pregnancy (Fennestad and Borg-Petersen 1966) and this was certainly true in the present study since 70 per cent of the infected litters were either aborted in the last two weeks of pregnancy or were stillborn.

References

BERCOVICH, Z., SPEK, C. W. & COMVALIUS-ADRIANN, I. (1983) *Tijdschrift voor Diergeneeskunde* **108**, 133

DIKKEN, H. & KMETY, E. (1978) Methods in Microbiology, vol II. Eds T. Bogan & J. R. Norris. New York, Academic Press. p260

ELLIS, W. A., BRYSON, D. G., NEILL, S.D., McPARLAND, P. J. & MALONE, F.E. (1983a) *Veterinary Record* **112**, 291

ELLIS, W. A., BRYSON, D. G., O'BRIEN, J. J. & NEILL, S. D. (1983b) *Equine Veterinary Journal* **15**, 321

ELLIS, W. A., McPARLAND, P. J., BRYSON, D. G. & McNULTY, M. S. (1985a) *Veterinary Record* **117**, 66

ELLIS, W. A., MONTGOMERY, J. & CASSELLS, J. A. (1985b) *Research in Veterinary Science* **39**, 292

ELLIS , W. A., O'BRIEN, J. J. & CASSELLS, J. (1981) *Veterinary Record* **108**, 555

ELLIS, W. A., O'BRIEN, J. J., CASSELLS, J. A. & MONTGOMERY, J. (1983c) *Equine Veterinary Journal* **15**, 317

ELLIS, W. A., O'BRIEN, J. J., NEILL, S. D., FERGUSON, H. W. & HANNA, J. (1982) *Veterinary Record* **110**, 147

FARINA, R., ANDREANI, E. & TOLARI, F. (1977) *International Journal of Zoonoses* **4**, 38

FENNESTAD, K. L. & BORG-PETERSEN, C. (1966) *Journal of Infectious Diseases* **116**, 57

HATHAWAY, S. C., ELLIS, W. A., LITTLE, T. W. A., STEVENS, A. E. & FERGUSON, H. W. (1983a) *Veterinary Record* **113**, 153

HATHAWAY, S. C. & LITTLE, T. W. A. (1981) *Veterinary Record* **108**, 224

HATHAWAY, S. C., LITTLE, T. W. A., HEADLAM, S. A. & STEVENS, A. E. (1983b) *Veterinary Record* **113**, 233

HATHAWAY, S. C., LITTLE, T. W. A. & STEVENS, A. E. (1981) *Research in Veterinary Science* **31**, 169

HATHAWAY, S. C., LITTLE, T. W. A. & STEVENS, A. E. (1982) *Veterinary Record* **111**, 100

HATHAWAY, S. C., LITTLE, T. W. A., STEVENS, A. E., ELLIS, W. A. & MORGAN, J. (1983c) *Research in Veterinary Science* **35**, 64

HATHAWAY, S. C., LITTLE, T. W. A. & WRATHALL, A. E. (1983d) *British Veterinary Journal* **139**, 404

LITTLE, T. W. A. & HATHAWAY, S. C. (1983) Veterinary Annual, 23rd issue. Eds F. W. G. Hill & C. S. G. Grunsell. Bristol, John Wright & Sons. p116

MICHNA, S. W. (1962) *Veterinary Record* **74**, 917

MICHNA, S. W. & CAMPBELL, R. S. F. (1969) *Veterinary Record* **84**, 135

SCHNEIDERHAN, M. (1961) *Monatshefte für Tierhielkunde* **13**, 273

SEBEK, Z. & ROSICKY, B. (1975) *Zentralblatt für Bakteriologie, Parasitenkunde, Infektionskrankheiten und Hygiene. Abt Orig Reihe A* **233**, 380

THIERMANN, A. B., HANDSAKER, A. L., MOSELEY, S. L. & KINGSCOTE, B. (1985) *Journal of Clinical Microbiology* **21**, 585

WEBER, B. & FENSKE, G. (1978) *Monatshefte für Veterinarmedizin* **33**, 652

Effects of xylazine on renal function and plasma glucose in ponies

C. M. Trim, R. R. Hanson

Veterinary Record (1986) **118**, 65-67

The intravenous administration of xylazine (1·1 mg/kg bodyweight) in six ponies resulted in a significant increase in urine output over two hours, with maximum flow occurring between 30 and 60 minutes after injection. Urine specific gravity, osmolality and glucose concentration decreased. Renal clearance of endogenous creatinine was unchanged. Significant increases in the excretion of potassium and chloride occurred. Plasma glucose concentration was increased 30 minutes after the administration of xylazine by a mean value of 37 per cent. Serum osmolality and sodium, potassium and chloride concentrations remained unchanged.

