mittee been more carefully scrutinized and evaluated, higher compliance might have been attained. In July of 1981, the American Veterinary Medical Association (AVMA) adopted a resolution concerning the use of drugs in racing horses. Their position paralleled that of the AAEP.

Once the racing commissioners within a given jurisdiction fulfill their responsibility of formulating the rules regarding medication, the question arises as to who has the responsibility for following these rules. The equine practitioner engaged in practice at the race track is bound by these rules whether or not he is in agreement with them. The AAEP position on medication is clear in admonishing its members to adhere to all rules of racing, including those regarding medication, within their respective racing jurisdictions, even jurisdictions that do not support the AAEP's approach to therapeutic medication of the racehorse.

The trainer certainly has the ultimate responsibility for the horse, including the presence of a substance not approved by the controlled medication rule that may have been detected during post race blood and/or urine analysis. Most racing jurisdictions now adopt the "absolute insurer rule" as it applies to trainer responsibility in these situations, and thus render moot the arguments that "someone got to the horse."

When an infraction occurs, in the form of a "bad test" or a positive test in a pre- or post-race sample, the matter is brought before the board of Stewards of the race track involved for disciplinary action. One immediate question that arises is what is the source of this prohibited substance? In attempting to ascertain the source, evidence comes to light that many professionals, para-professionals, and lay individuals have access to all descriptions of medications, many of which are not even intended for use in the horse. Most of the positive tests can be traced to one or more of these nonveterinary sources. Regrettably, occasions do arise when the veterinarian has either supplied or administered the illegal medication, but this occurrence is rare. If the case is not resolved to the trainer's satisfaction by the board of Stewards, the trainer has the option of a hearing before the racing commission. If further pursuit of the case is desired, the case must proceed to the governmental judicial system.

Some commissioners believe that owners in their jurisdictions have raced for years without the "evils" of medication and then say they intend to continue doing so. Conversation with various practitioners as well as pharmaceutical firms working in these jurisdictions reveals that such racing programs may not be as "medication-free" as the commissioners believe. This finding again supports the contention that the alternative to controlled medication is uncontrolled medication.

The racing commission chemists and their laboratory staffs are necessarily an integral part of controlling medication, both legal and illegal, in all racing jurisdictions. They have made marked technologic advances in their ability to detect various substances in increasingly small amounts in both urine and blood. Such progress was made possible by the efforts of excellent racing chemists across the nation who, united with various researchers and practitioners, gained a wealth of knowledge concerning the metabolism and excretion patterns of not only therapeutic medication but also potentially illicit substances. Racing chemists can now detect far greater numbers of substances in smaller amounts.

In those racing states with officials who have chosen to ignore the expertise available on the subject of controlled medication and have opted to disallow the presence of "any substance foreign to the horse" in a pre- or post-race blood and/or urine specimens, the veterinary practitioner and the trainer are placed in a particularly precarious position. Now that many substances can be accurately detected for days and even weeks after administration, how do the practicing veterinarian and the trainer contend with the horse that has been in their care for only a short time and is scheduled to race? How do they contend with the horse that received therapeutic medication days or weeks before racing to alleviate disease or injury? Increased expertise in these areas has forced all individuals involved to look beyond the "48-hour rule" or the "72-hour rule" time frames that once were adequate to ensure clearance of many of these substances. In these situations, a team effort involving the racing chemist, the racing commission veterinarian, and the practicing veterinarian is an absolute necessity. This cooperative atmosphere is stronger in some jurisdictions than in others. A void in this area can work to the detriment of all involved, including the racing public.

How does the racing public perceive the picture of controlled medication? Are the racing fans and professional gamblers naive enough to believe that rules concerning controlled medication give a free rein to "doping" of

horses? Perhaps not. At a recent annual meeting of the AAEP, a sports writer from a larger metropolitan newspaper made some rather amazing observations concerning the use of therapeutic medication in the racing horse. As his dissertation progressed, it became evident that his aggressive attitude was sparked by the fact that he had wagered on a trifecta race at a certain race track and had omitted a horse that in several previous outs had exhibited exercise-induced pulmonary hemorrhage (EIPH) and had consequently performed poorly. These outs were performed in a state in which controlled medication was not allowed. The horse was later moved to another state and, unbeknown to the bettors, was medicated under a controlled medication rule, which allowed the horse to "return to his form" or to race up to his innate ability. The horse placed, thus upsetting the potentially large trifects.

