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The Oracles

"It is surprising that an augur can see an augur without smiling."

—Cicero, *De Natura Deorum*

We smile at those bygone days when the medicine man was aided in his diagnosis of disease by inspecting an astrologic chart or by noting in which way the smoke from a burnt sacrifice drifted. We have laboratories, bright automated chambers with chromium-plated machinery, flashing lights and row on row of test tubes, flasks, slides and other glass paraphernalia. We also have portable machines whose tentacles attach to various parts of the body and which spew out rolls of graph paper imprinted with wiggly waves. We have dark rooms, too, in which tubes looking like an illustration from a science-fiction magazine are manipulated from distant control consoles. Biochemistry and biophysics are enlisted in the aid of the doctor seeking to find out what's ailing us or how we are responding to treatment. Reliance on laboratory findings is taken for granted as a sign of a physician's acumen.

Not with dread but with abiding faith you submit to having your finger pricked or blood drawn for examination. Not with doubt but with confidence you accept the results of the tests. To do otherwise would relegate you to the ranks of the backward and the benighted. You are a true believer in Science and what could be more scientific than a laboratory? Oliver Wendell Holmes, a physician as well as a litterateur, cautioned that "science is a first-rate piece of furniture for a man's upper-chamber, if he has common sense on the ground floor."

Too many people believe that Science is a religion. Theologians have sarcastically given that new creed the name of *scientism*. Scientism has more followers, especially amongst the presumably better educated classes, than Christianity or Zen Buddhism. Those followers mistake the map for the road, the X-ray photograph for a likeness, and numbers for facts.

Their belief sometimes leads to hilarious requests by patients who pride themselves on being cautious consumers of medical sergices. *They* are not going to be taken in by withcraft. Oh no! *They* are skeptics. They demand proof in black and white. "How do you know, Doc, unless you X-ray my nerves?" and "Where's the proof of your diagnosis?" Their skepticism lasts, how-

ever, only until a ghostly photograph is exhibited or until a sheet of paper typed with numbers from 0.2 to 5,150,000 is shown to them. When those are displayed they sit back and relax. *That's* proof.

Because most doctors are really good guys at heart and are sincerely trying to make their patients better as well as themselves rich, they have submitted to and often encouraged the naive belief in the infallibility of laboratory objectivity. They have become victims of their own propaganda despite the repeated cautions of medical hierarchs. One of the latter says that doctors are lazy: they won't take time to make a diagnosis; they find it easier to write slips for laboratory studies than to think. Another decries both the practitioner's failure to use his senses in trying to make a diagnosis and his reliance on the laboratory. Dr. Walter Alvarez puts some of the onus on the patient: "Often I cannot blame my brother physicians for sending a patient for useless tests because every so often I have to do it. If I didn't he or she would think I did not know my business, or I was highly negligent. . . . What I often marvel at is that so many people, and even well educated ones, have no interest in what an old clinician of enormous experience thinks about their problem: they want tests."

All right. So you have tests. Even if it turns out that not one of them shows up anything of importance, there was always the possibility that they might have. Why take chances? You're only spending money and who stints on money where health is concerned? Man, are you wrong! The odds against you are almost as bad as those on double aces at a Las Vegas crap table, and sometimes worse.

Suppose you rend the sacred veil and enter into the mystic chambers of the laboratory. And suppose you ask what's going on, but don't ask the acolytes in white but instead ask the very high priests, the teachers and mentors. Ask them to tell you in all honesty what happens when the machines stop whirring and the centrifuge stops rotating. They won't tell *you*. You're the patient. I will, but only in their own words.

