Clinical Medicine

Physical Diagnosis Versus Modern Technology
A Review

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The role of physical diagnosis in an age of modern diagnostic technology has been evaluated by investigators assessing specific techniques in a number of areas, though there has been no systematic comprehensive study of the sensitivity, specificity, cost-benefit ratio, and reliability of physical diagnosis relative to technologic diagnostic tools. In a review of published studies comparing physical with nonphysical diagnostic techniques, the startling accuracy of physical diagnosticians in some areas contrasts sharply with the extremely poor correlation of physical findings with autopsy or imaging studies in others. In a time of constricting financial resources, physicians—and those who teach or judge physicians' skills—must begin to compare physical and nonphysical diagnostic techniques rigorously so that the best, safest, and least expensive diagnostic test is chosen in each clinical situation.

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With their discovery by Wilhelm Conrad Röntgen in 1895, x-rays were incorporated into clinical medicine with astonishing rapidity, and Röntgen was awarded the Nobel prize in 1907.[1(p721)] The physical diagnosis of chest diseases, a meticulously developed craft of observations, sounds, percussion, and maneuvers, seemingly became passé. In the 1980s many chest physicians agreed with the chapter author in a textbook of physical diagnosis that it is best to see a roentgenogram of the chest first and then the patient, as "it can save valuable time to identify in advance the areas that require the most meticulous examination."[2(p226)]

What is the current place of physical diagnosis in an era in which laboratory diagnosis, advanced automatic multichannel serum analyzers, computed tomographic (CT) scans, nuclear medicine, positron emission scanners, magnetic resonance imaging, ultrasonography, and electrodiagnosis offer expanded, often uncanny, entry into the mysteries of the body? Is physical diagnosis in some circumstances arcane, outmoded, an almost cabalistic rite,[3] or does it still have value in the armamentarium of the modern physician?

It appears that there are pragmatic pressures to resuscitate an emphasis on physical diagnosis in the United States. In two surveys of graduates of residency teaching programs, history and physical examination skills were highly rated as important in practice, and the physicians surveyed felt that their training programs had underprepared them in these areas.[4,5] Others have warned of the intrusion of technology into the patient-physician relationship,[6,7] a diminution of time spent with patients at the bedside,[8,9] and the loss of skills in patient-physician negotiation, patient comforting, and psychiatric techniques.[10] Pressures to use the laboratory or nonphysical diagnostic techniques are many: Busy house staff may find it more efficient to write laboratory orders before seeing a patient[11]; new technologies are faddish, and curiosity as well as compulsivity increase their use[12]; the laboratory serves as a "quality control" reference for physicians.[13] Some patients clearly get therapeutic benefit from laboratory tests, expect or demand them, and do not feel well "worked up" without them. Lawyers and third-party payers appear to be impressed by laboratory results, or at least physicians perceive this to be the case.

If physical diagnosis is to be used, it must be assessed in the same rigorous way as are nonphysical diagnostic techniques, but there are difficulties in comparing physical with technologic diagnosis:

- *Unreliability of method.* Whenever a study comparing physical diagnosis with technologic diagnosis is evaluated, it is important to note *who* did the physical diagnosis and *who* interpreted the technologic diagnosis. Studies of the interobserver consistency of physical examination show much variability, but questionable also is the reliability of nonphysical studies.[14] Even when a technologic "gold standard," such as magnetic resonance imaging, is agreed on generally, it may not have been truly well assessed.[15,16]
- *The rapid evolution of technology.* Studies of physical diagnosis versus phonocardiography, or early-generation CT scanners, or the early echo-imaging techniques are of little current value. Of more pertinence, perhaps, is the assessment of the overall accuracy of diagnosis in the face of evolving technologic diagnostic advances. A retrospective analysis of 100 randomly selected autopsies from 1960, 1970, and 1980 showed that in all three decades, despite their vastly different diagnostic tools, 8% to 12% of autopsies revealed major missed diagnoses that, had they been made antemortem, might have prolonged survival. Another 12%

