Drugs and race horse performance

Thomas Tobin, Steven G. Kamerling and R. L. Anderson

Since 1900, stimulant drugs have been used illegally to improve the performance of racing horses. Classic performance trials with small numbers of horses have failed to detect drug effects on maximal performance. Careful characterization of the responses of horses to illegal drugs, followed by studies in large numbers of racing horses are required to demonstrate performance effects of drugs in horses. In an article which contains no TIPs tips, Thomas Tobin and his colleagues describe and analyse the various 'dope tests' that have been used and discuss their impact on the racing world.

In the early 1900s, George Lambton, a leading English racehorse trainer, publicly announced that he was 'doping' horses with newly available American 'dopes'. His purpose was to demonstrate to the English Jockey Club what stimulant medications could do for racing horses. What the performance effects of these treatments were is not recorded, but the regulatory effects of his experiments are still with us. Based on Lambton's work, the Jockey Club banned the use of drugs in racing horses, and made the penalty for violation 'ruling off'[1]. Since then, virtually all racing jurisdictions have banned the use of stimulant medications in racing horses, and enforce the ban by chemical testing. While we still do not know how effective these medications are in racing horses, a number of investigators have tried to answer this question. Unfortunately, this is a difficult question to answer and the experimental approaches to this problem are most conveniently divided into four categories (Table I).

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The maximal output performance experiment

The simplest approach to this problem is in the maximal output performance or Horseman's Experiment[2], so-called because these are the people who usually suggest it. In this experiment, one runs about six horses, with or without the drug, for about a mile at top speed. The distinguishing characteristic of this experiment is that the control horses are run at maximal output, and the drug is being asked to produce a supramaximal performance. Drugs studied in this type of experiment include amphetamine, furosemide and the anabolic steroids[3-6]. Perhaps, not unexpectedly, such a

TABLE I. Experimental approaches to the effects of drugs on equine performance

1 'Maximal output experiment': run horses ± drug at top speed for one mile
2 'Sub-maximal output experiment': trot or canter horses ± drug for short distances
3 'Pharmacologist's experiment': study the effects of drugs on simple behavioral models
4 'Statistician's experiment': retrospective study of times ± drug in large numbers of horses

Trends in Pharmacological Sciences. Vol. 6, No. 3. March 1985(67):129-132.

TABLE II. Results of maximum output performance tests

Drug	Control	Test	Test–Control	n	% Change	Conclusion
Furosemide[3]	136.33	136.00	−0.33 ± 1.59	5	−0.24	no sig. diff.
Furosemide[4]	146.7	145.2	−1.5	6	−1.02	no sig. diff.
Amphetamine[5]				3	+2.4	no sig. diff.
Nandrolone[6]	72.8 ± 1.8	75.8 ± 1.76	3.0 ± 2.5	6	4.1	no sig. diff.

Only Ref. 3 presents actual performance times for each horse. Report no. 4 provides mean and range, with the notation that the effect is non-significant. Report no. 5 provides only maximum, minimum and mean percent changes. In study no. 6, a cross-over study, the investigator simply notes that his second period times were 4.1% slower than his first period times. Based on the data of Ref. 3, testing at the 5% level and desiring a significant result 80% of the time, furosemide would have to produce an increment in performance of 5.08 seconds or of 3.75%.

drug-induced supra-maximal performance effect has yet to be demonstrated.

The problem with this experiment is that the drug effect is likely to be small, while the noise or background variability found in the controls may be large. We are aware of four such studies in racing horses, and all have yielded negative results (Table II).

More recently, we analysed the data from these experiments to determine the potential for these tests to produce statistically significant results (Table II). Unfortunately, no other workers have presented individual data points or a mean and a statistical estimate of the variance encountered in their performance trials. However, on the basis of the variance reported in time trial work from our laboratory, one would need a performance improvement about 3.75% on top of an already maximal performance in control animals for statistical significance (Table II). This is a large increment in performance to expect of any medication, and is unlikely to be observed in the small number of animals tested in maximal output performance experiments to date.

The sub-maximal performance experiment

A modification of the maximal performance experiment is to run the horses at less than maximal output with and without the drug. Because the horses are not being tested at maximal output, there is a better chance of obtaining statistically significant results. Using this approach, which I call the 'Quasi Horseman's' experiment, a number of workers have reported statistically significant effects of drugs in horses. However, the problem with this experiment is that one cannot know whether the effect obtained is a behavioral or a performance effect. Therefore, while this experiment will yield statistically significant data, it cannot answer the fundamental question being asked, which is whether or not the drug being tested will actually improve racing performance.