XYLAZINE hydrochloride is commonly used as a sedative in animals. Increased urine production following the administration of xylazine has been reported in cattle (Thurmon and others 1978), cats (Hartsfield 1980) and horses (Thurmon and others 1984). Increased blood glucose levels have also resulted from xylazine sedation in cattle (Symonds 1976, Symonds and Mallinson 1978, Eichner and others 1979), cats (Feldberg and Symonds 1980), sheep (Brockman 1981, Muggaberg and Brockman 1982), dogs (Benson and others 1983) and horses (Thurmon and others 1982, 1984). This investigation of xylazine was designed to measure any increase in urine production, document changes in electrolyte loss and to establish whether alterations in renal function affected serum electrolyte concentrations in ponies.

C. M. Trim, BVSc, MRCVS, **R. R. Hanson**, DVM, Departments of Large Animal Medicine and Physiology-Pharmacology, College of Veterinary Medicine, University of Georgia, Athens, GA 30602, USA

R. R. Hanson's present address is College of Veterinary Medicine, Box J 116, JHMHC, University of Florida, Gainesville, FL 36201, USA

Materials and methods

Eight pony mares weighing between 154 and 334 kg (mean 241 kg) were used. The mares were brought in from pasture the day before the investigation and individually stalled with access to hay and water. The studies were performed in the summer, starting between 09.00 and 10.00, using two ponies simultaneously. A 14 gauge catheter (Terumo) with a three-way stopcock was placed in a jugular vein for collection of blood. Two to 3 ml of blood was withdrawn from the catheter and discarded before sampling and the catheter was flushed with 2 to 3 ml heparinised saline after each sampling. A sterile Foley catheter (Bard) with a 30 ml balloon was introduced into the urinary bladder for collecting urine. The bladder was emptied by alternately injecting air and aspirating with a syringe. Urine volume was measured with a graduated cylinder. Urine and blood were collected for measurement of specific gravity (TS meter; American Optical), osmolality (Osmette precision osmometer; Precision Systems Inc), glucose concentration (hexokinase method, Gilford 3500 Analyser), sodium and potassium concentrations (IL flame photometer 143), chloride (Corning chloride meter 920M), and creatinine concentration (kinetic, modified Jaffe method, Gilford 3500 Analyser). Blood glucose was measured on plasma harvested from blood collected into tubes containing potassium oxalate and sodium fluoride.

The bladder was initially emptied, the Foley catheter plugged and the mare returned to the stall for one hour. The mare was then tethered, the bladder emptied of urine and the volume measured. Urine and blood samples were collected for measurement of osmolality, glucose, sodium, potassium, chloride and creatinine, and urine specific gravity.

Xylazine hydrochloride (Rompun; Haver-Lockhart), (1·1 mg/kg bodyweight) was injected intravenously into six mares. Two others mares did not receive xylazine and were monitored for comparison. Extension tubing was connected to the Foley catheter and urine was allowed to run freely into a container. At 30, 60, 90 and 120 minutes after injection of

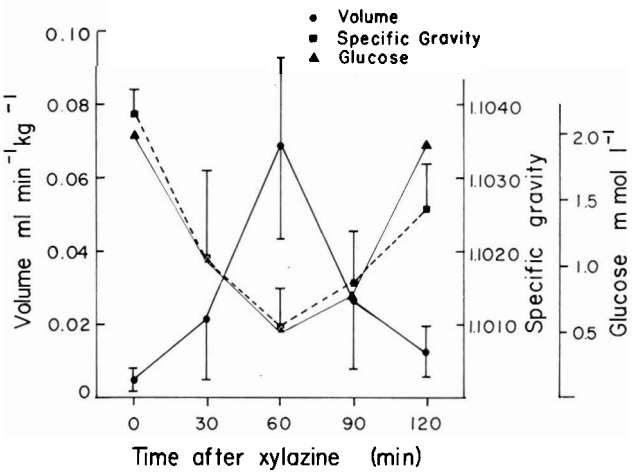

FIG 1: Urine volume (●), specific gravity (■), and glucose concentration (▲) before (time 0) and after intravenous injection of xylazine, 1·1 mg/kg, in six ponies. Data expressed as mean ± sd