One purpose of a sensible, controlled medication program is to allow a horse to run to its potential while keeping the welfare of the horse in mind. Thus, the existence of a controlled medication program in that state should not have incited the writer/bettor, but rather the lack of such a program in locations where the horse raced previously was cause for the abrupt change in the horse's form. While instances such as this often incite emotional public outcries against medication, my opinion is that the knowledgeable public understands and accepts the basic philosophy of a controlled medication program, especially when they are appraised of the alternatives.

The role of the equine practitioner with regard to the medication issue must be divided into two categories: those practicing in states with a controlled medication program and those practicing in a state allowing only "hay, oats, and water." The advances in therapeutic medications, therapeutic techniques, and methods of surgical correction have occurred at an astounding rate in recent years and the practitioners that are privileged to practice in a jurisdiction racing under the guidelines of controlled medication are given the advantage of utilizing these advances to preserve the health, soundness, and welfare of the horse. In addition to allowing the use of approved therapeutic medications in the treatment of disease and injury, these rules usually provide for prescribed pre-race use of certain classes of drugs. Although the rules concerning controlled medication vary from state-to-state, the following discussion is an overview of some of the groups of medications allowed in a controlled medication environment.

Anti-inflammatory Agents. This group is further divided into nonsteroidal anti-inflammatory drugs (NSAID) and the corticosteroid group. The NSAID include many drugs now available, such as phenylbutazone (Butazolidin or "Bute"), flunixin meglumine (Banamine), naproxen (Equiproxen), meclofenamic acid (Arquel), and aspirin and related salicylates. Phenylbutazone or "Bute" has received the most attention from both the media and various opponents of the controlled medication philosophy. Bute was even included in the NASRCs "medication guidelines" with the erroneus allowable upper limit of 2 μg/ml of plasma (recent research showed this level is closer to 5 μg/ml of plasma if dosed under the NASRC guidelines) while they specifically excluded the presence of all other NSAIDs in the sample. In most situations necessitating the use of an anti-inflammatory agent to aid in the healing of mild to moderate inflammatory problems, the drug of choice is usually phenylbutazone. Although some claims have been made by certain humane organizations concerning the supposedly potent analgesic effects of this substance (to the point of claiming that the agent can "numb the limb of the horse allowing it to race with fractures of the limb"), in my experience the choice of this drug is made on the basis of its anti-inflammatory properties alone. The analgesic properties of phenylbutazone have been compared to the effects of aspirin in the human. Phenylbutazone is usually administered, either orally or intravenously, to achieve the healing effects (2 g daily until the final dose of 2 g no later than 24 hours before post time for the first race). Rules regarding controlled medication in a given jurisdiction may impose time and dosage constraints that differ from those cited here.

Another NSAID that is commonly used in a controlled medication environment is flunixin meglumine or Banamine. Although this product possesses excellent analgesic properties, I find it to be less effective as an anti-inflammatory agent than phenylbutazone, and thus seldom use it as such. The inclusion of this product in a controlled medication program is important to allow the practitioner to use it in the treatment of mild colic a few days before racing. In these cases, the medication would not be pharmacologically active at the time of a race but would be picked up by the racing chemist in trace amounts. The balance of the NSAIDs are approved in some states but phenylbutazone is usually the drug of choice.

The corticosteroid anti-inflammatory medi-

cations were once used widely in racing, but the advantages of the use of NSAIDs as well as the adverse side-effects associated with long-term corticosteroid therapy have greatly lessened their application as a parenteral anti-inflammatory agent.

Bleeder Medications. The universal drug of choice used by race track practitioners in an attempt to control EIPH in the racing equine athlete has been furosemide (Lasix). Although the requirements for a horse to be considered a "bleeder," or to suffer from EIPH, vary from state to state, most jurisdictions that maintain a sensible controlled medication program allow the use of this drug to attempt to prevent this potentially disastrous condition. Variations exist with regard to dosage and time of administration of this product, as well as security arrangements surrounding the post-administration surveillance of the horse. At this writing, furosemide appears to be the safest and most effective medication available for use under controlled medication guidelines in attempts to prevent EIPH in the racing horse. Other injectable medications employed by some practitioners to prevent this condition include the conjugated estrogens, vitamin C, vitamin K, and other combinations. Various oral products are also allowed under most guidelines, including vitamin K, vitamin C, bioflavinoid products such as hesperidin complex, and various combinations of these substances.