This experimental approach has been taken by Sanford in England and by Fujii in Japan[1]. Some of Sanford's data, which are typical of the data generated by this approach, are presented in Table III. With this type of experiment, Sanford reported statistically significant effects of drugs in gallop tests, but how these data may relate to effects of drugs on maximal or near maximal performance is not clear.

The pharmacologist's experiment

A much more effective way of asking questions about the effects of drugs in horses is to test their actions in simple behavioral models[7]. For example, narcotic analgesics in the horse produce a well-defined locomotor response which can be accurately measured by simply counting steps that the animal takes with its left front leg (Fig. 1). Using this model, one can generate classic dose and time response data for these drugs in the horse (Fig. 2) and demonstrate the likelihood of performance effects. These models produce data similar qualitatively to that obtained with the sub-maximal output performance experiment, but which are far more detailed and informative. For example, these experiments can identify dosage rates and times post-dosing at which one may expect to obtain peak drug effects. They can also show that some drugs do not produce consistent behavioral effects in the horse, and that the effective doses of some drugs can vary up to 100-fold between individual horses[7]. For these reasons, simple behavioral experiments are useful, if not necessary, before performance experiments of any kind can be attempted in horses.

The necessity of careful characterization of the pharmacological actions of drugs in horses was brought home to us by our experiments with fentanyl. Fentanyl is a highly lipid-soluble narcotic analgesic, about 80 times more potent than morphine, which was reportedly widely used in racing horses in America during the 1970s. When we started our performance work on this drug, we used the dose and routes of administration (0.25 mg horse^{-1}, 30 min. before race time) report-

TABLE III. Gallop test 2 × 200 m. Compounds increasing speed significantly $P < 0.05$

Compound	Dose (mg kg^{-1})	Route	Number tested
Methylamphetamine	0.1	i.m.	3
	0.2	i.m.	1
Methylphenidate	0.25	s.c.	4
	0.5	s.c.	4
Pemoline	4.0	oral	4
	8.0	oral	4
Caffeine	2.0	oral	3
	4.0	oral	3
Phenylbutazone	8.0	oral	1
	6.6	i.m.*	4

* Injection made 23 h before test. In these gallop tests, horses were run singly over a 200-metre course from a flying start. After an interval of about 5 min, during which period the horse returned to the start at a trot or slow canter, this gallop was repeated. No data on the dosing times, the actual performance times, or the variability in the performance times on which these conclusions were drawn were presented.

Source: Sanford, Symposium on Large Animal Therapeutics, University of Surrey, Guildford, Surrey, 1978. Courtesy of Blackwell Scientific Publications.

Cited in Tobin, T., 'Drugs and the Performance Horse', 1981.

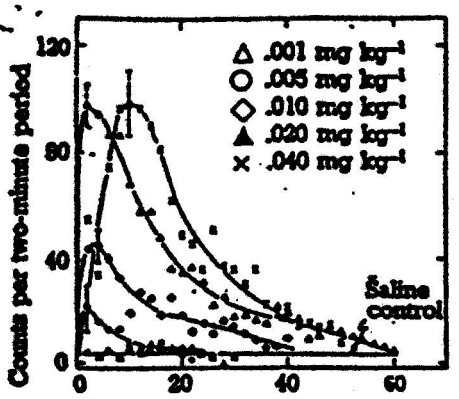


Fig. 1. Effect of fentanyl on spontaneous locomotor activity in four horses. Horses were injected with saline or increasing doses of fentanyl i.v. The average counts per two-min period following saline injection are shown by the straight line near the bottom of the graph. The response to 0.001 mg kg⁻¹ fentanyl is shown by the open triangles (△—△); 0.005 mg kg⁻¹ by open circles (○—○); 0.010 mg kg⁻¹ by open diamonds (◇—◇); 0.020 mg kg⁻¹ by solid triangles (▲—▲); and 0.040 mg kg⁻¹ by crosses (×—×). At the highest dose tested, all horses showed a loss of co-ordination resulting in a decrease in locomotion during the first six min. All points are the means of counts determined on four horses and the vertical bars represent S.E.M.s Reproduced with permission from *Ref.* 1.

edly used illegally on the racetrack. In this work, we saw no behavioral or performance effects due to fentanyl whatsoever.

Later, when we increased the dose of fentanyl for kinetic studies, we discovered the characteristic behavioral effects presented in Fig. 1. It then became apparent to us that the behavioral effects of fentanyl require a minimum dose of about 2–3 mg horse^{-1} and that the drug has to be given i.v. This lesson brought home to us the necessity of defining carefully the pharmacology of a drug in racing horses before starting expensive performance experiments.

