50%) carcasses), pneumonia (75 (0.19%) carcasses), arthritis (31 (0.08%) carcasses, and "white spotted kidneys" (30 (0.08%) carcasses). Peritonitis, jaundice, hepatic abscesses and "fever" occurred at very low rates (< 0.03%), while other lesions occurred sporadically.

The current inspection system in New Zealand requires calves with "acute inflammatory lesions" to be condemned. In this study, this requirement resulted in the condemnation of virtually all diseased calves, whether the disease was acute, chronic, generalised, localised or non-infectious in nature. There was, however, considerable variation found in the severity, age and likely pathogenesis of the lesions in each disease category. Because this "blanket" approach to disease in the bobby calf leads to unnecessary condemnation and wastage, it is suggested that more appropriate judgement criteria such as the trimming of localised infectious and traumatic lesions should be considered.

ACKNOWLEDGEMENTS

This thesis has been the result of a great deal of effort from a number of people from within the bobby calf industry, the meat industry, meat services, and Massey University.

I would like to thank first and foremost all the meat inspectors, seniors, supervisors, veterinarians, and company personnel who took this project on board and made it happen. Without their co-operation then, and now, the project would not have achieved as much as it did. I especially thank Dr. McKenzie for supporting me through this very steep learning curve.

The meat services and the Department of Veterinary Pathology and Public Health of Massey University have been co-financiers of this project. That spirit of co-operation was invaluable in allowing this work to be completed.

The support of my supervisors is particularly acknowledged, especially those who spent a great deal of time trying to teach me the methods and principles of meat hygiene, public health, and epidemiology. Dr. Madie, Emeritus Professor Blackmore, Associate Professor Alley, Professor Wilks and Professor Manktelow have all been very patient as we discussed issues central to the theme of the thesis.

Dr. Hathaway has been a tremendous support and teacher, particularly in the area of risk analysis.

There are a great many people at Massey who have helped me learn the basics of a number of specialist disciplines in a very short time. I would particularly like to thank Ms. Cullinane and Ms. McMillan for their patience in the microbiology lab, and Associate Professor Alley for his assistance for many hours at the microscope.

There are people too numerous to name who have helped me master the computing and photography equipment, who have obtained for me the equipment I used during the season, and performed the technical tasks required for the preparation of slides and media: all these I thank.

TABLE OF CONTENTS

	PAGE
Abstract.	i
Acknowledgements.	iii
Table of Contents.	iv
List of tables.	viii
List of figures.	xi
The Bobby Calf Industry in New Zealand.	1
The Development of Specialty Dairy Breeds.	1
The Beginnings of the Bobby Calf Industry.	1
New Zealand's Bobby Calf Industry in Perspective.	1
Legislation Concerning the Bobby Calf.	3
Calves Used in the Bobby Calf Industry.	4
Calf Managment.	4
The Bobby Calf Pool System.	5
The Slaughter and Processing of Bobby Calves.	10
Calf Products, Economics and Markets.	20
The <i>Post-Mortem</i> Inspection of Bobby Calves.	22
Judgements in Other Countries in Relation to those used in New Zealand.	25
The Economic Impact of Disease in the Bobby Calf at Slaughter.	26
Diseases of the Bobby Calf.	28
Omphalophlebitis, -arteritis, and -urachitis "Navel Ill".	28
Pleurisy/Pneumonia/Pericarditis.	30
Arthritis.	35

Enteritis.	36
Miscellaneous Bacterial Infections.	40
Septicaemia/Bacteraemia.	41
Working Definition of Septicaemia for this Study.	45
Objectives of the Present Study.	46
Materials and Methods.	
Part I: Comparison of the Gross Lesions, Histological Lesions, and Microbial Flora of Bobby Calf Cohorts With and Without Omphalophlebitis ("Navel ill").	48
Selection of Cohorts.	48
Examination of Samples.	49
Estimation of the Prevalence of Haematomas Associated with the Umbilical Arteries in Bobby Calves Submitted for Slaughter.	54
Part II: Observations of the Lesions Present in Calves Condemned by Meat Inspectors.	55
Results.	
Part I: Comparison of the Gross Lesions, Histological Lesions, and Microbial Flora in the Carcasses from Bobby Calf Cohorts With and Without Omphalophlebitis ("Navel III").	57
Normal carcasses and viscera.	57
Condemned carcasses and viscera.	65
The Relative Risk of Bacteraemia in Carcasses from Calves with "Navel III".	79
Changes in the Rate of Detection of Bacteraemia Between Categories of "Navel III".	81
The Accuracy of the Meat Inspection Judgements.	83
Estimation of the Prevalence of Haematomas Associated with Umbilical Arteries in Bobby Calves Submitted for	85