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of autopsies in these groups showed clinically missed major diagnoses for which therapy would not have changed the outcome. Though the indications for autopsy in each of the three decades might have been very different, the authors of the study thought that an over-reliance on radionuclide scanning, ultrasonography, and CT scanning in several cases contributed directly to the failure to make the major diagnoses.[17]

- *Time, expense, and ease of diagnosis.* In assessing the relative merits of technologic versus physical diagnosis, time and expense become part of the therapeutic ratio. Is physical diagnosis less expensive in dollars than technologic diagnosis? It depends. Clinicians must do physical diagnosis, whereas technicians may do a large part of technologic diagnosis concurrent with clinicians making other use of their time. It may require a skilled neurologist several hours of history taking and physical examination to find a lesion easily demonstrable by CT scan of the brain in half an hour. The time saved may have great value to a busy patient as well as to the clinician. An erroneous diagnosis due to an underuse of the laboratory or to a poor physical examination may be expensive in these litigious times, not to mention disastrous to the patient.

- *Quality control.* Independent assays of serologic studies may allow reproducible (reliable) results. How good is the reliability of physical diagnosticians? Not very, it seems. In studies on the assessment by faculty of physical diagnostic skills of residents and medical students, significant doubts are raised as to our ability as physicians to recognize a good physical examination when we see it.[18-20]

- *Clinical significance of findings.* Even if a technologic assessment is reliable, sensitive, and specific for a given finding, we must ask, "so what?" Much of our clinical advice and prognoses are historically predicated on history and physical examination, or these plus older technologic diagnostic studies. The actual meaning to a patient of a finding uncovered by a newer technology is often uncertain until further experience accumulates. Does a mitral valve prolapse on an echocardiogram mean the same thing as a mitral valve prolapse on auscultation?[21] Has the use of ultrasonography in the diagnosis of appendicitis[22] improved or worsened[23] patient outcome in this disease? Too sensitive a diagnostic technology, even if highly specific, could conceivably even create disease when the condition detected has a lesser morbidity than its diagnosis and therapy. Transrectal ultrasonography, for example, has been reported to have a detection rate for prostatic carcinoma two times greater than that with digital examination.[24] How many men who would normally have died with, but were not symptomatically bothered by, a prostatic cancer would be frightened by its detection and injured by its biopsy or removal? The risk-benefit ratio for this and other highly sensitive diagnostic tests remains to be determined.

Physicians still believe that the history and physical examination have value in diagnosis, with the history overwhelmingly the most useful diagnostic tool.[25,26] The value of the physical examination has been studied and compared with that of technologic diagnosis in many areas of the body, though not extensively nor systematically. A brief literature review, arranged along the lines of a standard physical examination, illustrates not only what has been done to date, but also the need for more—and more stringent—comparative studies.

General Examinations

Most experienced clinicians value an as-yet-unquantified ability to distinguish a sick from a not-so-sick patient, as well as the experientially derived skill of defining or, at the least, identifying a classic syndromic general appearance. To what degree these assessments are valid remains unstudied in any formal sense.

Physical examiners judging patients' nutritional status agreed in 81% of cases, and their opinion correlated well with laboratory evidence. Clinical morbidity—number of days in hospital, incidence of infection, need for antibiotics—related well to clinical assessment.[27] In a prospective evaluation of 50 patients, there was a significant correlation between a measured hemoglobin concentration and the color tint of the lower lid conjunctivae, nail bed rubor and blanching, and the rubor of the palmar crease. It appears that both the presence and the degree of anemia can be reliably estimated clinically by a careful physical examination.[28] In patients admitted to a medical intensive care unit, clinical examination was found inadequate to predict right-sided heart catheter findings in critically ill patients without myocardial infarction. In nearly half the patients in this study, the data obtained by right-sided heart catheterization resulted in important changes in therapy.[29] In a similar study, Unger and associates looked at 14 patients with the adult respiratory distress syndrome and found no clinical criteria that would allow an examiner to accurately distinguish those with left ventricular failure from those without it.[30] A physical examination may be of less value in the diagnosis in a critically ill patient. There are difficulties inherent in the physical examination of patients in an intensive care unit, including the physical impediments of tubes, lines, and monitors; potentially high levels of ambient noise may impair auscultation (in nonintensive care patient rooms, peak noise levels of 70 decibels have been recorded, equal to the noise generated by a vacuum cleaner).[31] Nonetheless, the high frequency of incorrect clinical predictions in seriously ill patients merits caution.