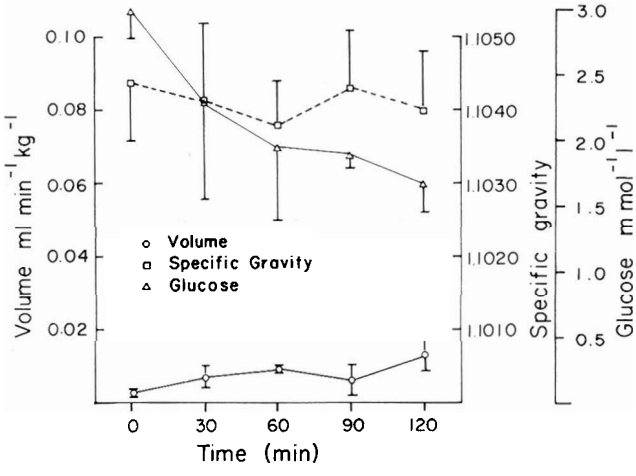

FIG 2: Urine volume (○), specific gravity (□), and glucose concentration (△) in two ponies determined one hour (time 0) after insertion of a Foley catheter in the bladder, and then every 30 minutes for two hours. Data expressed as mean ± sd

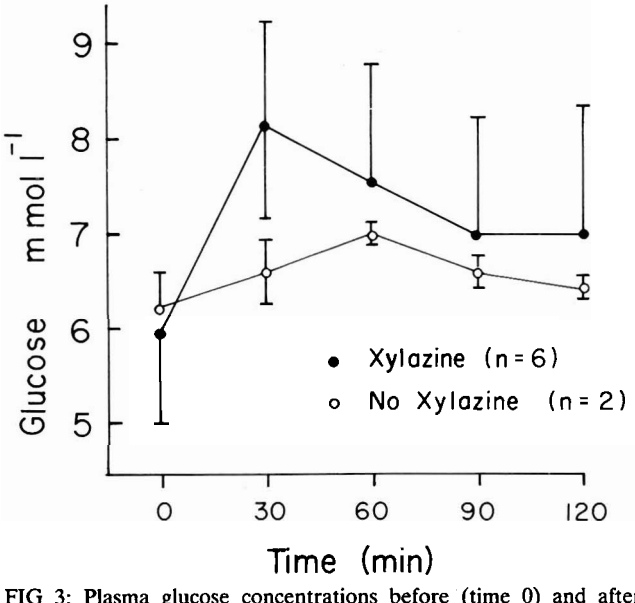

FIG 3: Plasma glucose concentrations before (time 0) and after intravenous injection of xylazine, 1·1 mg/kg, in six ponies (●). Plasma glucose concentrations of two unsedated ponies are given for comparison (○). Data expressed as mean ± sd

xylazine, a sample of urine was collected as it flowed from the catheter for the measurement of specific gravity and glucose, and blood was collected for determination of plasma glucose. The bladder was emptied and the volume of urine produced during each 30 minute period was measured. At 120 minutes the measurements made before the injection of xylazine were repeated on blood and urine. All the urine produced after the injection of xylazine was mixed and a sample was analysed for creatinine, sodium, potassium and chloride concentrations.

Renal clearance of endogenous creatinine before and after xylazine administration was calculated using the creatinine measurement in the pooled urine samples (Finco 1980). The ratios of the clearances of sodium, potassium and chloride to the clearance of creatinine were then calculated as percentages.

The results are expressed as the mean ± standard deviation. The data on specific gravity, urine volume, urine glucose and blood glucose were analysed using a one-way analysis of variance, followed by a Dunnett's test. These data were also analysed for curvilinear regression. Other data were compared using a paired *t* test. Sodium clearance was analysed using the Mann-Whitney test.

Results

All the ponies receiving xylazine became heavily sedated. The ponies began to show awareness of their surroundings after 50 minutes, and little sedation was evident 60 minutes after the injection of xylazine. Urine production increased after the injection, with a significant increase between 30 and 60 minutes ($P < 0.05$) (Fig 1). Urine specific gravity and glucose concentration decreased in a curvilinear fashion ($P < 0.01$) when the urine production increased (Fig 1). The specific gravity was significantly lower than control at all times, whereas the urine glucose concentration was significantly lower only at 60 minutes ($P < 0.05$). There was a small increase in urine production over three hours in the two ponies which did not receive xylazine (Fig 2). The urine glucose concentration was initially high but it decreased to a concentration similar to that measured in other mares before xylazine administration (Fig 2). Urine osmolality before xylazine was 1340 ± 186 mOsm/kg. This was significantly decreased at 120 minutes to 899 ± 153 and in the pooled urine to 547 ± 243 mOsm/kg ($P < 0.05$). In the ponies which did not receive xylazine urine osmolalities at corresponding times were 1531 ± 154, 1403 ± 318, and 1405 ± 202 mOsm/kg.

