Medical Grand Rounds

Routine Hospital Admission Screening Tests

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January 30, 1986

Introduction

The cost of medical care has been of major concern in the United States for the past several years. In 1983 an estimated $355.4 billion was spent for health care in the United States (1). This represented 10.8% of the gross national product and amounted to $1,459 per person living in this country. Public sources paid for 42% of the health care dollars spent in 1983. The absolute amount of money spent in this country on health care is disconcerting. Even more troublesome is the increase of expenditures over the past two and a half decades, which has outpaced inflation.

Table 1 (2).

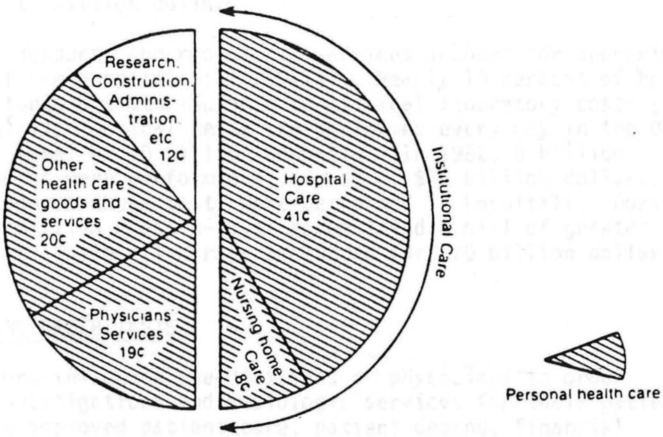
National Health Expenditures: 1960 to 1983

Year	Total (billion dollars)
1960	$ 26.9
1965	41.9
1970	75.0
1975	132.7
1980	248.0
1981	285.8
1982	322.3
1983	355.4

These statistics have captured the attention of the American consumer for several reasons. In addition to the money paid directly for health insurance or personal health care, a portion of each person's tax dollars are going to support the health care of those generally unable to afford it. Also a portion of the costs of consumer goods goes to pay for the health care of the workers producing those goods.

The cost of hospital care accounted for 41¢ of every national health expenditure dollar spent in 1983.

Figure 1. The Nation's Health Dollar in 1983



This component accounts for the largest portion of health care costs. As a result the attention of those attempting to reduce health care expenditures has frequently focused on the cost of hospital care. The Health Care Financing Agency which administers funding for Medicare has focused great attention on the reduction of public expenditures for health care. This is exemplified by the institution of a system of fixed payment for hospitalization based on Diagnostic Related Groups (DRG's) in 1983 (3). The implementation of DRG's has compelled physicians and hospital administrators to work closely together to limit expenditures, since the hospital is at risk for costs incurred above the prospective payment rate. As a result the components of the costs of hospital care have been evaluated in an attempt to utilize fixed financial resources in the most optimal manner. Personnel costs make up the largest portion of hospital care costs. However, attempts to regulate the wages and numbers of workers employed by health care institutions and maintain quality care have not generally been successful (4). Therefore a major focus of controlling hospital costs has been placed on altering the services ordered by physicians.

Originally it was felt that high cost technologies were a major contributor to the marked increases in hospital costs. However, as Maloney and Rogers point out it appears that little ticket items comprise the largest cumulative costs rather than the more expensive technologies (5). They noted that if the annual operating costs of four high cost technologies (CT scans, coronary artery bypass surgery, renal dialysis and fetal monitoring) were decreased by 50%, only 1% of the yearly national health care bill would be saved (5-8). The same reduction in laboratory procedures and radiologic services upon hospitalized patients would reduce the expenditures by five times as much. Feinberg looked at expenditures for capital equipment in 1973 which amounted to approximately $600 million dollars for large items

(9). During that same year the bill for laboratory studies increased by an estimated $1 billion dollars.

