

# Bacteraemia in neonatal foals: clinicopathological differences between Gram-positive and Gram-negative infections, and single organism and mixed infections

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**TABLE 1a: Univariate analysis of continuous variables associated with Gram-classification of organism in 72 cases of foal bacteraemia**

| Parameter                             | No. foals with Gram-positive bacteraemia in which parameter recorded | Mean (± s.d.) foals with Gram-positive bacteraemia | No. foals with Gram-negative bacteraemia in which parameter recorded | Mean (± s.d.) foals with Gram-negative bacteraemia | P value |
|---------------------------------------|--|--|--|--|---------|
| <b>Total number of foals</b>          | 13   |  | 59   |  |         |
| <b>Admission physical examination</b> |  |  |  |  |         |
| Capillary refill time                 | 13   | 1.8 ± 0.4 sec                                      | 56   | 2.3 ± 1.0 sec                                      | 0.065   |
| <b>Admission haematology</b>          |  |  |  |  |         |
| Total white cell count                | 13   | 11.7 ± 7.6 x10 <sup>9</sup> /l                     | 57   | 7.5 ± 6.8 x10 <sup>9</sup> /l                      | 0.029   |
| Neutrophil count                      | 13   | 9.0 ± 7.0 x10 <sup>9</sup> /l                      | 55   | 5.7 ± 6.2 x10 <sup>9</sup> /l                      | 0.081   |
| Lymphocyte count                      | 13   | 1.51 ± 0.6 x10 <sup>9</sup> /l                     | 55   | 1.20 ± 0.7 x10 <sup>9</sup> /l                     | 0.038   |
| <b>Haematology at 48 h</b>            |  |  |  |  |         |
| Eosinophil count                      | 12   | 0.05 ± 0.09 x10 <sup>9</sup> /l                    | 40   | 0.009 ± 0.025 x10 <sup>9</sup> /l                  | 0.025   |
| <b>Blood biochemistry at 48 h</b>     |  |  |  |  |         |
| Chloride concentration                | 10   | 100.2 ± 7.5 mmol/l                                 | 31   | 96.8 ± 4.8 mmol/l                                  | 0.033   |

Only parameters with P<0.10 are shown.

**TABLE 1b: Univariate analysis of noncontinuous variables associated with Gram-classification of organism in 72 cases of foal bacteraemia**

| Parameter                                 | No. for which parameter recorded | Variable over-represented in foals with Gram-positive bacteraemia (no. with variable/no. of foals with Gram-positive bacteraemia) | Variable over-represented in foals with Gram-negative bacteraemia (no. with variable/no. foals with Gram-negative bacteraemia) | P value |
|---|----------------------------------|---|--|---------|
| <b>Admission physical examination</b>     |                                  |   |  |         |
| Demeanour                                 | 72                               | Alert and Responsive (8/13)   | Depressed (42/59)  | 0.050   |
| <b>Admission haematology</b>              |                                  |   |  |         |
| Cytological features of 'and' neutrophils | 67                               | No toxic changes noted (13/13)  | Moderate and marked toxic changes (12/54)  | 0.018   |

Only parameters with P<0.10 are shown.

**TABLE 2a: Univariate analysis of continuous variables associated with single versus mixed organism bacteraemia in 85 cases of foal bacteraemia**

