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The effect of beta blockade on stage fright

A Controlled Study

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"Don't shoot the pianist—he's doing his damndest". (Sign in Wyman's Saloon, Leadville, Colorado 1882)

To most members of the medical profession, stage fright is an insignificant condition, cured by repeated exposure to the inciting stress. To the psychologist, stage fright or performance anxiety, known also to them as the "Fight or Flight Reaction" can produce the same cardiovascular stress as strenuous exercise. To the professional musician, stage fright is a disabling condition, just as disabling as angina pectoris is to the laborer.

Although the sympathetic and circulatory hyperactivity of "Fight or Flight" may have been useful to our forefathers in dealing with grizzly bears and saber-toothed tigers, it interferes severely with musical performance. Many performing artists are disabled or partially disabled by stage fright to the extent that over fifty per cent of these musicians consume tranquilizers or alcohol to combat performance anxiety. Although these agents are effective in alleviating anxiety, they also cause a significant decrement in performance. Although many have come to fear the effects of these agents, they must continue to use them in quantities sufficient to get them onto the stage relatively intact.

Recent studies, reported mostly in the British literature, have suggested that the physical manifestations of stage fright are mediated by the beta adrenergic receptors of the sympathetic nervous system. Previous clinical trials have suggested that blockade of the beta receptors can eliminate these effects without affecting mental function. Our initial uncontrolled trials have shown small doses of propranolol to be spectacularly successful in eliminating the physical manifestations of stage fright.

Accordingly, a double-blind crossover study was designed to test the efficiency of propranolol in alleviating performance anxiety. Our multidisciplinary team, including a cardiovascular surgeon who uses beta blockade in his practice and who is also a performing musician, an ophthalmic surgeon with experience using propranolol to treat performance anxiety and tremor, a doctor of musical arts with extensive recital experience and a long standing research interest in performance anxiety, coupled with a group of performing musicians with stage fright problems, afforded a unique opportunity to study the physiologic, psychologic and performance effects of beta blockade on stage fright.

Materials and Methods

The study, approved by the University of Nebraska Institutional Review Board, was a double-blind crossover study comparing the effects of 40mg of propranolol with a placebo taken 90 minutes before a performance. The subjects were eight keyboard students and teachers at the University of Nebraska, many with a history of severe stage fright problems. After receiving a briefing on the nature of the study and on the drug to be tested, the subjects agreed to participate in the study.

A brief history and medical examination, including a baseline EKG rhythm strip, was carried out by one of the physicians. The subject then took a capsule labeled either "A" or "B". Ninety minutes later the subjects were connected to the EKG monitor* and required to introduce themselves and their musical selection. They then performed before the assembled
group of their peers and instructors. Their electrocardiograms were monitored continuously during the time of the introduction and of their performance both for rate and rhythm. Their performance was recorded on audio tape for subsequent evaluation by their professors, and recorded with the EKG signal superimposed on the music. The following afternoon the sequence was repeated with the subjects taking the other drug. The level of anxiety created by this protocol (particularly on the second day, as the students and faculty developed a certain camaraderie) was not as great as the investigators had created during previous studies.

The following evaluations were carried out: the subjects were evaluated for outward manifestations of stage fright, by both an investigator and members of the audience. Each subject was required to fill out a questionnaire grading his performance on the basis of nervousness, anxiety, tremor, sweating, accuracy, style, ease of performance, control, tempo, rhythm, pace, memory, and comfort. Both audience members and a faculty member graded each performance for musical quality and technical proficiency. After results of the above evaluations were tabulated, the code was broken.

Results

No untoward effects were experienced by any subject. There was no consistent difference in technical performance quality or musicianship noted either by performers or teachers. Although overall assessment of performance showed no difference between propranolol and control, questions reflecting on the components of performance such as accuracy, memory, rhythm, and tempo favored propranolol. The questionnaires showed improvement in all questions having to do with sympathetic discharge (Fig. 1) in all subjects. All subjects except one correctly distinguished propranolol from placebo on the basis of a decrease in the physical symptoms of performance anxiety. The subject who misidentified the active drug was manic following her performance with placebo, with gross tremor and high speech pressure, having misidentified manic euphoria as drug effect.