Let's start with an electroencephalogram. Everybody who's seen Ben Casey and Dr. Zorba argue about one

knows what that is. That's real up-to-date! And so impressive! Think of it—electrodes stuck with gooey jelly here and there on the scalp, a flick of the button, and little waves appear on paper. You just take it for granted that an electroencephalogram is a necessity for accurate diagnosis of a brain lesion. Alackaday! The EEG (not to be confused with the ECG, which is discussed further on) is a weak reed on which to rely. I quote, without comment, from an article written for practicing physicians by Dr. Charles M. Poser, head of the Division of Neurology at the University of Missouri School of Medicine in Kansas City: "Fifteen to 20% of patients with clinically established convulsive disorders never have an abnormal EEG. On the other hand, 15 to 20% of the general population with no history of convulsive disorders have an abnormal EEG. . . . Rarely can it [the EEG] give clues to the etiology, or more important, to indication for long term management . . . it is seldom imperative for diagnostic purposes. . . . In summary, the value of the EEG must be considered comparable to that of all other laboratory tests. It does not make the diagnosis. . . ."³

Well, maybe the electroencephalograms are too new. Maybe all the bugs haven't been worked out of the procedure as yet. What about X-rays? Nobody can lie about a picture. Statistics can lie but not a picture. Something's there or it isn't. There's an abnormal spot in the lung or there isn't; there's a blocked area in the intestines or there isn't. The truth is otherwise. The evidence for such a sharp dichotomy is woefully lacking. In 1948 Dr. L. Henry Garland, in his presidential address to the Radiological Society of North America, reported on results of a survey of readings of chest films. (The readings were supposedly not of the same nature as the readings given by gypsy fortune tellers.) The survey showed that as many as 24% of radiologists differed with each other in their interpretations of the same films, even in the cases of extensive disease; worse—the same radiologists disagreed with themselves to the extent of 31% on the same films when read at another time. In 1955 it was found that 32.2% of chest X-rays that showed definite lesions in the lungs were misdiagnosed as negative.⁴ In 1959, eleven years after the first survey, with only experts doing the readings, 30% disagreed with another's reading and 20% disagreed with their own readings at another time. And now, eleven years still later, a study at Harvard, reported in the *American Journal of Epidemiology* (91:2), showed that radiologists disagreed with each other on the diagnosis 20% of the time and with themselves 10% of the

time on a second reading of the same film. Not much progress, is there?

All right, you say, so mistakes are made, but on the whole who can deny that mass X-ray screening of chests is of no value? Just think of all the cancers that are picked up that the possessors knew nothing about! Your reasoning may be logical, but it doesn't conform with the facts. In a mass screening program covering more than 7,900,000 persons there was "no appreciable gain in salvageable lung cancer patients. Symptoms appear to be the best clue to the presence of bronchogenic cancer."⁵

Don't go away—here's more about chest X-rays in the early detection of lung cancer, with an orbiter dictum: "It would seem prudent, therefore, to use clinical sense to a high degree and to continue the search for a test other than routine X-ray examination for presymptomatic diagnosis of cancer, not only of the lung but of other sites as well."⁶

That last remark gives you pause, doesn't it? The doctor implies that X-rays of areas other than the chest are equally fallible. He's right but I'll give you only two more examples. You've been discouraged and disillusioned enough already. One survey showed that 10% of cancers of the large intestine were overlooked as well as 27% of cancers of the cecum, the blind pouch at the junction of the small intestine with the large.⁷ In 1965 another survey of gastrointestinal X-rays showed that in 300 consecutive cases readers disagreed in their diagnoses 30% of the time.⁸

Why go on? That Halloween photograph of your insides serves to bemuse you (and too often your doctor) into thinking that it's tangible and visible proof that a diagnosis has been made. Sort of reminds you of the laurel leaves on which prophecies were written so ambiguously at Delphi, doesn't it?

Laurel leaves were safer. X-ray radiation is intrinsically hazardous. At a conference on tuberculosis, two Nova Scotia investigators reported that the repeated chest fluoroscopies done on female patients in the

³ *American Family Physician*, April, 1968, p. 75. There will be many references like this from now on. If I didn't give them, you might think I was making up the dreadful information to come.

⁴ Dr. J. Yerushalmy, *American Journal of Surgery*, January 1955.

⁵ Dr. H. Wilson, in the *Medical Journal of Australia*, 2:936, 1968.

⁶ Dr. P. Lesley Bidstrup, *British Journal of Radiology*, May, 1964, p. 357.

⁷ Drs. R. Cooley et al., *American Journal of Roentgenology, Radium Therapy, and Nuclear Medicine*, August 1960, p. 316.