| Parameter                             | No. foals with single organism bacteraemia in which parameter recorded | Mean ( $\pm$ s.d.) of foals with single organism bacteraemia | No. foals with mixed organism bacteraemia in which parameter recorded | Mean ( $\pm$ s.d.) foals with mixed organism bacteraemia | P value |
|---------------------------------------|--|--|---|--|---------|
| <b>Total number of foals</b>          | 66   |  | 19  |  |         |
| <b>Admission physical examination</b> |  |  |   |  |         |
| Heart rate                            | 64   | 108 $\pm$ 27 beats/min                                       | 19  | 123 $\pm$ 35 beats/min                                   | 0.028   |
| Respiratory rate                      | 64   | 40 $\pm$ 16 beats/min  | 19  | 34 $\pm$ 17 beats/min                                    | 0.062   |
| Capillary refill time                 | 63   | 2.1 $\pm$ 0.8 sec  | 19  | 2.7 $\pm$ 1.3 sec  | 0.068   |
| <b>Admission biochemistry</b>         |  |  |   |  |         |
| Sodium concentration                  | 61   | 137 $\pm$ 8.1 mmol/l   | 18  | 142 $\pm$ 4.3 mmol/l                                     | 0.001   |
| Chloride concentration                | 60   | 97 $\pm$ 7.6 mmol/l  | 17  | 101 $\pm$ 6.2 mmol/l                                     | 0.012   |
| Urea concentration                    | 59   | 4.2 $\pm$ 3.6 mmol/l   | 18  | 6.3 $\pm$ 2.8 mmol/l                                     | 0.045   |
| <b>Admission blood gas analysis</b>   |  |  |   |  |         |
| pH                                    | 30   | 7.31 $\pm$ 0.09  | 9   | 7.17 $\pm$ 0.16  | 0.007   |
| Arterial carbon dioxide tension       | 28   | 54 $\pm$ 13 mmHg   | 10  | 66 $\pm$ 14 mmHg   | 0.037   |
| <b>Blood biochemistry at 24 h</b>     |  |  |   |  |         |
| Potassium concentration               | 48   | 3.8 $\pm$ 0.72 mmol/l  | 8   | 4.5 $\pm$ 1.1 mmol/l                                     | 0.030   |
| Urea concentration                    | 45   | 3.1 $\pm$ 3.0 mmol/l   | 8   | 4.2 $\pm$ 2.4 mmol/l                                     | 0.055   |
| <b>Haematology at 48 h</b>            |  |  |   |  |         |
| 'Band' Neutrophil count               | 49   | 0.075 $\pm$ 0.23 $\times 10^9$ /l                            | 9   | 0.33 $\pm$ 0.59 $\times 10^9$ /l                         | 0.045   |
| <b>Blood biochemistry at 48 h</b>     |  |  |   |  |         |
| Sodium concentration                  | 41   | 136 $\pm$ 4.2 mmol/l   | 6   | 142 $\pm$ 6.2 mmol/l                                     | 0.034   |
| Chloride concentration                | 40   | 98 $\pm$ 5.7 mmol/l  | 6   | 102 $\pm$ 4.0 mmol/l                                     | 0.078   |
| Calcium concentration (total)         | 42   | 2.6 $\pm$ 0.8 mmol/l   | 6   | 2.5 $\pm$ 0.7 mmol/l                                     | 0.029   |
| Urea concentration                    | 38   | 1.7 $\pm$ 0.9 mmol/l   | 6   | 3.0 $\pm$ 1.6 mmol/l                                     | 0.049   |

Only parameters with P<0.10 are shown.

**TABLE 2b: Univariate analysis of noncontinuous variables associated with single versus mixed organism bacteraemia in 85 cases of foal bacteraemia**

| Parameter  | No. for which parameter recorded | Variable over-represented in foals with single organism bacteraemia (no. with variable/no. of foals with single organism bacteraemia) | Variable over-represented in foals with mixed organism bacteraemia (no. with variable/no. of foals with mixed organism bacteraemia) | P value |
|--|----------------------------------|---|---|---------|
| <b>Historical Information</b>                                      |                                  |   |   |         |
| Parturition  | 83                               | No dystocia reported (60/64)  | Dystocia (4/19)   | 0.076   |
| <b>Admission physical examination</b>                              |                                  |   |   |         |
| Respiratory Distress   | 85                               | No respiratory distress (64/66)   | Respiratory distress (6/19)   | 0.001   |
| Alertness  | 85                               | Alert and responsive (27/66)  | Depressed (17/19)   | 0.014   |
| Standing on admission  | 85                               | Able to stand (42/66)   | Recumbent (14/19)   | 0.008   |
| <b>Admission biochemistry</b>                                      |                                  |   |   |         |
| Immunoglobulin concentration                                       | 61                               | >4 g/l (25/51)  | <4 g/l (8/10)   | 0.092   |
| <b>Admission clinicopathological status</b>                        |                                  |   |   |         |
| Meets definition of systemic inflammatory response syndrome (SIRS) | 78                               | SIRS absent (27/61)   | SIRS present (14/17)  | 0.053   |
| <b>Haematology at 24 h</b>   |                                  |   |   |         |
| Cytological features of 'band' neutrophils                         | 66                               | No toxic changes noted (49/54)  | Toxic changes (3/12)  | 0.049   |
| <b>Outcome</b>   |                                  |   |   |         |
| Survival to hospital discharge                                     | 85                               | Survived (49/66)  | Did not survive (11/19)   | 0.013   |
| <b>Association with particular bacterial species</b>               |                                  |   |   |         |
| <i>Actinobacillus</i>  | 85                               | Not present (53/66)   | Present (8/19)  | 0.069   |