Vital Signs

Though the blood pressure is perhaps the most frequently measured of all physical findings, numerous studies have shown that the reliability of blood pressure measurements is poor. A sphygmomanometric measurement of the systolic blood pressure using auscultation underestimates the direct systolic pressure by an average of 16 to 17 mm of mercury[32] and varies by the age of the patient,[33] cuff size,[34] and arterial compliance.[35] The auscultatory blood pressure also varies depending on arm position,[36,37] pressure of the head of the stethoscope on the artery,[38] and even the profession of the person taking the blood pressure.[39] How these variations relate to the long-term clinical prognosis of a "hypertensive" patient remains unknown, as does the question of whether intra-arterial or sphygmomanometric blood pressure is the better predictor of clinical sequelae.

Fever, an ancient sign of disease, has been studied. Eisenberg and colleagues found that emergency department physicians admitted to the hospital febrile patients with subsequently positive blood cultures far more often than they admitted febrile patients who turned out to have negative blood cultures, suggesting that clinical judgment could predict bacteremia in a patient.[40] A subsequent study, however, has found that emergency department physicians' diagnostic

predictions did not correlate with a final diagnosis of infective endocarditis in febrile intravenous drug abusers.[41] Similarly, Makadon and co-workers found house-staff predictions of bacteremia in febrile inpatients to be inaccurate, concluding that clinical judgment is not an adequate substitute for blood cultures in this population.[42]

Eye

Because intraocular pressure measurements do not correlate directly with clinically significant glaucoma, it is accepted that ophthalmoscopy by a skilled examiner gives fewer falsely abnormal results than tonometry in detecting glaucoma.[43]

Head, Ears, Nose, and Throat

In the evaluation of sphenoid sinusitis, physical examination is useful in providing clues (turbinate pus, fever, neurologic changes) but not diagnostic: CT scan is held to be the diagnostic test of choice.[44] The opacity of the maxillary sinuses when illuminated by a Welch-Allyn-Finnoff transilluminator was a sensitive and specific predictor of abnormal sinus aspirates.[45] Physical examination of the pharynx in pharyngitis does not distinguish viral from bacterial infection.[46]

Breast

An early study suggested that the most rewarding method of screening for breast cancer was the annual clinical examination by a physician[47]: 1,000 women were observed prospectively, comparing the annual clinical examination, mammography, thermography, and breast self-examination. Of 23 malignant solid lesions first detected clinically in this study, only 4 showed changes on mammography. Other investigators, however, have maintained the superiority of mammography to clinical examination, with the best sensitivity of detection obtained by combining the use of both.[48,49]

Chest

Spiteri and colleagues studied physician reliability in eliciting physical signs in the examination of the chest and found that there was generally poor agreement among physicians about particular chest signs. More than 25% of physicians' diagnoses were incorrect. Agreement among the physicians was greatest for percussion note, wheezing, and the presence of pleural rubs. It was little better than chance for tactile fremitus, pectoriloquy, and displacement of the trachea.[50]

