Polly Schoning,[1] *D.V.M., Ph.D. and*
A. C. Strafuss,[1] *D.V.M., Ph.D.*

Postmortem Sera and Cerebrospinal Fluid Enzymes

REFERENCE: Schoning, P. and Strafuss, A. C., **"Postmortem Sera and Cerebrospinal Fluid Enzymes,"** *Journal of Forensic Sciences*, JFSCA, Vol. 25, No. 2, April 1980, pp. 344-348.

ABSTRACT: Antemortem and postmortem sera from 60 dogs were evaluated for lipase, amylase, alkaline phosphatase, γ-glutamyltransferase, and alanine aminotransferase (AAT); cerebrospinal fluid was examined for AAT and alkaline phosphatase. The postmortem intervals were 3, 6, 12, 24, and 48 h at temperatures of 4, 20, and 37°C. Amylase levels remained stable at 4 and 20°C and may be beneficial for diagnosing pancreatitis. Lipase levels may be useful as an adjunct to amylase values. Serum alkaline phosphatase values increased with postmortem interval; values were higher at 37°C than at 4°C. Other enzymes were of little value for diagnosis.

KEY WORDS: pathology and biology, enzymes, postmortem examinations

Serum alanine aminotransferase (SAAT) and γ-glutamyltransferase (γGT) are specific for hepatic disease; alkaline phosphatase supports the diagnosis. An elevated serum lipase level is diagnostic for acute pancreatic necrosis. The serum amylase level increases with pancreatic necrosis; its increase from stress is questionable. Reported evaluations of enzymes in postmortem sera [*1-4*] and cerebrospinal fluid [*5,6*] are scarce.

In the study reported here, antemortem values for AAT, γGT, alkaline phosphatase, amylase, and lipase in canine sera and for AAT and alkaline phosphatase in cerebrospinal fluid are tabulated. The effects of postmortem time and temperature on those factors are also recorded.

Materials and Methods

Experimental dogs and procedures were described previously [*7*].

Values for AAT and alkaline phosphatase in sera and cerebrospinal fluid were determined with a Micro SMA/12-60 (Technicon Instruments, Inc., Tarrytown, N.Y.). The γGT values were obtained with an Abbott ABA-100 (Abbott Labs, N. Chicago, Ill.). Amylase and lipase levels were determined with a Perkin-Elmer Nephelometer, Model 91.

Contribution 79-299-j, Department of Pathology, Kansas Agricultural Experiment Station. Received for publication 31 July 1979; accepted for publication 10 Oct. 1979.

[1]Veterinary pathologists, Department of Pathology, College of Veterinary Medicine, Kansas State University, Manhattan, Kans.

Results

Antemortem means, standard deviations, ranges, and sample sizes are given in Table 1.

Serum amylase values for dogs in the 20 and 4°C groups, although higher than antemortem values, appeared stable; means ranged from 172.75 to 293.25 units (Table 2). Although the 3- and 6-h groups at 37°C were within this range, the 12- and 24-h groups had significantly lower values. The antemortem-postmortem difference for the dogs held at 20 and 4°C ranged from a drop of 18 units to an increase of 57.5 units.

Serum lipase values increased by 1.2 to 14.7 times the antemortem values (Table 3). The postmortem mean range was 0.2 to 2.64 units. The antemortem-postmortem difference rose between 0.0625 and 2.125 units.

Gamma-glutamyltransferase (γGT) levels increased in four groups after death and decreased in 7 (Table 4). In groups that did not differ statistically (excluding 37°C, 12 h), the postmortem mean varied from 0 to 6.625. Postmortem values were influenced by neither time nor temperature.

Values for SAAT increased markedly after death, from 19.989 to 186.25 mU/ml (Table 5). Increases were related neither to time nor temperature.

Alkaline phosphatase levels increased as early as 3 h and rose continually with time (Table 6). Temperature effected increases at 12 h and later; levels were 2.2 times antemortem values at 4°C, 48 h; 5.6 times at 20°C, 24 h; and 5.5 times at 37°C, 12 h.