⁸ Dr. Marcus J. Smith, in the same journal, July 1965, p. 689.

course of their treatment could probably be implicated in the unusually high incidence of breast cancer that later developed. Nine times greater in the fluoroscoped patients than in a control group! In an interview with a reporter from *Medical World News* (September 11, 1970), Dr. Robert D. Moseley, Jr., chairman of four national committees on radiation hazards, said about mass screening for gastrointestinal disease, the use of X-rays for diagnosis in large populations, "The dose [of radiation] received is higher and the incidence of disease turned up is lower. In these cases I'd have serious doubts about using radiologic procedures in routine screens." A British survey showed that even one X-ray during pregnancy can significantly increase the risk of a child developing cancer in the first ten years of his life. "This radiation risk is greatest during the first trimester, but it exists throughout pregnancy."⁹ Dr. Donald R. Chadwick, of the United States Public Health Service, says, "Responsible authorities agree that all radiation exposure carries some risk of adverse biologic effects, and therefore unnecessary exposure should be reduced or eliminated *whenever possible*." Note the cautious attitude expressed in the last clause. If it's unnecessary, why reduce it? Why not eliminate it altogether? Can it be that X-rays are necessary for mystification?

Let's leave Dr. Casey and Dr. Roentgen and go on to sweet Dr. Kildare and Raymond Massey (or Lionel Barrymore, depending on how old you are). The internists at Blair General Hospital put much stress on the electrocardiogram. You've seen them holding that strip of paper in their hands and shaking their heads. You've even seen the cardiac monitor's electronic eye go across your TV screen with the up and down waves that trail off into a horizontal line with the patient's exitus. That *can't* be magic; that's science and accuracy. Want to bet?

In 1956 a survey similar to that done with X-ray interpretation was done on electrocardiographic tracings. The reports of the ECG readers varied by 20% between individuals and 20% on rereading of the same tracing by the same individual at a later date.¹⁰ Eight years later, in 1964, an editorial in the *Journal of the American Medical Association* entitled, "The ECG: a Re-appraisal" commented that variations in the electrocardiogram were so great, depending on the time of day, activity, digestive function and so on, that interpretation must be undertaken with great precaution because so many normal people showed changes usually regarded as evidence of cardiac pathology. The editorial concluded with a plea for standardization of

ECG testing to preclude error. What was done? nothing. Electrocardiograms are still being taken before and after meals, during the stress of an acute illness, after arguments with nurses and orderlies. In 1968 Dr. Irving Wright, a prominent clinician, wrote, "A relatively common error is the over-interpretation of minor electrocardiographic chances . . . the physician should not jump to hasty conclusions. . . ."¹¹ Interpretation is not always at fault. "Electrocardiographic technique is often poor and sometimes execrable," writes Dr. Abraham Genesin, Associate Professor of Medicine at Johns Hopkins University School of Medicine.¹² He lists eleven common causes of bad tracings (reversal of limb leads, twisting and torsion of the cables, etc.). He warns that the ECG cannot substitute for the data derived from a full history and physical examination. Even the speed at which the paper rolls out makes a difference, a Boston cardiologist says, because abnormal values for the PR, QRS and QT intervals may appear (Those radio-message-like capitals indicate various portions of the wave shown on the electrocardiograph).

A personal experience: While I was a patient in an intensive care unit in a hospital, the nurse reported that the monitor showed an abnormally fast heart rate. An electrician came, fiddled with some wires and switches on the ECG machine, and proudly said, "There! I've got his rate down now."

Right then I almost had a heart attack. Why? Because I could have been electrocuted. Dr. Carl W. Walter, Chairman of the Safe Environment Committee, Peter Bent Brigham Hospital, in Boston, says, "No one knows how many patients die of undiagnosed accidental electrocution in hospitals each year. An insurance actuary . . . estimates the number at 1200, but I am inclined to believe that the true figure could be . . . something like 5000. These unrecognized electrocutions are usually diagnosed as cardiac arrest, and they occur during resuscitation efforts or during the application of electric monitors, pacemakers, or other appliances. . . ." He goes on to discuss the causes of the 110-volt macroshock that everyone is familiar with, and then, ". . . there is also the problem of microshock. When we

⁹ Drs. A. Stewart and G. W. Kneale, in *Lancet*, 1:1185, June 6, 1970.