In a study designed to assess the skill of private internists in recognizing obstructive lung disease by physical findings alone compared with pulmonary function tests, there was immense variation among the physicians in signs detected and poor ability to predict the presence or absence of abnormal physiologic measurements of respiratory function. Decreased breath sounds were the most reliable single sign detected, with barrel chest, decreased chest expansion, impaired cardiac dullness, the use of accessory muscles of respiration, an absence of the cardiac point of maximal impulse, cyanosis, and decreased diaphragmatic excursion following in order. Impaired liver dullness and decreased diaphragmatic movement showed no statistically important relation to emphysema by pulmonary function tests.[51]

Perhaps the absence of a value of the physical detection of diaphragmatic excursion in evaluating emphysema is illuminated by the study of Williams and associates in which diaphragmatic percussion showed wide interobserver variation and poor correlation with diaphragmatic excursion as measured by inspiratory-expiratory chest roentgenograms.[52]

Physical examination to detect or quantify obstructive lung disease may be unreliable compared with pulmonary function studies and chest roentgenography, but does this make a difference in management? Owens and co-workers assessed by history and physical examination 100 patients with lung disease in an outpatient clinic, classifying them clinically as improved, stable, or worse. None of those who were clinically improved and but 3% of the stable patients had any change in clinical management as a consequence of spirometry or chest x-ray film; 29% of those clinically categorized as deteriorated had their management plans modified after a review of their spirograms and chest films.[53]

Only 32% of fatal pulmonary emboli in patients admitted to hospital are clinically suspected during life,[54] and the history and physical examination show low sensitivity and specificity for diagnosis compared with pulmonary angiography, with its sensitivity of 98% and specificity of greater than 99%.[55]

Numerous attempts have been made to find good clinical predictors of the severity of asthma, the need for admitting to a hospital, and the likelihood of relapse, using both physical and spirometric examinations,[56] with arguable success.[56-58] The severity of acute episodes of asthma is imperfectly reflected by the signs and symptoms of the disease, though sternocleidomastoid retraction,[59] a disturbance of consciousness, unequivocal central cyanosis, pulsus paradoxus,[60,61] sitting upright, and diaphoresis[61] have all been shown to reflect severe disease. The forced expiratory volume in 1 second has been said to be a more reliable guide to adequate therapy for discharge from an emergency department in a patient with acute asthma than the disappearance of dyspnea, the diminution of labored breathing, a reduction of wheezing, or loss of a pulsus paradoxus or sternocleidomastoid retraction.[62] Patients have been shown to be capable of greater accuracy in assessing their own peak expiratory flow rates than are the physicians examining them.[63]

Cardiovascular

There has been a recent reawakening to the possibilities of the precise cardiac diagnosis of heart murmurs by a variety of bedside maneuvers,[64-70] but only some investigators address the question of a physician's skill, investment of clinician's time, and limitations in sensitivity and specificity of each maneuver—Valsalva's, Müller's, isometric handgrip, and so forth.[7] Apparently a combination of these skills and maneuvers applied by an experienced clinician may be extraordinarily revealing.[64] Modern cardiac diagnostic technology can be retrospectively compared with expert clinical diagnosticians. Two decades ago, before the widespread use of technologic diagnosis in cardiac disease, Pestana and colleagues found that in patients with congenital heart disease, 80% of clinical diagnoses were confirmed as "completely accurate" at operation.[72] In the remaining 20%, the clinical diagnosis was actually confirmed, but an unsuspected additional lesion was also present: the additional lesion, however, made a major difference in only 3.7% of the total group. A more recent survey of the usefulness of M-mode echocardiography, chest roentgenography, and electrocardiography in discriminating between the presence or absence of heart disease in children with heart murmurs concluded that the tests

were unlikely to add anything to a qualified pediatric cardiologist's accurate assessment of "definite heart disease" or "no heart disease."[73]

Echocardiography adds significantly to a clinician's ability to diagnose and quantitate aortic stenosis,[74] and auscultation of aortic insufficiency is less sensitive and specific than Doppler echocardiography (though auscultation is more sensitive than M-mode or two-dimensional echocardiography in the diagnosis of aortic insufficiency).[75] Echocardiography is clearly more sensitive than clinical examination for detecting pericardial effusions.[76] The urgent need for further studies to establish the practical utility of auscultation versus echocardiography is emphasized by the exquisite sensitivity of echocardiography in detecting valvular regurgitation: does tricuspid, mitral, or even pulmonic insufficiency[77] by echocardiogram have the same meaning as that detected by physical examination? It appears not.