Slaughter.	
Part II: A Study of the Lesions Present in Calves Condemned by Meat Inspectors.	88
The Rate of Condemnation for Disease, Contamination and Wounds and Bruising.	88
"Navel III".	90
Focal interstitial nephritis.	92
Pleurisy/Pneumonia/Pericarditis.	98
Arthritis.	107
Wounds and Bruising	109
Miscellaneous Conditions	109
Discussion.	
Part I: Comparison of the Gross Lesions, Histological Lesions, and Microbial Flora in the Carcasses from Bobby Calf Cohorts With and Without Omphalo- phlebitis ("Navel III").	113
Study Design.	113
The Lesions of "Navel III" in Bobby Calves at Slaughter.	113
The Baseline Test for Septicaemia.	115
The Relationship Between "Navel III", Bacteraemia and Septicaemia.	116
The Risk of Bacteraemia in Calves with "Navel III".	118
Hazard Identification.	119
The Cost of Condemned Carcasses to the Producer.	121
Conclusions.	122
Part II: A Study of the Lesions Present in Calves Condemned by Meat Inspectors.	124
Focal Interstitial Nephritis.	124
Pleurisy.	124
Arthritis.	125

Jaundice.	126
Enteritis.	126
Wounds and Bruising.	127
Conclusions.	127
Appendix I: Development of Bacteriological Materials and Methods.	129
Pilot Trial A.	129
Pilot Trial B.	104
The Effect of the Sticking Procedure on the Sterility of Heart Blood in Bobby Calves.	105
Investigation of the Effect of Heparin on the Via- bility of a Broth Containing <i>Escherichia coli</i> .	108
Appendix II: Details of Microbiological and Histological Methods and Materials.	138
Appendix III: Recording Form.	145
Appendix IV: Random Times Table.	151
References.	153

LIST OF TABLES.

TABLE		PAGE
1.1	List of products derived from the bobby calf and their market destination.	21
1.2	Tickets used in the inspection of bobby calves, with the defects covered by each ticket used.	23
1.3	Numbers of defective carcasses identified (prevalence) and condemned under standard ticketing categories.	24
1.4	Causes of carcass loss to the producer after collection from the farm gate.*	27
3.1	Location and dates of visits to slaughterhouses during the 1989 bobby calf season.	55
4.1	The number of carcasses with gross, microbiological and histological abnormalities from 31 calves passed as normal by meat inspectors.	62
4.2	Comparison of gross findings of detailed examination with meat inspection dispositions on carcasses with and without "navel ill".	65
4.3	Number and identification of bacterial isolates from the sample sites in condemned carcasses. (In some cases, more than one isolate was recovered from one sample site.)	70
4.4	Histological lesions in 42 grossly normal livers from calves condemned for "navel ill".	74

4.5.	Histological findings in 45 grossly normal kidneys from calves condemned for "navel ill".	78
4.6	Number of carcasses in each category of "navel ill" which were truly bacteraemic (D+ve), false test positives (D-ve), and the positive predictive value (P(T/D+)) of the test.	79
4.7	Relative risk, 95% confidence intervals and χ^2 statistics calculated for each category of "navel ill" in Table 4.6.	80
4.8	Detection rates (DR), wastage rates (WR), and their 95% confidence limits for the sub-categories of "navel ill" detected by meat inspectors.	82
4.9	Comparison of the meat inspection judgement (T+/-) with the "true" presence of bacteraemia (D+/-) determined using the combined microbiological, histological and gross findings.	83
4.10	Numbers of carcasses with substantial haemorrhage in the serosa supporting the bladder and umbilical arteries.	85
5.1	Calves slaughtered, and condemned for disease by meat inspectors, at six slaughterhouses in New Zealand during the 1989 season.	89
5.2	Calves slaughtered, and condemned by meat inspectors for "navel ill", at six slaughterhouses in New Zealand.	90
5.3	The numbers of carcasses condemned for "navel ill" with phlebitis, arteritis and/or urachitis in six slaughterhouses.	92
5.4	Gross lesions in kidneys and carcasses condemned for "white spotted kidneys" (Focal Interstitial Nephritis).	93

5.5	Histopathological findings in 27 calves condemned by meat inspectors at six slaughterhouses on the basis of lesions in the kidneys.	97
5.6	Gross findings and severity of lung and pleural lesions in 75 calves which were condemned by meat inspectors for pleurisy at six slaughterhouses.	99
5.7	Lesion categories ticketed for pleurisy which were associated with gross signs of a concurrent bacteraemia.	100
5.8	Gross features of the joints of 32 carcasses condemned for arthritis by meat inspectors in six slaughterhouses.	108
5.9	Diseases detected by meat inspectors which resulted in the condemnation of carcasses using the tickets OC, PYO, and SAL.	111
I.1	Comparison of two methods of surface sterilization: hot sear with a spatula vs. sear with an alcohol flame.	131
I.2	Comparison of contamination rates of duplicate blood samples from 10 calves taken in the yards and at the inspection stand. (Expected distribution of values for χ^2 are subscripted.)	135
I.3	Total viable count (TVC) of an <i>E. coli</i> broth cultured with and without heparin.	137