Laboratory procedures and radiologic services account for approximately 25 percent of the hospital bill (10-14). Nearly 10 percent of health care expenditures are attributable to clinical laboratory costs (15). Overall 27 million medical tests are performed every day in the United States for a total of 10 billion annually. In 1982, 8 billion laboratory tests were performed at a cost of $30 billion dollars. At least 3 billion of these tests were performed in hospitals. During that same year 80 million chest x-rays accumulated a bill of greater than $2 billion dollars while all x-rays accounted for $20 billion dollars (16).

WHY PHYSICIANS ORDER TESTS

Several factors influence the decisions of physicians to order laboratory investigations and radiologic services for their patients. These include improved patient care, patient demand, financial incentives and medicolegal considerations (11,17-21). Several groups also point out the increased tendency to order tests in teaching hospitals compared to community hospitals even when caring for similar patients (11,22).

Wertman et al., analyzed the reasons physicians gave for ordering tests at Los Angeles County Hospital (23). Physicians were asked to complete a questionnaire whenever ordering one of the eleven most frequently requested laboratory tests or panels employed in that institution. These included an electrolyte - renal - bone panel, liver - cardiac panel, glucose, hematology profile, VDRL, prothrombin time, arterial blood gases, bacterial culture and sensitivity, mycobacteriology culture and urinalysis.

The most common reasons given for ordering each test are shown in Table 2.

Table 2

Physicians' Reasons for Ordering Laboratory Tests

	Frequency Ordered, %								
	Diagnosis	Screening	Prognosis	Monitoring	Previous Abnormal Result	Education	Medicolegal	For Presentation to Senior Staff	Previous Result Not Available
Glucose	31	8	8	44	11	6	3	0	0
Potassium and sodium	44	6	6	44	38	0	0	0	0
Electrolyte-renal-bone panel	8	11	6	53	31	3	0	0	6
Liver-cardiac panel	46	49	21	26	15	0	0	0	0
Hematology profile	48	48	9	35	0	4	0	0	0
Serology	21	88	0	0	0	0	0	0	0
Prothrombin time	3	11	8	76	11	3	0	0	0
Blood gas	57	0	14	50	14	7	0	0	7
Routine culture	86	9	5	9	5	0	0	0	5
Tuberculosis culture	90	20	5	0	5	0	0	0	0
Urinalysis	36	69	0	12	5	0	3	0	0
All tests	37	32	7	33	12	2	1	0	1

The most frequent reasons given by the physicians for ordering tests were diagnosis (37%), screening (32%), and monitoring (33%). Medicolegal aspects (1%) were rarely given as reasons for ordering the tests.

Murata et al. (24) asked housestaff at Cedars Sinai Medical Center in Los Angeles to select any number of prepared statements that best represented their reasons for ordering serum electrolytes on patients upon admission to the hospital. The reasons reported are outlined below.

Table 3

1.	Suspect abnormality on clinical basis	59%
2.	Baseline in case of change	43%
3.	To direct therapy	33.7%
4.	Screening	12.4%
5.	Confirm previous abnormality	5.8%
6.	Someone else wants test	20.6%
7.	No risk and inexpensive	5.8%
8.	Medicolegal reasons	4.1%
9.	Academic interest	3.4%
10.	No specific reason	1.0%

Patient care factors including diagnosis, treatment, and screening were still the most common reasons for ordering the tests. Since the physicians could choose more than one reason for ordering tests non-patient care factors are more highly represented in this group. These include presenting the results to someone else, medicolegal reasons, and academic interest. The "other" physicians for whom the tests were ordered included medical residents, private physicians, and full time faculty.

Myers and Schroeder (11) summarized physicians' reasons for ordering tests and noted that the "principal goal of physicians is to insure the health of their patients. However, there may be many alternative pathways to that goal differing in both treatment and cost."

Although physician's major motivation for ordering tests is to improve the care of the patient, ordering too many tests may actually have a negative impact on patient care. Enthoven, a medical economist, introduced the concept of "flat-of-the-curve" medicine in an address entitled "Cutting Costs Without Cutting the Quality of Care" (25). He used several studies as examples of the fact that increasing the quantity and cost of care do not necessarily improve quality after a certain point. In fact they may actually adversely affect the outcome of that care by the increased cost and morbidity associated with pursuing abnormal values.