It is generally acknowledged that electrocardiograms in an emergency department should seldom if ever alter the ultimate decision, based on the history and physical examination, of whether or not to admit a patient with chest pain.[78] Vascular disease elsewhere, congestive heart failure, hypertension, ventricular gallops, and cardiomegaly are surprisingly poor predictors of significant coronary artery disease, though a history of risk factors, previous myocardial infarction, and an abnormal electrocardiogram are useful predictors.[79] A physical examination is reliable in excluding hemodynamically significant right ventricular infarction in a patient with an inferior wall myocardial infarction who has neither elevated jugular venous pressure nor Kussmaul's sign.[80]

In patients with a clear clinical diagnosis of infective endocarditis, M-mode echocardiography showed vegetations in but 49%, with two-dimensional echocardiogram revealing vegetations in 80%.[81]

The bedside determination of the duration and size of the cardiac apical impulse predicted left ventricular hypertrophy by angiography more accurately than did electrocardiography or chest roentgenography,[82] but the location of the left ventricular impulse was less reliable.[82,83]

When cardiologists were asked to estimate the left ventricular ejection fraction compared with gated blood pool scan measurements, 56% of physicians' estimates were accurate, 17% underestimated, and 27% overestimated.[84] In a similar study, the clinical cardiologist was able to predict in 61% of cases whether or not the left ventricular ejection fraction would be normal, mildly to moderately reduced, or severely reduced in 99 patients with known coronary artery disease studied by radionuclide ventriculography.[85] Cease and Nicklas have proposed a formula using direct heart rate, blood pressure, and heart size on chest film that can predict a radionuclide ventriculographic ejection fraction of less than 40% with 87% sensitivity and 83% specificity.[86]

In 458 diabetic patients, noninvasive testing was found to reveal peripheral arterial disease in nearly a third of patients without a history of claudication and 20% of those with normal findings on clinical examination.[87]

Abdomen

Abdominal aortic aneurysm is ill diagnosed by physical examination compared with arteriography[88] and ultrasonography,[89] although in the latter study clinicians could accurately detect all aortic aneurysms in the study patients with abdominal girths less than 100 cm. Overall, however, the positive predictive value of a definite or suggestive pulsatile abdominal mass was but 35%.[89]

Abdominal bruits were found in almost 16% of normal persons in one study and in 64% of those with renal artery stenosis, though one could not predict accurately from the side of the ausculted bruit the location of the vascular stenosis.[90] A more recent study has confirmed the insensitivity of abdominal bruits in predicting renal arterial stenoses or occlusions found by angiography.[91] In patients younger than 25 years, the frequency of abdominal bruits or murmurs may be as high as 44%.[92] In patients with known renovascular hypertension, the presence of a systolic-diastolic abdominal bruit was more sensitive than upright plasma renin activity but far less sensitive than rapid-sequence urography in defining their disease.[93]

A palpable spleen has been detected in 2.86% of 2,200 routinely examined college students.[94] A palpable spleen strongly suggests enlargement of that organ and is more sensitive than increased splenic size by abdominal roentgenography, but nonpalpable spleens may be enlarged.[95] Of 92 cases of splenomegaly by nuclear scan, only 26 (28%) were determined by physical examination.[96] Splenic percussion may be a more sensitive sign by physical examination than palpation and compared well with splenic size by nuclear scan.[97]