Serum sodium, potassium and chloride concentrations immediately before xylazine was administered were 139 ± 6, 3·9 ± 0·4 and 103 ± 6 mEq/litre, respectively. At 120 minutes these values were not different from the control period.

Plasma glucose was increased by 37 per cent at 30 minutes after the injection of xylazine ($P < 0.05$) (Fig 3).

Creatinine clearances before and after xylazine administration were 0·90 ± 0·41 and 1·13 ± 0·14 ml/minute/kg respectively. The direction of change varied between ponies

TABLE 1: Mean fractional clearances (±sd) of sodium, potassium and chloride in six ponies before and after intravenous injection of xylazine (1·1 mg/kg)

	Before xylazine	After xylazine
$\frac{C_{Na} \times 100}{C_{Cr}}$	0·10 ± 0·20	1·29* ± 1·24
$\frac{C_{K} \times 100}{C_{Cr}}$	34·78 ± 31·49	70·19* ± 40·79
$\frac{C_{Cl} \times 100}{C_{Cr}}$	1·59 ± 1·53	3·57† ± 1·77

Na Sodium Cl Chloride
Cr Creatinine * $P < 0.05$
K Potassium † $P < 0.01$

and the means were not statistically different. Similar values were obtained in the two unsedated ponies. The calculated mean values (± sd) for the fractional clearances of sodium, potassium and chloride are given in Table 1. The clearances for sodium and potassium ($P < 0.05$) and chloride ($P < 0.01$) were significantly increased after injection of xylazine.

Discussion

An increase in urine production after xylazine administration has been reported in cats, cattle and horses (Thurmon and others 1978, 1984, Hartsfield 1980). In cattle and horses the greatest increase occurred during the first hour and the effect lasted for two to three hours. More urine was produced after a large dose of xylazine than after a small dose. In cats the greatest volume of urine was collected in the second hour and the increase in urine production extended for at least four hours (Hartsfield 1980).

In this study the volume of urine collected during the one hour control period was at the low end of the range previously published fo normal ponies (Rawlings and Bisgard 1975) and horses (Tasker 1966). The low values may have been either the result of a higher environmental temperature or a physiological response to the insertion of a urinary catheter. The urine production of the two unsedated ponies also increased slightly (Fig 2). Injection of xylazine caused a marked increase in urine production over two hours. The urine produced was more dilute, as indicated by a decrease in specific gravity and osmolality, and a larger fraction of the electrolytes filtered were excreted.

The hyperglycaemic effect of xylazine in cattle has been well documented (Symonds 1976, Symonds and Mallison 1978, Eichner and others 1979). In one investigation, injection of xylazine (0·2 mg/kg) produced a maximum mean blood glucose concentration of 16·9 mmol/litre after three hours (Eichner and others 1979). The magnitude of the hyperglycaemia suggested that osmotic diuresis might be a mechanism for the increased urine production in cattle. However, in the authors' ponies and in horses (Thurmon and others 1982, 1984) blood glucose values which do not exceed the renal tubular maximum for reabsorption of glucose of 10·0 to 11·1 mmol/litre (Kaneko 1980) have been recorded. In this study xylazine sedation resulted in only a 37 per cent increase in plasma glucose at 30 minutes, with a maximum individual value of 9·2 mmol/litre. Similarly Thurmon and others reported that the highest plasma glucose values measured in individual horses were 8·9 mmol/litre (1982) and 8·3 mmol/litre (1984).

Clearance of endogenous creatinine has been demonstrated to correlate well with insulin clearance in the horse (Coffman 1980, Zatzman and others 1982). Creatinine clearance values after xylazine administration did not show a consistent change from control values. This suggested that xylazine increased urine production by mechanisms other than an increased glomerular filtration rate.

A single injection of xylazine produced no significant changes in serum osmolality or in sodium, potassium and chloride concentrations in our ponies, or in horses (Thurmon and others 1984). However, there is a possibility that hypovolaemia or electrolyte imbalance might occur when an animal is compromised and unable to restore fluid balance. For example, a horse with colic is often given one or several injections of xylazine to control pain. Xylazine administered early in the course of the disease could precipitate hypovolaemia if urine production were increased. Furthermore, an increased loss of potassium in the urine could potentiate the hypokalaemia which develops in animals with intestinal obstruction. Thurmon and others (1984) demonstrated that the effect of xylazine on urine production and electrolyte excretion was considerably less at a dose of 0·5 mg/kg than at 1·1 mg/kg. Injections of xylazine in a horse with colic should therefore be as small as possible to limit the effects on its water and electrolyte balance.