¹⁰ Dr. G. L. Davies, *British Heart Journal*, 1956, vol. 18, p. 568.

¹¹ *Internist Observer*, April, 1968.

¹² "Abuse of the Electrocardiogram," *Current Medical Digest*, July, 1968.

bypass the electricity-resistant skin and insert cardiac catheters, sensors, and probes, premature systole or ventricular fibrillation [not good, believe me!] can be caused by a current almost too small to measure—as low as 10 milliamperes. Voltage gradients as low as 5 mv may be significant. Leakage currents may occur in a path from the patient's tissues to the ground even when the electric device is not turned on. Transient voltage when a switch is flicked can also stimulate the heart."¹³

The ECG is a tracing that purports to give information about the state of the heart muscle. The latest survey showed that only in one-fourth of the cases of proved acute myocardial infarction (proved by autopsy or subsequent course) was the ECG positive; in half, the findings were equivocal; in the remaining fourth, they were totally negative, what the doctors called *false negatives*. That's not all. In more than half of another series *without* infarction, the ECG was grossly abnormal, *false positive*. As a totally reliable diagnostic tool, the ECG is woefully lacking.¹⁴

A New Jersey cardiologist tells of a patient who, at the age of 46, had a "routine" electrocardiogram which showed that he had inverted T waves in leads I, II and the left V. So instead of going to North Carolina on a golfing vacation, he disgustedly went to the hospital for four weeks with a diagnosis of coronary artery disease. T waves remained inverted on discharge and were still inverted two years later when a large hiatus hernia was found. Twenty years later, the T waves were still unchanged and the patient was playing eighteen holes of golf without any symptoms. The moral: an inverted T does not always a coronary make.¹⁵

So much for reliance on the mystic machine. Its value for diagnosis and for checking the result of treatment is limited, and yet it is used almost routinely. Not because of the venality of the doctor, but because sometimes he is taken in by his own propaganda and more often because of the childlike belief of his patients in gadgetry.

And sometimes the doctor is stupid. Or careless. Which is the same thing when it comes to reliance on clinical laboratories. In the first place, too often the doctor doesn't know beans about the quality of the laboratory doing his tests. In eighteen states and the District of Columbia anybody—that's right, *anybody*—can open up a laboratory and without control or supervision advertise for and get customers. Secondly, the doctor is just as impressed as is his patient by an array of equipment. He seldom asks who uses those fancy machines—a qualified technician or one hastily trained for

a stopgap job?

Good training is necessary. Those laboratory manipulations look simple, especially if you remember a little high school chemistry or biology. But don't forget, it is not the starch content of potatoes that is being measured. And the more sophisticated the instruments, the better trained must be the personnel using them.

From time immemorial medicine men have concerned themselves with the excretions from the body as diagnostic criteria. The Hindus discovered the presence of *diabetes mellitus* by tasting the urine to determine whether it was sweet. Centuries later, Western doctors made diagnoses by pouring the urine into a flask and holding it up to the light. This quaint practice, called *uroscopy*, can be seen pictured in Renaissance paintings. (Inversion of the flask, emptying the urine on the floor, was depicted in old woodcuts as a sign that the patient would die. It was the medical equivalent of thumbs down.) A modern doctor takes that specimen of urine and hands it over to a technician. The specimen is either freshly passed or brought to the doctor in a variety of containers, varying from a gallon jug still redolent of laundry bleach to a tiny perfume vial. I have often seen both. I can understand the former but the latter gets me. Had I been a real scientist I would have asked the patient how she got that dram of urine into that wee, wee (no pun intended) bottle with the pinpoint opening. (I never did ask, but I'm still interested and think about it on long plane rides.)

The technician examines the urine in minute detail and submits a report on it. On that report (if he looks at it) the doctor may base his diagnosis. I say "if he looks at it." One study showed that ward nurses didn't bother doing even the simplest tests on urine because they knew the doctor didn't pay any attention to what was written on the chart. But suppose he does look at it? Is it helpful? I have known doctors who point to the report of albumin and other abnormalities in the urine and on that basis confidently make a diagnosis of kidney disease. Are they right? Alas, not so. I quote: "In

¹³ Greatly abbreviated from an article in *Hospital Practice*, December, 1970, p. 53. The whole article is well worth reading, as well as "Is Your CCU [Cardiac Care Unit] Electrically Safe?" by Dr. Hans A. Von der Mosel, in *Medical-Surgical Review* for October, 1970, p. 28, in which the "trivial" microshock that causes death is vividly described.