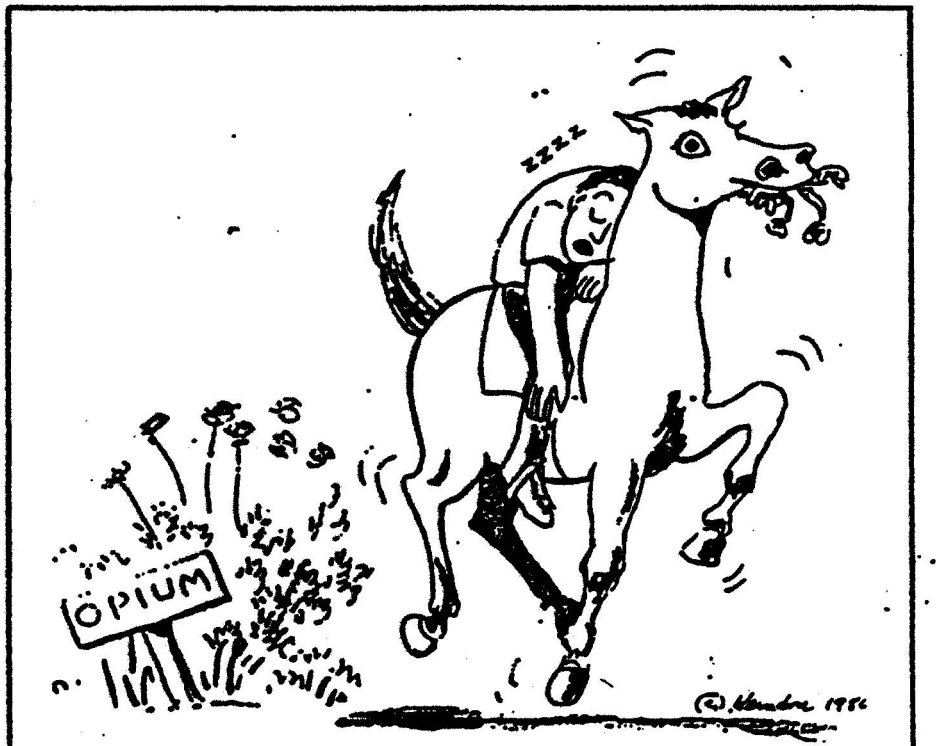
The statistician's experiment

The last type of experiment that we will discuss is the so-called statistician's experiment. In this type of experiment, the data are obtained by a study of the effects of approved medications on actual track times of racing horses. This is potentially the most powerful of all the experimental methods available for answering questions about the actions of drugs in racing horses.

This experiment was first proposed by Mr Carl Larsen of the Kentucky Harness Racing Commission, who pointed out that in 1977 the only drug permitted in harness racing in Kentucky was furosemide. He suggested that we study the differences in track times for harness horses racing at the Louisville Downs with and without furosemide. Furosemide pre-race is recommended in racing horses for the treatment of exercise-induced pulmonary hemorrhage (epistaxis or 'bleeders'). Whether or not it is effective in the treatment of this condition and whether or not it improves the performance of racing horses is unknown. We identified about 232 times for these horses while they were on furosemide, compared with 160 times for the horses without furosemide. The results of this study (Table III) suggest that the horses treated with furosemide were about one-tenth of a second slower after treatment than before. The numbers are large, the experiment undoubtedly relates to the performance situation, and statistically the answer is unequivocal. Furosemide treatment had no effect whatsoever on the performance of standardbred horses at this Louisville Downs meet.

In contrast with the small probability of obtaining statistically significant data from maximal output performance experiments (Table I), these racetrack experiments are much more promising. From the data of Table IV one can calculate that a true mean difference of 0.72 s. (a 0.56% improvement) would be required to produce significant differences from controls at the 0.05 level, assuming that it is desired to obtain a significant result 80% of the time. These are more attainable figures than those developed from maximal output performance trials, and suggest that this experimental approach should be pursued.

This approach has been taken a step further by Larry Soma of the University of Pennsylvania in studies on thoroughbred horses[8]. (Soma *et al.* unpublished observation.) Dr Soma studied the effects of furosemide at Keystone Race-track on horses whose times had declined for three successive races and whose owners had then had them endoscopically examined. Those found positive for epistaxis (pulmonary bleeding) were then put on furosemide. The results showed that furosemide restored the performance of the epistaxis-positive horses to the level observed prior to their decline in performance. This experiment,



While narcotic analgesics make man drowsy and want to sleep, the right dose makes horses want to run.

