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 EFFECTS OF
FOUR DIFFERENT INDUCTION TECHNIQUES
ON ANAESTHETIC MAINTENANCE AND
RECOVERY IN HORSES

A Thesis
Presented in Partial Fulfilment of the Requirements
for the Degree of
Master of Veterinary Science
at
Massey University

Linda Rose Dickson
1991
ACKNOWLEDGEMENTS

Funds for this study were generously provided by the New Zealand Equine Research Foundation.

There are many people to thank for their assistance during this study:
Paul Hensen for his valuable practical assistance in administering anaesthetics, collecting data and looking after horses.
Anne Lascelles, Denise Holtham, Helen Foster and Rosalinde Foote for their willing, and expert, technical assistance during the experimental work.
Greg Arnold, whose valuable assistance in statistical methodology and interpretation, shed light in dark places.
Fiona Dickinson, whose computer mastery processed word filled pages into a legible thesis.
Robert and Judith Williams for their cheerful caretaking of Jennifer, which gave me precious time to study.

Bayer NZ Ltd, for their generous supply of Rompun.
R. Lester Ltd, for their generous supply of Ketavet.

I am especially grateful to my supervisors:
Dr. D.H. Carr and Professor E. C. Firth for their interest, encouragement and careful reading of many manuscripts.

Dr. B. E. Goulden whose enthusiasm, patience and persistence have made completion of this thesis a reality.

Particular thanks go to Mark, my husband, whose patience and encouragement have been endless.
ABSTRACT

Anaesthetic recoveries have been the target of little research, and the information available on the effect of anaesthetic induction agents on recovery lacks detail and specificity. The aim of this study was to compare the anaesthetic recovery periods after 4 different induction procedures: (1) acetylpromazine, glycerol guaiacolate, thiopentone; (2) xylazine, glycerol guaiacolate, thiopentone; (3) xylazine, ketamine; (4) acetylpromazine, glycerol guaiacolate, ketamine, which were followed by 1 hour of halothane in oxygen anaesthesia. Ten horses each received all 4 techniques with at least 1 week between successive anaesthetics. The 10 results for each induction technique were grouped, means determined, and statistical analysis performed on these group means.

Strikingly, the use of thiopentone, when compared to ketamine combinations, resulted in consistently poorer recoveries. The possibility that this may be due to the persistence of subanaesthetic barbiturate levels during the recovery period is discussed. In man, residual barbiturate levels have been shown to increase the awareness of pain, and it is possible that a similar effect may be present in horses, detrimentally affecting their anaesthetic recoveries. The role of ketamine in the consistently better recoveries is unclear. It is hypothesised that it may be due to residual ketamine levels in plasma exerting a stimulatory effect on areas of the central nervous system.

Interestingly, the use of acetylpromazine as a premedicant before both thiopentone and ketamine combinations, prolongs recovery and significantly increases 3 hour post anaesthetic creatinine phosphokinase (CPK) levels. No statistical relationship was found between longer recumbency times and elevated CPK levels, and it is postulated that the CPK rise may have been indirectly caused by acetylpromazine lowering the packed cell volume, and therefore muscle tissue oxygen supply.

The difference in pharmacokinetics of the individual drugs used apparently influenced the smoothness and the rate of recovery observed. It cannot be
assumed therefore, that horses experiencing longer or shorter anaesthetic periods would show similar recovery attributes to those found in this study.