Vitamins and Amino Acid Preparations. There are as many pre-race vitamin and vitamin-amino acid combinations and formulas as there are equine practitioners. The purpose of the administration of these products is to help the horse "come off the race better" or to recover more quickly from the stress of racing. Although these preparations may be of questionable value, they are used widely and are permitted under the controlled medication guidelines of most jurisdictions.

Hormonal and Anabolic Agents. These products possess therapeutic benefits of long duration and are usually administered several days before racing. As in other classes of medication, a number of these products are available and various drugs or combinations are utilized by the practitioner. With the recent removal from the marketplace of some of the anabolic agents by the Federal Drug Administration, the choice of this class of drugs is somewhat limited. The substances that remain available, however, enjoy fairly widespread use when the guidelines allow their use.

Intra-articular Medications. Many medications of this type are used in both situations that have a controlled medication program and those that lack such a program. For many years, various corticosteroid preparations were injected intra-articularly in an attempt to relieve inflammation from a damaged joint. The availability of hyaluronic acid for intra-articular use as well as mounting evidence, both clinically and through various research channels, indicating that corticosteroid products may contribute to the progression of degenerative joint disease, these substances are used less commonly in the joints of the horse.

The use of stimulants, depressants, narcotics, tranquilizers, mood enhancers, and local anesthetics is prohibited in all controlled medication programs. Perhaps the use of these prohibited agents may be more realistic under controlled medication guidelines, as the trainers and owners are offered a reasonable therapeutic alternative to an ever present problem in equine athletes.

In states in which those individuals who formulate medication rules regarding the racehorse chose to deny the practicing veterinarian, the trainer, the owner, and, most importantly, the racehorse, the complex issue of the benefit of therapeutic medication under a sensible, controlled medication program becomes even more complex. The concept of controlled medication is not intended to allow unfit, unsuitable, diseased, or injured equine athletes to race, but rather it allows the use of modern therapeutic regimens and techniques to treat these diseases and injuries. Any thinking individual knows that a horse that has an injury that precludes racing should not be "patched together" to allow it to race, because these animals rarely even finish the race. Rather, the intended treatment involves minor ailments such that the horse may participate safely and to its innate ability, with the health and welfare of the horse of primary concern.

Many of the races in Thoroughbred, Quarter Horse, and Standardbred racing have purses in the millions of dollars. If having qualified for a major race with a horse that has a minor ailment or injury or has shown a tendency toward the development of EIPH during a previous race, the trainer and owner, when offered the choices of "rest," "take home and turn out," or race with the problem and without the benefit of controlled therapeutic medication, will usually choose "none of the above." The reality of uncontrolled medication is more often chosen as the alternative in these situations. This choice places everyone involved in the medication issue—the veterinarian, the trainer, the owner, the horse, and

the racing public—in a compromising position. Is this a logical alternative?

Only a rare and foolish jockey would allow a trainer to "leg him up" on a known "bleeder" that was forced to race without the benefit of the use of the potentially life-saving medication furosemide. In some "hay, oats, and water" states, these facts are often concealed from the rider and the horse is sent out without medication. The results, regardless of how rare, can be tragic.

A popular issue when medication is discussed is the morality and ethics of the situation. If in the aforementioned scenario involving the "bleeder," an accident occurs as a result of racing this horse without medication, where does the responsibility lie? The literature and clinical reports are replete with information indicating the safety and advantages of furosemide to aid in reducing and preventing this condition. Further reports show conclusively that the use of the medication under controlled guidelines does not in any way interfere with the ability of chemists to detect other drugs present in the horse. Where then, does the responsibility lie? Could the trainer be responsible for entering the horse? Could the practicing veterinarian be responsible for not medicating the horse, even though he or she is prohibited from doing so in that particular jurisdiction? Could the commissioners themselves be responsible for ignoring the preponderance of evidence available to them and disallowing the use of the medication.

I had occasion to speak concerning EIPH to a racing commission of a racing state that was considering adoption of the use of furosemide in a confirmed bleeder. Before the meeting, I polled each member of the five-member commission concerning the control of "bleeders" at the track. None of the five members had ever actually seen a "bleeder" at the track, and only two of the five individuals were at all familiar with the condition. Fortunately, this particular commission was progressive enough to seek advice concerning this problem before implementing any rules.