Only parameters with P<0.10 are shown.

**TABLE 3a: Univariate analysis of continuous parameters associated with presence of *E. coli* in the blood culture of 85 foals with bacteraemia.**

| Parameters                    | No. foals with specific bacteria in which parameter recorded | Mean ( $\pm$ s.d.) foals with <i>E. coli</i> | No. foals without specific bacteria in which parameter recorded | Mean ( $\pm$ s.d.) foals without <i>E. coli</i> | P value |
|-------------------------------|--|--|---|---|---------|
| <b>Total number of foals</b>  | 37   |  | 48  |   |         |
| <b>Admission haematology</b>  |  |  |   |   |         |
| Eosinophil count              | 36   | 0.001 $\pm$ 0.008 $\times 10^9/l$            | 43  | 0.012 $\pm$ 0.063 $\times 10^9/l$               | 0.097   |
| <b>Admission biochemistry</b> |  |  |   |   |         |
| Calcium concentration (total) | 37   | 2.5 $\pm$ 0.85 mmol/l                        | 42  | 2.7 $\pm$ 0.85 mmol/l                           | 0.026   |
| Bicarbonate concentration     | 17   | 23.2 $\pm$ 8.2 mmol/l                        | 20  | 29.2 $\pm$ 6.2 mmol/l                           | 0.015   |
| <b>Haematology at 24 h</b>    |  |  |   |   |         |
| Total white cell count        | 27   | 7.4 $\pm$ 5.1 $\times 10^9/l$                | 39  | 10.9 $\pm$ 9.7 $\times 10^9/l$                  | 0.063   |
| Neutrophil count              | 27   | 5.5 $\pm$ 4.6 $\times 10^9/l$                | 39  | 8.6 $\pm$ 8.9 $\times 10^9/l$                   | 0.070   |
| <b>Haematology at 48 h</b>    |  |  |   |   |         |
| Lymphocyte count              | 24   | 1.2 $\pm$ 0.5 $\times 10^9/l$                | 35  | 2.1 $\pm$ 2.1 $\times 10^9/l$                   | 0.030   |
| <b>Biochemistry at 48 h</b>   |  |  |   |   |         |
| Sodium concentration          | 18   | 134.6 $\pm$ 5.4 mmol/l                       | 29  | 137.6 $\pm$ 4.1 mmol/l                          | 0.011   |
| Calcium concentration (total) | 19   | 2.7 $\pm$ 0.6 mmol/l                         | 29  | 2.5 $\pm$ 0.8 mmol/l                            | 0.067   |

Only parameters with  $P < 0.10$  are shown.

**TABLE 3b: Univariate analysis of noncontinuous parameters associated with presence of *E. coli* in the blood culture of 85 foals with bacteraemia.**

| Parameter                             | No. for which parameter recorded | Variable over-represented in foals with <i>E. coli</i> bacteraemia (no. with variable/no. of foals with <i>E. coli</i> bacteraemia) | Variable over-represented in foals without <i>E. coli</i> bacteraemia (no. with variable/no. foals without <i>E. coli</i> bacteraemia) | P value |
|---------------------------------------|----------------------------------|---|--|---------|
| <b>Historical information</b>         |                                  |   |  |         |
| Parturition                           | 83                               | No apparent problems at parturition (15/36)   | Parturition unobserved or problem occurred (37/47)   | 0.056   |
| <b>Admission physical examination</b> |                                  |   |  |         |
| Respiratory distress                  | 85                               | Respiratory distress (6/37)   | No respiratory distress (46/48)  | 0.073   |

Only parameters with  $P < 0.10$  are shown.