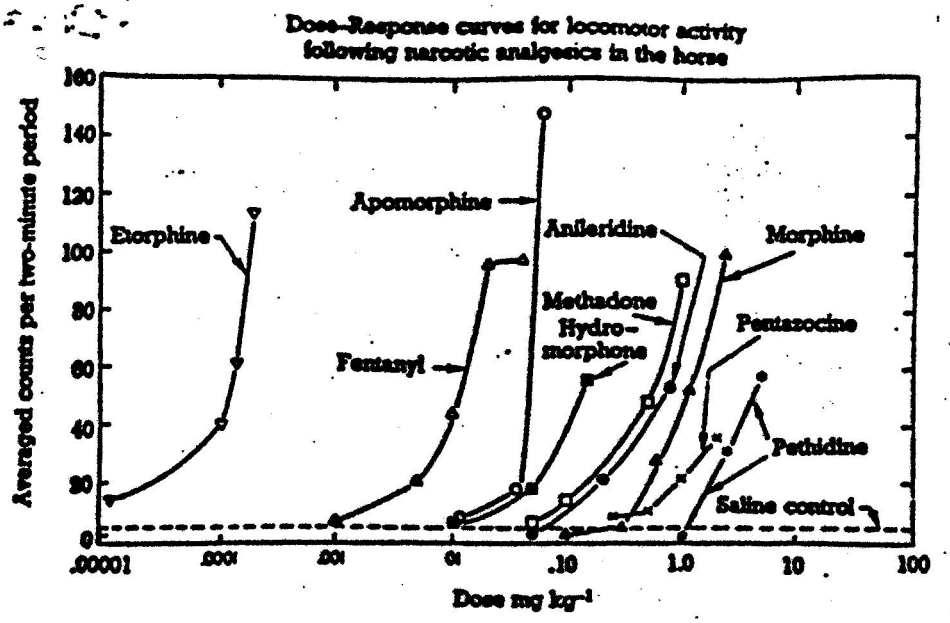


Fig. 2. Dose–response curves for locomotor activity following narcotic analgesics in the horse. Horses were dosed with increasing amounts of the indicated drugs and the average number of steps taken during the peak two-min period were plotted for etorphine, fentanyl and apomorphine. For all other drugs, average counts per two-min period were determined for the 16 min. interval of peak activity. Three to 10 horses were used in the experiments on etorphine, fentanyl, apomorphine, methadone, morphine and pentazocine. One horse was used to determine each dose–response curve for hydromorphone, anileridine and pethidine. The average counts per two-min period for the saline control are shown by the dashed line near the bottom of the graph. Reproduced with permission from Ref. 1.

therefore, suggests that the action of furosemide is to restore 'normal' performance in racing horses. While there were difficulties with the controls available for this experiment, this work clearly points to the racetrack as the most satisfactory experimental tool for answering questions about drugs and racing performance.

□ □ □

The classic performance trial or maximal output performance experiment is expensive, time consuming, and difficult to perform. Furthermore the information yield from these experiments has been trivial. If one reduces the output demanded of the animals, as in the sub-maximal output performance experiment, one can produce statistically significant results but these results do not necessarily demonstrate effects of drugs on performance.

Simple behavioral experiments can be used to determine the suitability of drugs for performance experiments, the optimal dose of a drug and the time post-dosing to test performance. They can also be used to determine the reliability and responsiveness of individual horses to drugs. Because of the expense of any performance experiment, it is advisable to use these experiments to characterize the action of drugs in the horse before any performance experiments are carried out.

The most satisfactory performance experiments are those carried out at a racetrack during an actual race. They are limited to the use of those drugs which are legal for racing horses or which are sanctioned by racing authorities. This experimental approach has yielded good results with the diuretic furosemide and should be extended to other drugs.

In the final analysis, however, the impact of any performance experiment on the way in which society views the use of stimulant drugs in racing horses is likely to be small. If the drug is found to have a stimulant effect, regulators will conclude that the ban on stimulant drugs is proper. On the other hand, negative results are not likely to lead to any change in the way society or racing regulators view stimulants. For these reasons, research efforts on the performance effects of drugs might be better directed towards drugs for which experimental results will resolve doubts or influence decisions for regulators or society in general.

TABLE IV. Effect of medication with furosemide on the performance of horses racing at Louisville Downs, Summer 1977

	No. of horses	No. of trials	Mean times	S.E.M.
Prefurosemide	58	160	128.5925	0.2031 F = 0.31
With furosemide	58	232	128.7366	0.1594 (F for significance should be > 3.0)

At this meet, furosemide was the only permitted medication, and its use was monitored by urinalysis. Horses could elect to go on furosemide at any time throughout the meet, but once on furosemide had to stay on it. Performance times for horses pre- and postfurosemide treatment were obtained from the meet programs and compared. Only times on good or fast tracks were taken. For the 58 horses selected, 160 prefurosemide times were available and 232 postfurosemide times. A randomized block design was used where each horse represented a block. After adjusting for blocks (i.e. differences between horses), there was no significant difference between treatments (i.e. times on and off furosemide).

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