The medication issue is a complex situation and one that is far from being totally resolved. Many questions have been raised but few answers have been supplied. As emphasis, the alternative to a sensible, controlled medication program is not the "hay, oats, and water" situation favored by many well-meaning racing commissioners, but rather uncontrolled medication. Through the efforts of individuals such as Dr. Gene Bierhaus and Dr. Alan Edmonson, controlled medication has been a reality in many of our racing states for many years and has proven beneficial to all involved, most importantly the racing equine athlete. From the perspective of a race track practitioner who has practiced under the extremes of the various medication rules, the controlled medication philosophy is the only sensible solution to a complex and often emotional problem. Only through a total cooperative effort among all persons involved in the formulation, enforcement, and obeyance of medication rules will the national trend continue to surpass guidelines set forth in 1981 by the NASRC in favor of the concept of controlled medication of our equine athlete. The members of the veterinary profession and the AAEP stand ready to ensure that expertise are available to assist in formulating these guidelines and, when possible, that the resulting rules of controlled medication are strictly enforced.

R.H. Galley

TESTING FOR DRUGS IN HORSES

Racing has one of the oldest and technically most elaborate systems for drug testing. The practice of drug testing in horses started in 1910; the first positive call was reported in 1912. Although analytic methods have improved significantly since the Russian Jockey Club used frogs as their test animals and listened to how they croaked to call a positive finding, testing is still enormously complex. Analytic chemical analysis has made major strides and is now remarkably accurate, yet the area of pharmacology or drug effects is still wide open to interpretative differences.

Obtaining a Sample. The basic tool used in drug testing is the urine sample, with blood testing increasing in popularity. The usual pattern is that the winner of a race, a beaten favorite, or any horse that the Stewards nominate goes to the test barn immediately after the race. The horse is washed down, a blood sample is taken if this is part of the testing procedure, and the horse is placed in a box stall. A urine catcher steps into the stall, equipped with a catching cup on a rod, and waits for the horse to urinate. When the horse urinates, the sample is caught and is transferred to tamperproof jar. The jar is sealed with evidence tape and is shipped in a secure container to the laboratory. The trainer or representative signs a sample tag witnessing that the sample came

from the horse in question. The thrust of the process at this point is to identify the urine sample correctly and to transfer it from the bladder of the horse to the testing lab with no possibility of contamination or confusion with other samples. This process is called *establishing the chain of evidence*, and it must be validated in court if medication violations are to be successfully prosecuted.

The Analysis. Once the sample arrives at the laboratory, it is logged in and its volume, pH, and specific gravity are measured. Volume measurement is important because disposition of the sample should be monitored. The pH or hydrogen ion concentration of the sample is of great importance because the concentration of some drugs or drug metabolites in equine urine is likely to vary as much as 9000-fold, depending on the pH of the sample. Finally, specific gravity should be measured because it may help to identify the sample and to indicate whether the animal received diuretics.

Once the sample is logged, the analyst takes small (< 5 ml) aliquots of the sample and adds enough acid or base to make the samples clearly acidic or basic. An equal volume of an organic solvent, such as benzene or dichloromethane is then added, and the entire mixture is shaken for 15 minutes or more. The oragnic solvent is then evaporated to a very small volume; about 2 μl of the extract is spotted onto thin-layer plates. These plates are then run in several different solvent systems, depending on the drugs thought present in the sample. Once the developing process is complete, the plates are sprayed with different oversprays to bring out, or develop, the individual drug spots. The analyst inspects these plates and marks any suspicious samples for further investigation.

Further investigation usually involves gas chromatographic or high-performance liquid chromatographic analysis of the samples. These techniques are more specific and selective than thin-layer chromatography and their use may yield information to confirm or deny the analyst's suspicions regarding what drug is present on the thin-layer plate. If thin-layer and gas chromatographic tests yield positive evidence of a particular drug, the analyst is ready for the next step, which is confirmation of the drug.

Confirmation of the presence of a drug in a sample is usually done by gas chromatography-mass spectrometry (more commonly known as GC-MS). In GC-MS, the drug is separated from the other blood or urine components on the gas chromatograph. The drug fraction from the gas chromatograph is then led into a vacuum chamber in the mass spectrometer, where it is bombarded with electrons. These electrons charge the drug molecule and, depending on their energy, may fragment the drug molecule. These fragments are then accelerated through a magnetic field, which separates them on the basis of their mass and electric charge. At the end of the analysis tube, the impact of these ions is recorded on an ion detector and the number of ions at each mass is counted. This process is extremely rapid; in about 1 second, a mass spectrum for a drug can be produced.