Postmortem means for alkaline phosphatase levels in cerebrospinal fluid ranged from 2.5 to 72; the group at 37°C for 12 h was excluded because it differed significantly (Table 7).

TABLE 1—*Antemortem enzyme levels in canine serum and cerebrospinal fluid (CSF).*

Enzyme	Sample Size	Mean	Range	Standard Deviation
Amylase, units	60	242.92	108-541	74.22
Lipase, units	60	0.35	0-0.99	0.25
Alkaline phosphatase, mU/ml	60	73.43	4-248	47.27
SAAT mU/ml	60	42.25	10-660	83.03
γGT, IU	60	1.78	0-13	2.56
Alkaline phosphatase—CSF, mU/ml	60	2.39	0-17	2.78
AAT—CSF, mU/ml	59	0.14	0-2	0.47

TABLE 2—*Postmortem means (upper number), difference means (lower number) between postmortem and antemortem means, and sample size for amylase (Model 91 units) in canine blood.*

	Postmortem Hours				
Temperature	3	6	12	24	48
4°C	256^{a}*	268^{a}	212^{a}	172.75^{a}	223.6^{a}
	$n = 4$	$n = 4$	$n = 4$	$n = 4$	$n = 3$
	27.25^{wx}**	4.5^{wx}	7.5^{wx}	18^{w}	21.6^{wx}
20°C	293.25^{a}	218^{a}	272^{a}	210^{a}	...
	$n = 4$	$n = 4$	$n = 2$	$n = 2$	...
	57.5^{x}	0.75^{wx}	4^{wx}	12.5^{wx}	...
37°C	275^{a}	268.5^{a}	120^{ab}	12.5^{b}	...
	$n = 4$	$n = 2$	$n = 1$	$n = 2$	...
	18^{wx}	27^{vw}	108^{v}	236^{u}	...

*Postmortem means with different superscripts are significantly different ($P < 0.05$).
**Difference means with different superscripts are significantly different ($P < 0.05$).

TABLE 3—*Postmortem means (upper number), difference means (lower number) between postmortem and antemortem means, and sample size for lipase (Model 91 units) in canine blood.*

	Postmortem Hours				
Temperature	3	6	12	24	48
4°C	0.2^{c}*	1.0475^{bc}	0.8^{bc}	0.995^{bc}	1.0066^{bc}
	$n = 4$	$n = 4$	$n = 4$	$n = 4$	$n = 3$
	0.0625^{x}**	0.7875^{xy}	0.71^{x}	0.9275^{xy}	0.65^{x}
20°C	0.465^{c}	0.585^{bc}	0.94^{bc}	1.2^{bc}	...
	$n = 4$	$n = 4$	$n = 2$	$n = 2$	...
	0.26^{x}	0.1975^{x}	0.75^{xy}	0.825^{xy}	...
37°C	0.9275^{bc}	0.735^{bc}	2.25^{ab}	2.64^{a}	...
	$n = 4$	$n = 2$	$n = 1$	$n = 2$	...
	0.695^{x}	0.15^{x}	1.44^{xy}	2.125^{y}	...

*Postmortem means with different superscripts are significantly different ($P < 0.05$).
**Difference means with different superscripts are significantly different ($P < 0.05$).

TABLE 4—*Postmortem means (upper number), difference means (lower number) between postmortem and antemortem means, and sample size for γGT (IU) in canine blood.*

	Postmortem Hours				
Temperature	3	6	12	24	36
4°C	0^{b}*	0^{b}	0^{b}	6.625^{b}	2.625^{b}
	$n = 4$	$n = 4$	$n = 4$	$n = 4$	$n = 4$
	-1.25^{x}**	0^{x}	-3^{x}	3.125^{x}	2.375^{x}
20°C	3.5^{b}	0^{b}	0^{b}	0^{b}	...
	$n = 4$	$n = 4$	$n = 2$	$n = 2$	...
	-2^{x}	-1.5^{x}	0^{x}	-4^{x}	...
37°C	3.2^{b}	0^{b}	20^{a}	0^{b}	...
	$n = 4$	$n = 3$	$n = 1$	$n = 2$	...
	2.45^{x}	-1.3^{x}	18^{y}	-1.5^{x}	...

