The organophosphorus and carbamate insecticides inhibit cholinesterase, causing an increase of acetylcholine at neuromuscular junctions. Toxicosis due to anticholinesterase compounds can be diagnosed by finding depressed cholinesterase activity in the blood, brain, and/or retina. Cholinesterase activity < 50% of normal has been associated with significant exposure to an anticholinesterase agent. Cholinesterase activity < 25% of normal is considered indicative of severe poisoning.

Previous studies have demonstrated that cholinesterase activity differs among regions of the central nervous system. Miniature swine have twice the cholinesterase activity in the cerebellum as in the cerebral cortex. The acetylcholinesterase activity in the cerebral cortex is about two-thirds lower than that in the cerebellum of guinea pigs but is about the same in both regions for the rat and monkey. In rabbits, the retina has lower acetylcholinesterase activity than do regions of the brain. The cerebellum, occipital lobe, and parietal lobe have similar activities, which are between those for the retina and those for the temporal lobe. The frontal lobe has acetylcholinesterase activity up to twice that of other regions of the brain.

Previous work measuring cholinesterase activity was performed using homogenates of entire brains. However, when submitting samples from large animals such as horses and cows, it is common practice for the referring veterinarian to only submit part of the brain. Because cerebral tissue appears similar regardless of the area sampled, the diagnostician often does not know which part of the brain is being tested. Therefore, the cholinesterase activity of the sample could possibly differ from the normals established using whole brain even if the animal has not been exposed to an anticholinesterase agent.

The purpose of this study was to measure the total cholinesterase activity of various areas of equine nervous tissue and to compare those activities with that of the half brain.

Brains and eyes were collected from 10 horses. The horses had been euthanized with intravenous barbiturate because of unrepairable musculoskeletal damage that occurred on the racetrack. None of the horses were known to be exposed to anticholinesterase agents.

The brains were cut in half sagittally. One half of each brain (cerebrum, cerebellum, brain stem) was homogenized. The other half was separated into frontal lobe, parietal lobe, temporal lobe, occipital lobe, cerebellum, and brain stem. Each entire section was homogenized. The eyes were cut circumferentially just posterior to the cornea. The retina was cut from the optic disc and removed with forceps.

The brain sections and retinas were analyzed for total cholinesterase activity. The technique used was an adaptation of the Ellman procedure, which has been previously described. Acetylthiocholine iodide was used as a substrate, and both acetylcholinesterase and butyrylcholinesterase activities were measured with this technique.

All cholinesterase activities were reported as µmole/gram/minute, and the mean and (SD) for each region of the brain was calculated (Table 1). The mean and (SD) of the half brain was similar to that previously reported in normal horses, indicating that these samples came from animals that had not had recent exposure to anticholinesterase agents. The activities in the frontal and temporal lobes most closely matched that of the half brain. The frontal lobe had the greatest range of activities.

The least variation among horses was found in the occipital and parietal lobes. These lobes had lower cholinesterase activities than did the other sections; their mean activity levels were < 50% of those of the other sections. Therefore, had these lobes been submitted for analysis without being identified, the diagnostician could erroneously interpret the cholinesterase activities and conclude that the horse had been exposed to an anticholinesterase insecticide.

The cerebellum and retina had much higher cholinesterase activities than did the other sections. In individual horses, the mean and (SD) of the half brain was similar to that previously reported in normal horses, indicating that these samples came from animals that had not had recent exposure to anticholinesterase agents. The activities in the frontal and temporal lobes most closely matched that of the half brain. The frontal lobe had the greatest range of activities.
the retina activity was always lower than that of the cerebellum. However, these activities did not correspond; the retina activities were between 35% and 95% of the cerebellar activities for individual horses.

Studies done in cattle³ and cats² have demonstrated that retinal cholinesterase depression parallels brain cholinesterase depression in animals suffering from organophosphorus insecticide toxicosis. Additional studies must be performed to determine the effect of anticholinesterase insecticides on individual regions of the equine brain. However, the present study demonstrates that interpretations of brain cholinesterase activity in the horse should be more cautious whenever the region of the brain being analyzed is unknown.

Acknowledgements. We thank Dr. Albert Mughannam for his ophthalmology advice and Frank Brown, Traci Francis, and Mine Palazoglu for their technical assistance.

References