The investigator observing the performances could reliably determine who had received the active drug by observation alone, but performers in the audience, including music faculty, could not. The investigators felt that much less stress was produced by the second performance than by the first, probably because the subjects had become more comfortable with each other. This observation was confirmed by the results of the questionnaire. Although improvement in sympathetic discharge questions was noted on both days, the average changes over the whole group were less the second day. This decreased the change in the average of all results which could have been obtained under a more stressful test.

Heart rates as high as 165 were monitored during the experiment, but with the exception of occasional premature atrial contractions, premature ventricular contractions and normal sinus arrhythmia, no other rhythm disturbances were noted. Propranolol caused a dramatic decrease in both maximum heart rate achieved by the group (Fig. 2), and in the average heart rate during the performance (Fig. 3). This effect on the pulse was most dramatic in the subjects with the most pronounced emotional tachycardia. For this reason the drug effect would have been enhanced had the experimental situation caused more stress.

Discussion

All of us have experienced stage fright, or performance anxiety, at some time during our lives. Somatic symptoms8 include a rapid heart rate with tachycardias reaching levels of 190 to 200 beats per minute both in public speaking9,10 and musical performance.11 Palpitations are common and may be caused by actual cardiac
arrhythmias. ST-T wave changes on EKG are not uncommon, particularly in patients with heart disease and resemble ischemic changes seen on graduated exercise testing. Increased sweating, tremor, including intention tremor, and fatigue are prominent.

In more severe cases visceral symptoms involving the alimentary canal and urogenital tract are common. These include nausea, diarrhea, and the urge to micturate. These symptoms, which are identical to those of the "Fight or Flight Reaction" are not only disabling in themselves, but also tend to increase the performer's emotional insecurity which in turn exacerbates the somatic symptoms. This syndrome is ubiquitous, and occurs in every field of huma endeavor. These changes have been observed in medical students giving presentations to instructors, medical staff meetings, in cardiologists performing heart catheterization, surgeons performing operations, in medical lecturers and in subjects driving in heavy downtown traffic, as well as in subjects in athletic competition.

From a physiologic standpoint, these somatic manifestations reflect sympathetic overactivity, specifically production of excessive catecholamines, particularly noradrenalin. Race car drivers, for example, increase their heart rates up to as high as 210 beats per minute. This tachycardia is associated with serum catecholamine levels two to ten times normal, and may not be noticed by the drivers themselves. Physicians, speaking before an audience, have been documented to have almost as high a tachycardia and almost as high levels of circulating catecholamines. Associated with the increase in catecholamines is an increase in serum free fatty acids. Triglycerides peak one to two hours after the event and have a more sustained rise than is seen in catecholamines or free fatty acids.

In many occupations this sympathetic hyperactivity may persist for a long period of time without the subject being aware of the stress placed on his cardiovascular system. Surgeons, for instance, during a routine afternoon operating schedule, may sustain heart rates between 120 and 150 beats per minute through the entire afternoon. These same surgeons could only sustain the level of physical work required to produce this cardiovascular response for periods of ten to fifteen minutes. Airline pilots, monitored over the course of an entire flight, have been found to have the same response. Although in studies of neophyte parachute jumpers, Taggart et al. documented that the outpouring of catecholamines decreases as the parachute jumpers become more experienced. Significant levels of physiologic stress persist, even in experienced public speakers, experienced airplane pilots, experienced surgeons, and musicians. In some occupations this circulatory stress may last for long
periods of time and account for a large proportion of the subject's waking hours. The almost constant elevation of free fatty acids and triglycerides may contribute to the development of atherosclerosis.\textsuperscript{18,20} The tachycardia increases myocardial oxygen demand and may lead to the discrepancy between supply and demand that we know as myocardial infarction in patients, once they have developed significant coronary artery occlusive disease. Likewise, the vasoconstriction associated with the catecholamine output, may eventually lead to sustained hypertension and all the medical problems associated with that condition. These health consequences of continued stress may be even more serious over the long run than the disability caused by the somatic manifestations. Certainly such a serious condition demands an effective pharmacologic remedy.