**TABLE 4a: Univariate analysis of continuous parameters associated with presence of *Actinobacillus* in the blood culture of 85 foals with bacteraemia**

| Parameters                            | No. foals with specific bacteria in which parameter recorded | Mean ( $\pm$ s.d.) foals with <i>Actinobacillus</i> | No. foals without specific bacteria in which parameter recorded | Mean ( $\pm$ s.d.) foals without <i>Actinobacillus</i> | P value |
|---------------------------------------|--|---|---|--|---------|
| <b>Total number of foals</b>          | 21   |   | 64  |  |         |
| <b>Admission physical examination</b> |  |   |   |  |         |
| Respiratory rate                      | 20   | 31 $\pm$ 14 breaths/min                             | 63  | 40 $\pm$ 17 breaths/min                                | 0.016   |
| Indirect blood pressure               | 6  | 85 $\pm$ 23 mmHg                                    | 8   | 60 $\pm$ 11 mmHg                                       | 0.020   |
| <b>Admission haematology</b>          |  |   |   |  |         |
| White blood cell count                | 20   | 5.8 $\pm$ 5.2 $\times 10^9$ /l                      | 61  | 9.4 $\pm$ 7.3 $\times 10^9$ /l                         | 0.016   |
| Neutrophil count                      | 19   | 4.3 $\pm$ 4.8 $\times 10^9$ /l                      | 60  | 7.3 $\pm$ 5.8 $\times 10^9$ /l                         | 0.024   |
| Lymphocyte count                      | 19   | 0.93 $\pm$ 0.5 $\times 10^9$ /l                     | 60  | 1.3 $\pm$ 0.7 $\times 10^9$ /l                         | 0.014   |
| Platelet count                        | 19   | 150 $\pm$ 70 $\times 10^9$ /l                       | 60  | 191 $\pm$ 86 $\times 10^9$ /l                          | 0.062   |
| <b>Admission biochemistry</b>         |  |   |   |  |         |
| Sodium concentration                  | 19   | 140.2 $\pm$ 5.2 mmol/l                              | 60  | 137.4 $\pm$ 8.3 mmol/l                                 | 0.080   |
| Bilirubin concentration               | 17   | 124 $\pm$ 65 $\mu$ mol/l                            | 55  | 100 $\pm$ 80 $\mu$ mol/l                               | 0.032   |
| <b>Haematology at 24 h</b>            |  |   |   |  |         |
| Platelet count                        | 13   | 120 $\pm$ 54 $\times 10^9$ /l                       | 53  | 175 $\pm$ 90 $\times 10^9$ /l                          | 0.024   |
| <b>Blood gas analysis at 24 h</b>     |  |   |   |  |         |
| pH                                    | 9  | 7.24 $\pm$ 0.11                                     | 14  | 7.34 $\pm$ 0.05  | 0.006   |
| <b>Haematology at 48 h</b>            |  |   |   |  |         |
| Platelet count                        | 13   | 122 $\pm$ 44 $\times 10^9$ /l                       | 46  | 171 $\pm$ 95 $\times 10^9$ /l                          | 0.056   |

Only parameters with P<0.10 are shown.

**TABLE 4b: Univariate analysis of noncontinuous parameters associated with presence of *Actinobacillus* in the blood culture of 85 foals with bacteraemia**

| Parameter                                  | N for which parameter recorded | Variable over-represented in foals with <i>Actinobacillus</i> bacteraemia (no. with variable/no. of foals with <i>Actinobacillus</i> bacteraemia) | Variable over-represented in foals without <i>Actinobacillus</i> bacteraemia (no. with variable/no. of foals without <i>Actinobacillus</i> bacteraemia) | P value |
|--|--------------------------------|---|---|---------|
| <b>Admission physical examination</b>      |                                |   |   |         |
| Demeanour                                  | 85                             | Depressed (18/21)   | Alert and Responsive (26/64)  | 0.034   |
| Degree of consciousness                    | 85                             | Obtunded (9/21)   | Not obtunded (50/64)  | 0.088   |
| Physical signs of immaturity               | 84                             | Immature (9/21)   | No signs of immaturity (50/63)  | 0.083   |
| <b>Admission haematology</b>               |                                |   |   |         |
| Cytological features of 'band' neutrophils | 78                             | Marked toxic changes (5/19)   | No toxic changes noted (52/59)  | 0.088   |

Only parameters with P<0.10 are shown.