LIST OF FIGURES

FIGURE	PAGE
1.1 Numbers of lambs (...), sheep (---), cattle (- - -) and bobby calves (___) slaughtered per month in New Zealand during the 1989 season.	2
1.2 Numbers of calves slaughtered from each pool during the 1989 season.	6
1.3 Percentage of each pool supplying slaughterhouses processing bobby calves during the 1989 season.	7
1.4 Number of calves slaughtered in each slaughterhouse during 1989.	8
1.5 The approximate geographic boundaries of each pool in New Zealand.	9
1.6 A calf with severed external carotids after the Halal cut.	15
1.7 The Halal cut is followed with a thoracic stick to ensure that the calves do not recover sensibility during exsanguination.	15
1.8 The calf is suspended from "spreaders" to facilitate freeing of the pelt in the forequarter area prior to removal.	16
1.9 The pelt is freed from the cheeks to facilitate pelt removal at the hide-puller.	16
1.10 The pelt is removed mechanically, much like a sleeve.	17
1.11 The removal of the abdominal contents (evisceration).	17

1.12	The carcass (foreground) and viscera move together past the inspection area.	18
1.13	MAF inspectors assess the carcass and viscera for their suitability for human consumption.	18
1.14	Carcasses are directed in two directions if not condemned outright: those to the left are detained for trimming, while those on the right are regarded as suitable for human consumption and are moving directly to the grader's stand.	19
4.1	Normal umbilici, illustrating the size range possible in the tissue. Normal umbilical veins are attached to each example.	59
4.2	An example of normal umbilical arteries and their relationship with the bladder.	59
4.3	Longitudinal section of a normal umbilical vein in a bobby calf. H&E, x10.	63
4.4	Normal bobby calf kidney. H&E, x100.	63
4.5	Bobby calf liver with vacuolated hepatocytes. H&E, x 200	64
4.6	Infection of the apical remnants of the umbilical arteries.	64
4.7	A large localised area of necrosis involving the urachus and the umbilical arteries. The ileum is adherent to the lesion.	68
4.8	Extensive necrosis of the urachus in case N ^o 11.	68

4.9	Longitudinal section of an umbilical vein showing severe inflammation, leucocytic infiltration, and fibrinous effusion of the mural tissues. H&E, x10.	72
4.10	Longitudinal section of an umbilical vein with severe leucocytic infiltration and fibrinous effusion. H&E, x10.	73
4.11	High power of the same tissue showing granulation tissue developing beneath the zone of infiltrating leucocytes. H&E x 40.	73
4.12	Bobby calf liver, showing moderate periportal cuffing with mononuclear cells. H&E, x100.	75
4.13	Bobby calf liver with an inflammatory focus dominated by monocytes in the parenchyma. H&E, x200.	75
4.14	Bobby calf kidney with chronic focal interstitial nephritis in the cortex, and severe tubular destruction. H&E, x100.	76
4.15	Bobby calf kidney showing an acute suppurative inflammatory reaction in the cortex. H&E, x100.	76
4.16	Focal interstitial nephritis involving both acute suppurative foci and early fibrosis of the cortical tissue. H&E, x100.	77
4.17	Variation in severity of haematomas associated with the umbilical arteries. These are presumed to arise from inadequate contraction of the umbilical arteries at birth.	87
4.18	Haemorrhage associated with the umbilical arteries and urachus.	87

- 5.1 A representative range of the lesions of "white spotted kidneys". "Acute", hyperaemic lesions in the kidney on the right, and two examples of "chronic" lesions to the left. 94
- 5.2 Severe infection of the kidney, with fibrinous exudate in the perirenal tissues and renal swelling. 94
- 5.3 Kidney with acute pyelonephritis. Note the radial distribution of the inflammatory lesions. H&E, x40. 95
- 5.4 Acute enzootic pneumonia with areas of hyperaemia and consolidation with an anteroventral distribution. 102
- 5.5 An old, well-encapsulated pulmonary abscess with fibrous adhesions to the surrounding tissues. 102
- 5.6 Bobby calf lung with acute suppurative bronchopneumonia. H&E, x10. 103
- 5.7 High power of the above showing intense neutrophilic accumulation in a bronchiole. H&E x 100. 103
- 5.8 Bobby calf lung with fibrinous bronchopneumonia containing an area of coagulation necrosis. There are bacterial colonies in the centre. H&E x 40. 104
- 5.9 Bobby calf lung showing severe distension of the interlobular septa with fibrin and necrotic material. H&E, x10. 104
- 5.10 Bobby calf lung containing streaming macrophages ("oat cells") typical of infection with *Pasteurella haemolytica*. H&E, x 200. 105

5.11	The edge of an old abscess in a bobby calf lung. There is encapsulation of the necrotic material and extensive destruction of the normal lung tissue. H&E, x10.	105
5.12	Bobby calf liver with one encapsulated abscess in the left lobe.	112
5.13	Generalised fibrinous peritonitis in a bobby calf.	112
IV.1	Random times table.	152