Tranquilizers and/or alcohol have been the chemicals most frequently used in an attempt to ameliorate the somatic manifestations of stage fright.\textsuperscript{21,22} These drugs are certainly effective, and in a number of studies have been shown to decrease both the mental level of anxiety and its somatic manifestations. Unfortunately, these drugs have more than just somatic effects. Their mood altering properties may leave the subject feeling euphoric and confident after an inferior performance. A prominent recitalist has recently confided to the investigators that his use of such drugs caused him to feel increasingly confident until his professional colleagues noted a decrement in virtuosity. This deterioration in performance and false sense of security has been documented in studies of students taking final examinations.\textsuperscript{23,24} Many performing musicians have come to dread tranquilizers and alcohol because they decrease manual dexterity and intellectual functioning. They find themselves less able to gauge their performances objectively and lose the mental keenness which comes from anticipation of a major performance. Quality of performance often deteriorates under the influence of these drugs. Alcohol and tranquilizers are certainly not the appropriate remedy.

Beta blocking drugs, on the other hand, may be a precise remedy. They specifically counteract the effects of the sympathetic discharge at relatively low doses - 40 mg propranolol in this study. As little as 10 or 20 mg. may be effective in most patients. Blockade of the beta adrenergic system is carried out with such surgical precision that there is no effect on mental functioning.\textsuperscript{25} Some effective beta blockers don't even cross the blood brain barrier.\textsuperscript{26} There are some disadvantages, however.

Beta blockade must be used with extreme caution in patients with cardiac disease, particularly where the conducting system is involved, as profound bradycardias may occur. Likewise, patients on the borderline of congestive failure, can be tipped over using even this small dose of drug. In patients with bronchial asthma, beta blockade may touch off an acute asthmatic attack. These effects are not idiosyncratic drug reactions, but are predictable responses to the drug. For this reason, subjects prone to these deleterious effects are relatively easily identified.

Many previous studies in the British literature have documented the effect of beta blockade in the treatment of anxiety. McMillan in 1975 studied twelve patients exposed to civil disorder in Northern Ireland.\textsuperscript{27} Of twelve patients complaining to their physician of anxiety, ten experienced relief of anxiety with 80 mg. of oxprenolol without sleepiness or mental compromise. Of the two dropouts from the study, one was injured by a bomb explosion, and the other took an overdose of another medication and had to be hospitalized. Twelve preoperative patients in the same study were treated with 80 mg. of oxprenolol or 5 mg. of diazepam. Again, one subject was dropped after a bomb attack. In the other patients, both drugs were felt to be equally effective in alleviating anxiety. Diazepam produced a better sleep, and oxprenolol better concentration.

Tallaght and colleagues in 1973 noted that among normal and coronary artery disease subjects speaking before an audience or driving in rush hour traffic a single dose of 40 mg. of oxprenolol was effective in suppressing tachycardia and EKG abnormalities. Plasma noradrenalin levels increased equally in the blocked and unblocked subjects, but the increases in free fatty acids were abolished by beta blockade. The somatic and cardiovascular stress effects of public speaking were abolished using beta blockade. Elisach and colleagues in 1967,\textsuperscript{8} using propranolol, were able to block the somatic effects of stress produced in pilots in simulated flight. Foster and colleagues in 1978\textsuperscript{14} reported that cardiovascular effects in
Our previous research into this subject concentrated on the psychological aspects of stage fright. Hypnosis was used to teach a group of seven organists how to use a self-induced trance to reduce stage fright in performance. Two performances were recorded for each subject - waking stress, and hypnotized stress - while continuous EKG monitoring was carried out. The performances were evaluated both for subjective musical quality as well as for technical accuracy. Questionnaires were used to determine the performer's psychological outlook concerning the two performances, and the subjects were observed for the manifestations of stage fright. Subjective musical quality and technical accuracy both were improved in 64 per cent of the patients. EKG monitoring demonstrated an average reduction of 20 beats per minute during hypnosis from levels substantially higher than those observed in the present study. Hypnotic training was beneficial in reducing performance anxiety in 100 per cent of these subjects selected for their difficulties with stage fright.

In many respects these two studies are complimentary. Beta blockade appears to be an effective way of reducing physical symptoms of stage fright, but affects psychological symptoms only indirectly. Hypnotic training has a direct effect on psychological symptoms but only an indirect effect on the physical symptoms. We plan to combine both modalities of therapy in future studies.