A mass spectrum yields much information about the material contained in the sample. If some of the parent drug survives the process just described, it turns up as a molecular ion with a molecular weight similar to that of the drug. When a drug breaks down into fragments, it breaks into a specific pattern of fragments of specific masses. When plotted, these fragmentation patterns are called *mass spectra*, and the spectra that they yield are specific for individual drugs. Spectra yield a virtual "fingerprint" of the drug in question and are commonly accepted as the best evidence of the identity of a drug. In addition, the mass spectrometer can detect nanogram quantities of drugs in fluid. As such, the mass spectrometer is sufficiently sensitive to be useful for drug detection in the body fluids of horses. Other tests sometimes used on specific drugs are radioimmunoassay tests, and rarely, microcrystal tests.

Race Track Procedures. Once the analyst has evidence for the presence of a drug in a sample on thin-layer chromatographic tests, gas or high-performance liquid chromatographic tests and, most importantly, good mass spectrometric data, the usual conclusion drawn is that a drug has been positively identified in the sample. If the drug in question is a prohibited or illegal drug, the analyst "calls a positive," which means that the unequivocal identification of an illegal drug in the sample is reported to the authorities.

The science of drug detection, identification, and confirmation has been fairly well perfected. Once a reputable analyst goes through the aforementioned procedure, the drug is likely present and other analysts will be able to confirm its presence. If the racing authority is wise, it will give the horseman the option of having the sample analyzed by another racing chemist. In the absence of a referee sample, other chemists can often point to flaws or irregular-

ities in the analytic procedures. When given a referee sample, however, all the chemist can do is repeat the analysis. If the drug in question is indeed in the sample, the chemist will have the same results and will confirm the presence of the "positive."

Complications of Analysis. Once an analyst identifies a drug in a sample, the process of determining its forensic significance begins. At this point, the fun really starts. A major problem in this area is that to determine when a drug was administered from a urine sample is virtually impossible. It is also difficult to generate time-of-administration estimates based on blood levels of drugs, although the potential for variation in drug concentrations in blood is less than that in urine. A further advantage to using blood levels is that estimates of the probability of a pharmacologic effect from a blood level are possible, whereas such a determination from a urine sample is difficult at best. For these reasons, blood is a superior forensic sample and should be used if at all possible.

Volume, pH (acidity), and other factors that may affect drug concentrations in the urine sample vary widely. In general, pH is likely to be the major factor, and it can cause up to 500-fold variations in the levels of oxyphenbutazone in equine urine. Some simple mathematical calculations suggest that the concentrations of drugs in urine may vary up to 9000-fold, depending simply on the pH of the urine sample. For these reasons, the ability of anybody—chemist, veterinarian, or pharmacologist—to estimate about when a drug was administered based on its concentration in urine is essentially nonexistent.

These facts create problems for racing authorities, who may wish to establish rules stating that certain drugs must not be administered within a certain time period before the race and then expect the chemist to enforce these regulations. Analysts can usually measure the amount of a drug in a sample with some confidence, yet the certainty with which they can make statements about the time at which the drug was administered is entirely another matter.

For years, many states regulated the use of phenylbutazone in horses by use of the so-called 165-μg/ml levels of phenylbutazone and its metabolites in equine urine; any horse with urine concentrations of more than 165 μg/ml had been medicated within 24 hours. Unfortunately, as previously noted, concentrations of oxyphenbutazone in equine urine can vary up to 500-fold, depending only on the pH of the urine. Urinary levels of drugs are, therefore, of little value if one is attempting to evaluate the time of administration of any drug. Therefore, if at all possible, the rules for residual or trace levels of legitimate therapeutic medications should be drafted in terms of concentrations rather than time and in blood rather than in urine, blood being a more reliable quantitative medium. The reason that concentrations should be stated is that analysts can confidently testify about a concentration, but they can only speculate about times of administration of drugs in either blood or urine.

Finally, in setting the upper level of a particular medication to be found in blood, the analyst must be aware that one cannot distinguish between random "overages" caused by the horse and intentional "overages" caused by the horseman. (An overage is a blood level of a drug that is above or "over" the legal level.) The overage level must therefore be set carefully so that the level selected is not too low or the penalty for exceeding it is not too high, because a certain percentage of innocent horsemen will inevitably be convicted under a quantitative rule, no matter how well drafted or carefully enforced.