*Postmortem means with different superscripts are significantly different ($P < 0.05$).
**Difference means with different superscripts are significantly different ($P < 0.05$).

TABLE 5—*Postmortem means (upper number), difference means (lower number) between postmortem and antemortem means, and sample size for SAAT (mU/ml) in canine blood.*

	Postmortem Hours				
Temperature	3	6	12	24	36
4°C	389.25^{c}*	1082.5^{c}	2372.5^{c}	5732.5^{b}	3083.75^{bc}
	$n = 4$	$n = 4$	$n = 4$	$n = 4$	$n = 4$
	358.25^{x}**	1054^{x}	2315.75^{xy}	5696.5^{y}	3057.5^{xy}
20°C	374.75^{c}	2033.5^{c}	1330^{c}	1900^{c}	...
	$n = 4$	$n = 4$	$n = 2$	$n = 2$	...
	186.25^{x}	2009.25^{xy}	1315.5^{x}	1859.5^{xy}	...
37°C	998.75^{c}	903.75^{c}	20000^{a}	...	...
	$n = 4$	$n = 4$	$n = 1$	...	...
	955.25^{x}	873^{x}	19989^{z}	...	...

*Postmortem means with different superscripts are significantly different ($P < 0.05$).
**Difference means with different superscripts are significantly different ($P < 0.05$).

TABLE 6—*Postmortem means (upper number), difference means (lower number) between postmortem and antemortem means, and sample size for alkaline phosphatase (mU/ml) in canine blood.*

	Postmortem Hours				
Temperature	3	6	12	24	36
4°C	92.375^{a}*	156.75^{a}	134.175^{a}	164.875^{a}	255.75^{a}
	$n = 4$	$n = 4$	$n = 4$	$n = 4$	$n = 4$
	23.875^{x}**	60.5^{x}	66.425^{x}	109.125^{xy}	135^{xy}
20°C	72.25^{a}	132.75^{a}	179^{a}	390^{a}	...
	$n = 4$	$n = 4$	$n = 2$	$n = 2$	...
	8.25^{x}	57.25^{x}	77.5^{xy}	325^{y}	...
37°C	176.75^{a}	230.25^{a}	410^{a}	...	...
	$n = 4$	$n = 4$	$n = 1$	...	...
	118.25^{xy}	130^{xy}	276^{xy}	...	...

*Postmortem means with different superscripts are significantly different ($P < 0.05$).
**Difference means with different superscripts are significantly different ($P < 0.05$).

TABLE 7—*Postmortem means (upper number), difference means (lower number) between postmortem and antemortem means, and sample size for alkaline phosphatase (mU/ml) in canine cerebrospinal fluid.*

	Postmortem Hours				
Temperature	3	6	12	24	36
4°C	9.5^{b}*	5^{b}	2.5^{b}	25.5^{b}	15^{b}
	$n = 4$	$n = 1$	$n = 4$	$n = 4$	$n = 1$
	9.5^{x}**	0^{x}	2.5^{x}	24.7^{x}	15^{x}
20°C	29.5^{b}	...	72^{b}	42.3^{b}	...
	$n = 4$	...	$n = 2$	$n = 3$	...
	27.5^{x}	...	67^{x}	38.6^{x}	...
37°C	41.3^{b}	25.25^{b}	400^{a}	...	...
	$n = 3$	$n = 4$	$n = 3$	...	...
	39^{x}	20.75^{x}	395^{y}	...	...

*Postmortem means with different superscripts are significantly different ($P < 0.05$).
**Difference means with different superscripts are significantly different ($P < 0.05$).

Values varied without correlation with time or temperature. Values for AAT in cerebrospinal fluid rose from an average antemortem value of 270.5 mU/ml to an average of 2301.1 mU/ml (range, 8 to 1178 mU/ml) (Table 8).

Discussion

Serum amylase and lipase levels can increase five to seven times normal with acute pancreatitis. Since the pancreas undergoes autolysis early, high postmortem amylase findings would help in diagnosing pancreatitis. Enticknap [2] reported postmortem amylase findings in man to be three to four times normal. In our study the amylase level increased but in no instance did it increase more than 1.5 times its antemortem level. It may be hypothesized that a high antemortem amylase level would be retained after death.