In spite of its effectiveness, the use of any drug to alter musical performance is controversial. Propranolol is certainly a safe drug. There has been a large experience in the treatment of angina pectoris and hypertension throughout the world using this drug in doses up to 600 mg per day. Doses as high as 1.2 gms. per day have been reported without serious side effects. The drug is, however, dangerous in certain forms of heart disease, particularly those involving the conduction system, and in patients with bronchial asthma. There have been reports of myocardial infarction occurring after the drug has been used continuously and then withdrawn. Although these infarctions were undoubtedly caused by progression of coronary arteriosclerosis at a time when myocardial oxygen consumption was decreased by the drug, continuous use of propranolol, even in the relatively low doses required to eliminate stage fright, is probably not warranted.
In this respect, the investigators are concerned about the proliferation of the use of this drug among musicians who are aware of our studies. The evidence that continuous use of propranolol in situations of continuous stress may reduce the incidence of coronary artery disease, strokes, hypertension, and arteriosclerosis must at this point be considered theoretical and not adequately documented scientifically to recommend continuous use of the drug. On the other hand, recitalists, frequently giving no more than ten major recitals in a year, and doctors, unaccustomed to speaking at national meetings who present papers only several times a year may, perhaps, legitimately use beta blockade in anticipation of such a discrete stress situation.

Beta blockade should find its best use as an adjunct to conservatory training rather than as a performance crutch. It appears to us that stage fright is a learned response which is carefully inoculated into performing musicians by their conservatory programs. In contrast to the training of cardiac surgeons, whose education is centered around a program of gradually increasing responsibility, the performing musician is exposed to a program which is crisis oriented.

From the very start, the performance major is required, often with negative feedback and inadequate preparation, to perform music beyond his ability for over-critical audiences. There is no better way to teach the stage fright response. We would prefer to see propranolol combined with self-hypnosis training in a carefully designed conservatory program modeled after the training of a surgeon, strenuous certainly, but designed to teach students not to have stage fright.

Summary

1. Propranolol in doses of 40 mg. or less is remarkably effective in eliminating the physical responses known collectively as stage fright.

2. The psychological aspects of stage fright may be disabling, even after the somatic effects are eliminated.

3. Beta blockade with propranolol has only a secondary effect in the emotional aspects of stage fright. This aspect of the problem is perhaps better reached by self-hypnosis training.

REFERENCES

Since the introduction of propranolol and other Beta blocker agents, the therapeutic effectiveness of these drugs has been demonstrated for an ever widening spectrum of medical problems. Dr. Brantigan et al. have provided us with another situation, stage fright, where Beta blockade therapy may be potentially useful. The specificity of Beta blockade to counteract the physiologic and biochemical consequences of the stress response has obvious advantages over those offered by alcohol and tranquilizers, agents which traditionally have been used in an attempt to subvert the unpleasant and potentially damaging effects of stress.

I would agree with Dr. Brantigan that propranolol is a safe drug, and that the dose schedule employed in his protocol is not unreasonable, particularly in view of the intermittent and relatively infrequent application of the drug in a given individual. If propranolol's effectiveness is demonstrated to the degree indicated by this preliminary report in future controlled studies, widespread application by individuals involved with "public performances" can be anticipated. Indiscriminate and uncontrolled use by individuals within the "performance" community can be anticipated to produce potentially serious medical problems. For this reason I would emphasize, as did Dr. Brantigan and his colleagues, that any individuals who receive Beta blockade therapy for this purpose need to be carefully screened by a physician familiar with the contraindications and side effects of the various Beta blocker agents.

Dr. Brantigan's comments regarding the varying "psychological" response of their subjects to Beta blockade therapy also deserves further comment. Unpredictable central nervous system side effects of propranolol therapy are now being recognized with increasing frequency and their mechanisms are poorly understood. The role that this aspect of propranolol therapy played in the varying emotional responses of their subjects cannot be defined by this present study protocol. This aspect of Beta blockade therapy needs to be considered and warrants further thought and investigation if the study protocols are to be expanded to larger groups of subjects.

Dr. Brantigan's and colleagues' article was an intriguing extension of propranolol therapy, and I look forward to the results of their expanded studies in the future.

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**Book Review**


Dr. Kiev, with extensive experience both as therapist and researcher/theoretician in the field of suicidology has written this slim volume addressed primarily to the suicidally depressed patient, secondarily to the patient's 'significant others,' and hardly at all to the medical profession. It can appropriately be recommended to the families of one's depressed patients; it is doubtful that it will be of much benefit to such patients themselves; they are unlikely to be capable of absorbing much of its message. That message is that depression is a serious but treatable illness, and that chemotherapy is almost always a prerequisite - in cases of 'serious' depression - to successful psychotherapy.

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