EFFICACY AND COST OF EQUINE MEDICATION TESTING

Until recently, no good information was available concerning the effectiveness of testing for illegal drugs. Over the last 2 years, however, we have conducted a survey on the effectiveness of medication testing, and are in a position to provide answers to some of the questions in this area. In addition, reports from the English Drug Testing Laboratory, Racecourse Security Services (RSS), a drug testing laboratory in England, Trinidad, and Iran has thrown further light on this problem.

Our inquiry into the effectiveness of drug testing was triggered by the problem of whether phenylbutazone "masks" or interferes with the detection of other drugs. Some chemists hold that phenylbutazone does interfere with the detection of other, more deleterious medications, and other chemists believe such interference is minimal and is of virtually no practical significance. In an effort to answer this question, we commenced a survey of the "positive call" rates for illegal medications in North America. The rationale behind this approach was that if the use of phenylbutazone was indeed interfering with the detection of illegal medications, then the positive call rates for illegal drugs should be less in states that allow

the use of phenylbutazone, as compared with those that do not allow its use. From this survey, however, came what is essentially the first analysis of the positive call rate for illegal medications in North America.

Before we could accurately compare the positive call rates of differing jurisdictions, however, we had to determine what we would regard as a "positive." This problem arises because of the very different medication rules in different states, e.g., Canada and New York do not allow detectable traces of any medication, and other states allow 2 μg or sometimes 5 μg/ml of phenylbutazone in blood. Similarly, some states allow furosemide, but New York and Canada do not. To circumvent this problem, we compared only the positive call rates for drugs that are illegal in all racing jurisdictions—stimulants, depressants, narcotic analgesics, local anesthetics, and tranquilizers. We called these drugs "hard" drug positive, and we compared the call rates for these hard or unquestionably illegal medications in about 28 North American racing jurisdictions.

Drawing hard conclusions from the data provided was difficult, in part because of the quality of the data, in part because of the medication rules and range of analytic techniques involved, and also because of the great variation in the size of the jurisdictions. For example, New York tested the largest number of samples, about 200,000 per year. On the other hand, Wyoming tested only 124 samples in 1 year, so a zero positive call rate for Wyoming for 1 year would not necessarily mean that testing in that state was less effective than in New York. Nevertheless, despite these limitations, some clear patterns concerning the efficacy of drug testing in North America became apparent.

The rates at which hard drug "positives" were called in North America between 1976 and 1983 varied from about 0.2/1000 samples tested to about 6/1000 samples tested. These values were the extremes of the ranges, the most common rate was about 1 sample/1000 tested. Some states were well above this rate, and others were below it. For example, the hard drug-positive rate from New York was about 0.3/1000 tested. Because of uncertainty in our data, the rate could be higher, although not higher than about 1.6/1000 samples tested, even on the unlikely assumption that all the positives called in New York were hard drug positives.

Other representative call rates from large racing jurisdictions were 0.6/1000 samples from Canada and 0.4/1000 samples, from California. The positive call rate for "hard" or illegal drugs in Kentucky was about 3/1000 samples tested. On the basis of these figures, therefore, the call rates for hard medications are on the order of 1/1000 or less in some major racing jurisdictions. Because the cost, conservatively, of testing a sample is about $15, it therefore costs, on the average, about $25,000 to detect one instance of illegal use of a hard medication. Because the costs and positive call rates vary substantially between different states, this cost value can only be viewed as an approximation, with some states spending more than $15,000 for each hard drug positive called.

Is the regulation of medication worth this large expenditure of money? To answer this question, we must attempt to estimate the effectiveness of illegal drug testing. More importantly, we have to determine how much illegal medication would come into play in the absence of effective medication control. The best answer to this question comes from Trinidad and Iran, where horses were suddenly subjected to drug testing, perhaps for the first time, or at least a greatly increased level of competence. Samples from these countries were abruptly sent to Racecourse Security Services (RSS) in England, which provides state-of-the art testing for drugs. In each case a rate of illegal drug detection was about 20% in the first samples, which were made available to RSS labs. In the case of the Trinidadian samples, the rate of use of illegal drugs dropped to zero within a period of weeks. Illegal medication use in Iran, however, tended to stay high, likely because of political conditions in Iran.