It was concluded that, after 1 hour of anaesthetic maintenance using halothane in oxygen mixtures, there is a better chance of horses having a coordinate recovery if ketamine combinations are used as induction agents; and a more rapid recovery if xylazine/ketamine is used to induce anaesthesia.
TABLE OF CONTENTS

Acknowledgements i
Abstract ii
Table of Contents iv

CHAPTER 1 INTRODUCTION 1

(i) Equine Post Anaesthetic Complications 2
(a) death
(b) fracture
(c) myopathy

(ii) Anaesthetic Recovery 4

(iii) Anaesthetic agents used in the horse 6
Acetlypromazine
Xylazine
Glycerol guaiacolate
Thiopentone
Ketamine
Halothane

CHAPTER 2 MATERIALS AND METHODS 13

1. Anaesthesia 13
(i) Induction groups
(ii) Induction techniques 14
(iii) Maintenance technique 16
(iv) Measurements during induction and maintenance 17
(a) Induction time
(b) Induction grade
(c) Heart rate
(d) Respiratory rate
(e) Blood pressure
(f) Blood gases

2. Recovery 18
(i) Measurements made during recovery 18
(a) Time to extubation
(b) Time to lifting head
(c) Time to sternal recumbency
(d) Time to standing
(e) Number of attempts to stand
(f) Recovery grade

3. Muscle enzymes

Statistical Analysis

CHAPTER 3 RESULTS

Analysis of variance

1. Anaesthesia
   (a) Induction time
   (b) Induction grade
   (c) Heart rate
   (d) Respiratory rate
   (e) Blood pressure
   (f) Blood gases
      (i) \( \text{PaCO}_2 \)
      (ii) \( \text{pH} \)
      (iii) \( \text{PaO}_2 \)

2. Recovery
   (a) Extubation time
   (b) Time to lifting head
   (c) Time to sternal recumbency
   (d) Time to standing
   (e) Number of attempts to stand
   (f) Recovery grade

3. Muscle Enzymes

Regression Analysis and Scattergraphs

CHAPTER 4 DISCUSSION

1. Anaesthesia
   (i) Induction
   (ii) Maintenance

2. Recovery
   (i) Recovery quality
   (ii) Recovery length

3. Muscle Enzymes
4. Critical Evaluation of Experiment
   (i) Experimental design
   (ii) Clinical assessment of induction techniques

CHAPTER 5 CONCLUSIONS

References

Appendix 1 Equine Anaesthetic Recovery Chart

Appendix 2 Tabulated Raw Data

Table 1
1. Time taken for induction of anaesthesia
2. Depth of anaesthesia following induction
3. Heart rate (per minute) during maintenance of anaesthesia
4. Respiratory rate (per minute) during maintenance of anaesthesia
5. Mean arterial blood pressure during maintenance of anaesthesia (mmHg)
6. Partial pressure of arterial carbon dioxide (PaCO₂) at 10, 30 and 60 minutes (mmHg)
7. pH readings at 10, 30 and 60 minutes
8. Partial pressure of arterial oxygen (PaO₂) at 10, 30 and 60 minutes (mmHg)
9. Time taken for horse to swallow and subsequent removal of endotracheal tube after discontinuation of gaseous anaesthesia (min)
10. Time taken for horse to lift head after discontinuation of gaseous anaesthesia (min)
11. Time taken for horse to achieve sternal recumbency after discontinuation of gaseous anaesthesia (min)
12. Time taken for horse to stand after discontinuation of gaseous anaesthesia (min)
13. Number of attempts of each horse to stand after discontinuation of gaseous anaesthesia
<table>
<thead>
<tr>
<th>Page</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>Recovery grade</td>
</tr>
<tr>
<td>15</td>
<td>CPK levels before and 3 hours after anaesthesia (iu/l)</td>
</tr>
<tr>
<td>16</td>
<td>GOT levels before and 24 hours after anaesthesia (iu/l)</td>
</tr>
<tr>
<td></td>
<td><strong>Appendix 3</strong> Examples of Two-way analysis of variance</td>
</tr>
<tr>
<td></td>
<td><strong>Appendix 4</strong> Example of Regression Analysis and corresponding Scattergraph (MINITAB)</td>
</tr>
<tr>
<td>86</td>
<td></td>
</tr>
<tr>
<td>87</td>
<td></td>
</tr>
<tr>
<td>88</td>
<td></td>
</tr>
<tr>
<td>89</td>
<td></td>
</tr>
<tr>
<td>90</td>
<td></td>
</tr>
</tbody>
</table>