**TABLE 5a: Univariate analysis of continuous parameters associated with presence of *Streptococcus* in the blood culture of 85 foals with bacteraemia**

| Parameters                    | No. for which parameter recorded | Mean ( $\pm$ s.d.) of foals with <i>Streptococcus</i> | No. foals without specific bacteria in which parameter recorded | Mean ( $\pm$ s.d.) of foals without <i>Streptococcus</i> | P value |
|-------------------------------|----------------------------------|---|---|--|---------|
| <b>Total number of foals</b>  | 10                               |   | 75  |  |         |
| <b>Admission haematology</b>  |                                  |   |   |  |         |
| Total white cell count        | 9                                | 13.3 $\pm$ 8.5 $\times 10^9$ /l                       | 72  | 7.9 $\pm$ 6.6 $\times 10^9$ /l                           | 0.041   |
| Neutrophil count              | 9                                | 10.9 $\pm$ 7.5 $\times 10^9$ /l                       | 70  | 6.0 $\pm$ 6.0 $\times 10^9$ /l                           | 0.036   |
| Lymphocyte count              | 9                                | 1.5 $\pm$ 0.6 $\times 10^9$ /l                        | 70  | 1.2 $\pm$ 0.7 $\times 10^9$ /l                           | 0.062   |
| <b>Admission biochemistry</b> |                                  |   |   |  |         |
| Total protein concentration   | 9                                | 57 $\pm$ 9.4 g/l                                      | 69  | 51 $\pm$ 8.9 g/l   | 0.093   |
| <b>Haematology at 48 h</b>    |                                  |   |   |  |         |
| Monocyte count                | 6                                | 0.55 $\pm$ 0.15 $\times 10^9$ /l                      | 53  | 0.37 $\pm$ 0.34 $\times 10^9$ /l                         | 0.008   |
| <b>Biochemistry at 48 h</b>   |                                  |   |   |  |         |
| Chloride concentration        | 6                                | 103 $\pm$ 4 mmol/l                                    | 40  | 97 $\pm$ 6 mmol/l  | 0.026   |

Only parameters with P<0.10 are shown.

**TABLE 5b: Univariate analysis of noncontinuous parameters associated with presence of *Streptococcus* in the blood culture of 85 foals with bacteraemia**

| Parameter                                  | No. for which parameter recorded | Variable over-represented in foals with <i>Streptococcus</i> bacteraemia (no. with variable/no. of foals with <i>Streptococcus</i> bacteraemia) | Variable over-represented in foals without <i>Streptococcus</i> bacteraemia (no. with variable/no. of foals without <i>Streptococcus</i> bacteraemia) | P value |
|--|----------------------------------|---|---|---------|
| <b>Historical information</b>              |                                  |   |   |         |
| Parturition                                | 83                               | Dystocia (3/10)   | No dystocia reported (68/73)  | 0.052   |
| <b>Admission physical examination</b>      |                                  |   |   |         |
| Demeanour                                  | 85                               | Described as 'quiet, alert, responsive' (4/10)  | Considered to be either bright or depressed (66/75)   | 0.042   |
| <b>Haematology at 24 h</b>                 |                                  |   |   |         |
| Cytological features of neutrophils        | 66                               | Toxic changes (2/8)   | No toxic changes noted (55/58)  | 0.048   |
| Cytological features of 'Band' Neutrophils | 66                               | Toxic changes (3/8)   | No toxic changes noted (53/58)  | 0.022   |
| <b>Outcome</b>                             |                                  |   |   |         |
| Survival to hospital discharge             | 85                               | Did not survive (4/10)  | Survived (53/57)  | 0.074   |

Only parameters with P<0.10 are shown.