Acknowledgements.— This work was supported by the Bolshoi Equine Research Fund. Thanks are extended to Cindy Jo Brown for her technical assistance, and to Dr John Brown, department of medical microbiology, for the statistical analysis.

References

BENSON, G. J., THURMON, J. C. & TRANQUILLI, W. J. (1983) Presented at the American College of Veterinary Anesthesiologists Annual Scientific Meeting, Atlanta
BROCKMAN, R. P. (1981) *Research in Veterinary Science* **30**, 383
COFFMAN, J. (1980) *Veterinary Medicine/Small Animal Clinician* **75**, 671
EICHNER, R. D., PRIOR, R. L. & KVASNICKA, W. G. (1979) *American Journal of Veterinary Research* **40**, 127
FELDBERG, W. & SYMONDS, H. W. (1980) *Journal of Veterinary Pharmacology and Therapeutics* **3**, 197
FINCO, D. R. (1980) Clinical Biochemistry of Domestic Animals, 3rd edn. Ed J. J. Kaneko. New York, Academic Press. p338
HARTSFIELD, S. M. (1980) Presented at the American College of Veterinary Anesthesiologists Annual Scientific Meeting, St Louis
KANEKO, J. J. (1980) Clinical Biochemistry of Domestic Animals, 3rd edn. Ed J. J. Kaneko. New York, Academic Press. p2
MUGGABERG, J. & BROCKMAN, R. P. (1982) *Research in Veterinary Science* **33**, 118
RAWLINGS, C. A. & BISGARD, G. E. (1975) *American Journal of Veterinary Research* **36**, 45
SYMONDS, H. W. (1976) *Veterinary Record* **99**, 234
SYMONDS, H. W. & MALLINSON, C. B. (1978) *Veterinary Record* **102**, 27
TASKER, J. B. (1966) *Cornell Veterinarian* **56**, 649
THURMON, J. C., NEFF-DAVIS, C., DAVIS, L. E., STOKER, R. A., BENSON, G. J. & LOCK, T. F. (1982) *Journal of Veterinary Pharmacology and Therapeutics* **5**, 241
THURMON, J. C., NELSON, D. R., HARTSFIELD, S. M. & RUMORE, C. A. (1978) *Australian Veterinary Journal* **54**, 178
THURMON, J. C., STEFFEY, E. P., ZINKL, J. G., WOLINER, M. & HOWLAND, D. (1984) *American Journal of Veterinary Research* **45**, 224
ZATZMAN, M. L., CLARKE, L., RAY, W. J., GARNER, H. E. & TRAVER, D. (1982) *American Journal of Veterinary Research* **43**, 608

Occult blood in bovine faeces

HEMOFEC and the Sangur test kits (Boehringer Mannheim) were suitable for the diagnosis of occult blood in faeces. Non-specific reactions with the semi-quantitative method could be avoided by appropriate dilution of the sample with distilled water (1:800). While the HemoFEC test involves 24 hours incubation, the semi-quantitative Sangur test can be read almost at once. When 25 g faeces was mixed with 0·5 ml blood, a positive reaction was obtained with sequential dilution to 1:6400.

FISCHER, W. (1985) *Tierärztliche Umschau* **40**, 931

Death from fire

FOLLOWING reports of possible offences against West German animal welfare legislation, a government veterinarian visited a farm and noted some cattle carcases. The official joint veterinary inspection the following day could not be carried out as the building had burned down, killing all the remaining cattle. Slaughterhouse examination of all carcases suggested some cattle had been dead at the time of the fire. The authors were instructed to examine the respiratory tracts and concluded that the presence of soot particles in the tracheobronchial and alveolar regions was prima facie evidence that the individual had died in the fire. Special stains differentiated and eliminated the possibility of anthracosis, melanin or iron pigment, or artefacts of formalin fixation. Further features diagnostic of death from fire suffocation included epithelial necrosis in the trachea and bronchi, and shock lesions (coagulopathy). The results are similar to those reported in human forensic studies.

SCHOON, H. A., MURMANN, W., SCHULZ, L. C., KIKOVIC, D. & MESSOW, C. (1985) *Deutsche tierärztliche Wochenschrift* **97**, 372