A good correlation is found between the liver size on nuclear scan and the estimated liver span by percussion in the right midclavicular and midsternal line, but little relationship exists between the liver size by scan and a clinical estimate of the position of the liver border.[98] A palpable liver appears to be a poor index of hepatomegaly, though one may somewhat more accurately rule out hepatomegaly if the liver is not palpable.[95,96]

In men admitted to a hospital with liver disease, physical examination was compared with ultrasonography of the abdomen in the detection of ascites. The positive predictive value of shifting dullness and prominent fluid waves was low—51% and 73%, respectively. In those patients with an increased prothrombin time, however, the presence of a prominent fluid wave had a 96% predictive value for ascites. In contrast, in those with a normal prothrombin time, both shifting dullness and prominent fluid waves were usually falsely abnormal findings.[99]

Musculoskeletal

Most authors agree that the history and physical examination are the most specific and sensitive studies available for the diagnosis of low back pain[100–102] and that in the absence of fever, a history suggestive of malignancy, major trauma, neurologic defects, corticosteroid, illicit drug or alcohol use, or advanced age, further studies are often legally rather than medically inspired.[102] The selection of patients with injured extremities who need x-ray films has been similarly argued to be well guided by history and physical examination alone.[103]

Neurologic

In a study of 25 patients with cerebral infarction unassociated with extracranial cerebrovascular disease, cerebral angiography was diagnostic in only a third of cases and altered the preangiographic diagnosis in only one case by revealing a previously unsuspected embolus.[104] A study on the

usefulness of CT scans in patients with a clinically diagnosed first stroke suggested that it was useful in a minority (up to 28%) who can be selected on simple clinical criteria.[105] Advanced techniques of echocardiography have been useful in detecting clinically silent atrial septal defects with paradoxic cerebral embolism.[106,107]

The history and physical examination appear to be the best diagnostic tools available for evaluating syncope,[108,109] sufficient in 85% of patients in whom a diagnosis could be established.[110]

Routine skull x-ray films and CT scans after head trauma were not found to be worthwhile unless specific criteria, established by history and physical examination, were present.[111,112] Similarly, patients with headache and a normal neurologic examination were found not to benefit by CT scan of the brain.[113] In patients with alcohol withdrawal seizures, a neurologic examination predicts which patients need prompt CT scanning of the brain, and the absence of focal defects or signs of acute head trauma suggests that a CT scan will be unhelpful.[114] In demented patients, studies suggest that the history and physical examination are superior to CT scan of the brain and other studies in determining the cause of their dementia.[115,116] The prognosis in patients with nontraumatic coma is similarly best determined by a careful evaluation of the neurologic system over the first few days of hospital admission.[117] In 209 patients studied with intentional drug overdose, a toxicologic analysis from the laboratory agreed with the clinical impression in 47% of cases, and though clinically unsuspected drugs were found in 27% of cases, this led to a change in therapy in only three patients and in none had a major influence on the outcome.[118]

Conclusion

It is clear that the best interest of patients lies in a judicious combination of a careful history and physical examination and directed laboratory studies. The physical examination has some clear advantages over laboratory studies, in that it allows therapeutic touching and a warmer interaction between patient and physician, renders the physician more autonomous in his or her diagnostic skills, and may be at least as accurate as many more expensive and time-consuming laboratory diagnostic studies. At the same time, certain time-honored physical examination techniques are being questioned as to their validity and relative merits compared with the rapidly evolving wonders of technologic diagnostic techniques.

Modern physicians, under the pressures of curiosity, compulsivity, insecurity, and the imagined or real threat of unpleasant legal or economic consequences, seem more comfortable with technologic than with physical diagnosis. Because of constricting resources and increasing alienation of patients from their physicians, it is imperative to scrupulously reexamine the role of the physical examination in modern diagnosis. Only in this way will we be able to preserve and expand the best of physical diagnosis and discard the remainder as historical remnants of an earlier, albeit simpler, time.

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