These data suggest that when effective drug testing is introduced, its use in association with sufficiently severe penalties can, within a period of weeks, reduce the level of illegal use of medication substantially. In the case of the Trinidad and Tobago authority, the rate of illegal drug use was about 20% when the sending of samples to Newmarket commenced. Over 5 months, however, the rate of illegal drug use dropped to close to zero. Thereafter, the rate crept to a "steady-state" level of about 1.0 to 1.5%, and remained at that level until completion of the survey. This steady-state level is apparently that common to Trinidad, given the attitudes of horsemen, the authority, and the penalties that the authority is willing to impose.

The situation in Teheran was similar with respect to drug use rates, with the proviso that although positives were detected and "called" by Racecourse Security Services, no change

in the rate of illegal medication use occurred. The probable reason for this discrepancy is that no administrative action or sanctions were being taken. At that time (1978–1980), attention in Iran was likely directed toward the Iranian revolution, and the use of illegal medications in racing horses drew minimal prosecutorial attention. Thus, as suggested by common sense, the imposition of suitable deterrent sanctions is an integral part of the regulation of illegal medication use.

The most clear-cut example of the deterrent effect of specific testing comes from the English experience with testing for anabolic steroids. These agents were used in English racing for a period, and no effective test for them was available. In the fall of 1976, the English racing authority introduced, without warning, its new anabolic steroid test. In the first weeks of December, the English Jockey Club called anabolic steroid positives at the rate of about 12% of the number of samples being tested. This positive call rate was comparable to the 20% rate from Trinidad and Iran. Within a matter of weeks, however, the positive call rate for anabolic steroids in England had fallen to zero, and remained at zero for 2 years. These results, dramatically demonstrate the ability of a test, combined with the use of effective sanctions, to reduce the incidence of illegal drug use in racing horses to almost zero.

Another factor that is clear from the data from Racecourse Security Services is the variation among different countries in the patterns of drug use. The tendency to use potent central nervous system stimulants in horses is apparently minimal in Britain; these drugs have never been reported from British racing. On the other hand, amphetamine was detected in almost epidemic proportions in Trinidadian racing (12 amphetamines in 500 samples in 1 year), and remained in use, although at a much lower level, throughout the period for which testing was performed. Although no information is available concerning the penalties imposed in Trinidad racing for an amphetamine "positive," the consequences were apparently not sufficient to inhibit the use of this drug completely.

The efficacy of drug testing in North America, therefore, runs at about one hard medication positive per 1000 samples tested. To detect a single hard drug positive, therefore, costs about $25,000. In the absence of effective drug testing, the data that are available suggest that at least 10%, but more likely 20% or more, of horses are illegally medicated. If effective testing coupled with effective sanctions are introduced, the incidence of illegal medication can be reduced to virtually zero for individual drugs for long periods of time. A tendency for horsemen to probe the system by trying other medications seems inevitable, however. Therefore, the positive call rates experienced in North America are apparently a function of both the efficacy of the testing process and the severity of the penalties imposed.

ELISA DRUG TESTS

Recently, the development of sensitive, simple, and inexpensive immunoassays for drugs that are abused in racing horses have increased the number of positives at many race tracks. Immunoassay is the only effective way to control the use of highly potent drugs and narcotics in racing horses. This technology is known as enzyme-linked immunosorbent assay (ELISA).

This ELISA technology is now widely used in infectious disease work. For example, the test used to screen for the acquired immunodeficiency syndrome is an ELISA test. To make an ELISA for a drug it is necessary to first make an antibody to the drug. Then this antibody is bound to a clear plastic well. At this point there is a clear plastic well that can very specifically bind the drug to be detected. Commercially, these wells are made in a single piece of plastic with a number of wells all in a row, for testing multiple samples.

When a laboratory technician is ready to test a serum or urine sample, a small amount of the sample is placed in the well. If the specific drug for which the antibody was prepared is in the sample, it will attach to specific sites on the antibody and "use them up." Then a drug-enzyme complex is added, and if the antibody sites are vacant (a negative sample) the drug-enzyme complex binds to the sites. Finally, a simple development test is performed, and the presence of the enzyme shows up as blue color when the test is negative.

A positive test occurs when there is drug present in the test sample that binds to the antibody before the drug-enzyme complex is added. The drug in the test sample occupies the binding sites and prevents the drug-enzyme complex from binding. Because no enzyme is bound, no color can develop, and the sample well remains clear. In the laboratory, these are called "white-outs," and they stand out distinctly as clear "positives," against a line of blue negative tests.

T. Tobin