Lipase levels rose after death but interpreting why is difficult for two reasons: first, the postmortem range was narrow, 0.2 to 2.64 units, and second, postmortem levels sometimes rose above eight times the antemortem levels. However, values may help support a diagnosis of pancreatitis, if, for instance, the amylase level is elevated.

The alkaline phosphatase level [1,2,4] rises after death. Enticknap [2] reported an in-

TABLE 8—*Postmortem means (upper number), difference means (lower number) between postmortem and antemortem means, and sample size for AAT (mU/ml) in canine cerebrospinal fluid.*

	Postmortem Hours				
Temperature	3	6	12	24	36
4°C	12.25^{c}*	8^{c}	19.6^{c}	...	95^{bc}
	$n = 4$	$n = 1$	$n = 3$	...	$n = 1$
	12.25^{x}**	6^{x}	19.6^{x}	...	95^{x}
20°C	85.75^{c}	...	1038.5^{ab}	371^{bc}	...
	$n = 4$	...	$n = 2$	$n = 3$	...
	85.75^{x}	...	1038^{xy}	371^{x}	...
37°C	38.3^{c}	45.25^{c}	1178^{a}	...	...
	$n = 3$	$n = 4$	$n = 3$	...	...
	37.6^{x}	45.25^{x}	1178^{y}	...	...

*Postmortem means with different superscripts are significantly different ($P < 0.05$).
**Difference means with different superscripts are significantly different ($P < 0.05$).

crease of ten times the antemortem value at 48 h. In our study, levels increased with time, thus supporting the work of others [*1*,*2*,*4*]. Temperature also affected values. Increases over antemortem levels were much less at 4°C than at 37°C. Levels were twice as high at 4°C, 48 h and 5.5 times as high at 37°C, 12 h.

Sera AAT and γGT, as well as cerebrospinal fluid AAT and alkaline phosphatase, appeared to offer no diagnostic aid. Although both enzyme levels fluctuated, often sharply, their values correlated with neither time nor temperature. Perhaps more elaborate instrumentation or different handling of specimens would yield more reliable results, but use of standard, acceptable techniques resulted in insignificant levels.

References

[*1*] Coe, J. I., "Postmortem Chemistries on Blood with Particular Reference to Urea Nitrogen, Electrolytes, and Bilirubin," *Journal of Forensic Sciences*, Vol. 19, No. 1, Jan. 1974, pp. 33-42.
[*2*] Enticknap, J. B., "Biochemical Changes in Cadaver Sera in Fatal Heart Attacks," *Journal of Forensic Medicine*, Vol. 7, 1960, pp. 135-146.
[*3*] Hall, W. E. B., "The Medico-Legal Application of the Serum Transaminase Test," *Journal of Forensic Sciences*, Vol. 3, 1958, pp. 117-122.
[*4*] Naumann, H. N., "Postmortem Liver Function Tests," *American Journal of Clinical Pathology*, Vol. 26, No. 5, May 1956, pp. 495-505.
[*5*] Cavallo, T., Machado, A. B. B., Rocha, A. G., and Galhardo, N., "O Liquido Cefalorraqueano No Post-Mortem," *Arquivos de Neuro-Psiquitria* (Sao Paulo), Vol. 27, 1969, pp. 294-307.
[*6*] Dito, W. R., "Transaminase Activity in Postmortem Cerebrospinal Fluid," *American Journal of Clinical Pathology*, Vol. 42, No. 4, Oct. 1964, pp. 360-363.
[*7*] Schoning, P. and Strafuss, A. C., "Postmortem Biochemical Changes in Canine Vitreous Humor," *Journal of Forensic Sciences*, Vol. 25, No. 1, Jan. 1980, pp. 53-59.

Address requests for reprints or additional information to
Polly Schoning, D.V.M., Ph.D.
Department of Pathology
Kansas Agricultural Experiment Station
College of Veterinary Medicine
Kansas State University
Manhattan, Kans. 66506