¹⁴ Dr. D. Short, *British Medical Journal*, 4:673, Dec. 14, 1968.

¹⁵ Dr. Bernard B. Eichler, *Journal of the Medical Society of New Jersey*, 66:582, October, 1969.

view of the unfortunate tendency of many physicians to rely on the laboratory report for a diagnosis of nephritis, the fact will bear emphasis that here, as in most conditions, the laboratory observations present only a part of the data necessary for a diagnosis."¹⁶ The painter John Opie, when asked with what he mixed his pigments to get such glowing colors, replied, "With brains, Madam, with brains." The doctor must do more than merely go through the ritual of testing the specimen. He must mix the report with brains.

Here are some fascinating statistics on blood examinations. In 1936 red blood cell counts on the same blood showed a gross variation of between 16% and 28% error when done by different technicians.¹⁷ In 1969, except where an electronic cell counter was used, the error was still at least 16%, which doesn't permit the distinction between microcytic and macrocytic anemia, often the only purpose in doing the count.

Doctors aren't always happy with the results of their auguries. They make periodic surveys of their techniques. I don't know why. After they're done, nobody seems to pay much attention to them. If you think red cell counts were bad—look at blood chemistries.

A survey showed that in hemoglobin determinations 22% were grossly wrong and of those, 67% were beyond the reasonable bounds of error. Blood glucose tests were so far out of the way that 37% were worthless for diagnosis. Total blood protein determinations—67% wrong.¹⁸

Some enterprising biochemical engineers have tried to do away with the human errors inherent in measuring, diluting and testing the blood. They have made ingenious machines working on the computer principle, machines that take a sample of blood and run it through a series of operations, ending up with figures that presumably could not be more accurate. But a machine slightly off balance may make the same mistake repeatedly. And with an automated analyzer doing eleven tests at once, let us say, there will be eleven more chances for error. Too bad the engineers have not remembered the human being who uses the figures. I quote again: "The wonderful accuracy of laboratory data done with modern apparatus may increase the credulity of those who employ them. A dial or scale accurate to the third significant figure triples the credulity of the user. He forgets that multiplying the complexity of the instrument multiplies the opportunity for purely mechanical error."¹⁹

Especially in mass screenings the computer laboratory may be misleading. In a group of healthy subjects

having fifteen tests done, about half of that group would show one or more abnormal values due purely to chance. With fifty tests, nine out of ten would show at least one false positive test. And that's with good machinery with a tolerance limit of 95% accuracy per test. Why? Plain mathematics. In one test the probability that a healthy individual will have an abnormal test is $1 - (.95)$, or 5%. For two independent tests, it is $1 - (.95)^2$, or almost 10%. For 15 tests, it is $1 - (.95)^{15}$ —over 50% chance of error. Dr. Bruce Schoenberg of the National Cancer Institute says there is not much physicians can do about these results except live with them. Or—use their heads when they find a result that doesn't jibe with other findings. Unfortunately, many doctors have so little confidence in their diagnostic skills that they believe the machine rather than what they see or hear.

Even in the absence of error, too much data makes a forest out of trees. In medicine this has been called *diagnostic overkill*. If a very large amount of information is offered, say the communications engineers, the general effect is that which they call *noise*. To make the information meaningful, irrelevancies must be filtered out or the relevancies exaggerated.

And finally, too often human frailty hits the most accurate laboratory work when the figures are transcribed onto the hospital chart or the office form. The laboratory reports a blood urea nitrogen of 10.2; the floor clerk omits the decimal and it appears as 102. Mrs. Mary Smith in Room 203 has a white blood cell count of 23,000; Mrs. M. (for Madeline) Smith in 207 has a count of 7000; I have seen the counts transposed. The urine analysis on Mr. Jones shows sugar, but the plus mark is put alongside the albumin box.

That's all technique. You can't put all the blame for error on the doctors. What about interpretation? *That's* strictly his job. A true (and sad) story: Some busybody in a hospital suspected that the doctors weren't looking at the laboratory reports. He checked on his suspicions by covering the figures with masking tape, thus forcing the doctors to do a minimum of physical work if they really wanted to see those figures. About a third didn't bother to peel off the tape! Worse yet, of those that did, another quarter paid no attention to grossly abnormal

¹⁶ Todd and Sanford, *Clinical Diagnosis by Laboratory Methods*, Tenth Edition, p. 177.

¹⁷ Drs. Magath *et al.*, *American Journal of Clinical Pathology*, 1936, vol. 6, p. 568.

¹⁸ Drs. W. P. Belk and F. W. Sunderman, same journal. November, 1947, vol. 17, p. 853.

¹⁹ Dr. W. B. Bean, *Archives of Internal Medicine*, 105:188, 1960.

results! They looked without seeing or they saw without perceiving.

The laboratory tests need interpretation as much as X-ray pictures do. An overzealous doctor worries when the hematocrit drops from 41 to 39 or the blood cholesterol rises ten points. He forgets the errors inherent in technique. A difference of ten per cent in blood counts, for example, is insignificant, as is the change from 180 to 190 in a blood glucose determination. And when the norm lies between 150 and 200, as in total blood cholesterol, what difference does it make if one report says 175 and another 190?

Another mistake in interpretation arises from scientism: if the test is positive, that's proof. Not so. An example: Increased serum enzyme activity has been regarded as diagnostic of acute coronary thrombosis. But a 1968 report to the College of American Pathologists pointed out that false positives were common in various gall-bladder disorders, so much so that clinical judgment was more valuable than the enzyme test in the differential diagnosis of the two conditions.

Why go on? A long list of laboratory reports may look good on the patient's chart, but how much does it contribute to his getting better?

Now let's go back. There's no denying that the X-ray tube, the ECG machine and the blood analyzer are necessary in some cases for the doctor to establish a diagnosis or to follow the results of his treatment. But the doctor must be aware of the perversity of inanimate objects and not rely on machinery alone. He needs to use his senses and his brains as well. He must be able to interpret tests properly, to discard grossly deviant findings and to take to heart the mistranslated but true Hippocratic dictum that experiment is fallacious. (The original said *experience*.) Dialectics: it's up to the patient to ask why the repeated tests, why the daily electrocardiograms, why the weekly chest X-rays. To ask why—and not be put off (or down) by double talk.

More dialectics: it's also up to the patient not to ask for irrelevant tests because they're fashionable (for example, monthly Pap smears). The doctor will undoubtedly oblige the patient by having the test done. *Cui bono?*

Still more dialectics: When a doctor tells you a test shows that you have a condition you could not possibly have, tell him he's wrong. Insist that he repeat the test in another laboratory or do a more thorough medical examination. Two examples: The X-ray series shows gallstones in the gall bladder, but your gall bladder was removed years ago (I had such a case!). The

Wassermann test for syphilis is positive, but you are a very moral person and never even use public toilets; maybe you have mumps or infectious mononucleosis, both of which sometimes give the same positive reaction as syphilis.

By now you realize that doctors are almost as credulous as their patients when it comes to laboratory tests. Right there is a danger to health—and sanity. When the medicine man believes that his divinations mean something, that's worse for the patient than when he cynically puts on an act for the sake of impressing the sufferer.

I give you now an example of how far credulity can go. Suppose you had no signs or symptoms of *diabetes mellitus*, but you have a very careful doctor on the alert for latent disease. Urine analysis shows no sugar. The doctor checks your fasting blood sugar and your blood sugar two hours after a meal. They're normal. Then he does a glucose tolerance test and then what is known as a provocative cortisone glucose tolerance test. They're normal, too. You think you're off the hook? Not at all. The doctor, a specialist in his field, says sadly, "Too bad. You have prediabetes." And if you think that's a made-up story, I refer you to a pamphlet by Dr. Arthur Krosnick under the imprimatur of the New Jersey State Department of Health. There the diagnosis of prediabetes is said to be confirmed by negative laboratory and clinical findings. There is also a treatment prescribed for this condition. The treatment consists of blood tests every six months for the duration of the patient's life.

When the magician believes in his magic, beware!