Figure 2 (11)

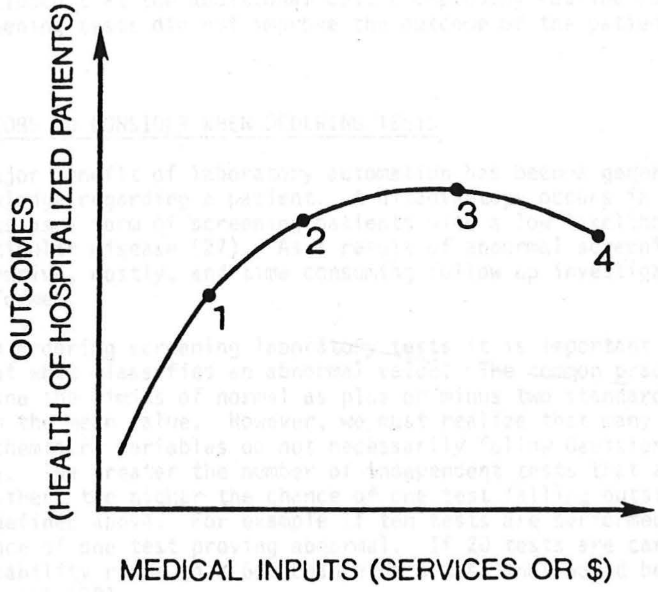


Figure 2. Marginal benefit curve showing relation between medical services or expenditures (inputs) and patient health (outcomes). At point 1, provision of a specific service will produce a certain and dramatic improvement in health. At point 2, additional services do not add greatly to the patient's health. At point 3, no gain in health results from additional services. Finally, at point 4, additional care does more harm than good.

In applying this concept to hospital admission testing Durbridge (26) looked at three groups of patients admitted to a hospital in Australia. One group of 500 patients had a standard panel of tests done upon admission and the results were reported to the physicians whether they had been ordered or not. A second group had the same tests performed but they were only reported when requested by the physician. A third group had only those tests performed which were ordered by the physician. The investigators evaluated several outcomes of medical care and found them not to be different among the three groups. However, in looking at hospital costs for the three groups the cost of performing subsequent investigations were found to be 64% higher in the group in which the results of admission screenings were reported to the physician. These presumably were additional investigations prompted by results from the admission screening. Overall this increased the hospital bill by 5% in this group. Additional morbidity encountered by the patient as a result of these tests was not analyzed. They concluded that the additional cost prompted by routine admission screening tests did not improve the outcome of the patient care.

FACTORS TO CONSIDER WHEN ORDERING TESTS

A major benefit of laboratory automation has been a generation of new knowledge regarding a patient. A disadvantage occurs in using multiple tests as a form of screening patients with a low likelihood of a particular disease (27). As a result of abnormal screening values extensive, costly, and time consuming follow up investigations may be performed.

When ordering screening laboratory tests it is important to be informed about what classifies an abnormal value. The common practice is to define the limits of normal as plus or minus two standard deviations from the mean value. However, we must realize that many clinical biochemistry variables do not necessarily follow Gaussian distribution (28). The greater the number of independent tests that are carried out together, the higher the chance of one test falling outside normal range as defined above. For example if ten tests are performed there is a 40% chance of one test proving abnormal. If 20 tests are carried out this probability rises to a 64% chance of a test that would be classified as abnormal (29).

Wilson sited an example of clinical chemical screening in 2000 inpatients at the Queen Elizabeth Hospital in Birmingham (26). Sixteen clinical chemical tests were performed on each patient for a total of over 31,000 tests. Of these, 24,000 would not have been requested for clinical purposes. Of these 24,000 tests 8% were abnormal. This 8% comprised 1% which proved diagnostic and 2% which were abnormal but expected. The remaining 5% of the total results were not explained by further testing and felt not to be clinically significant.

Since the overall yield of screening laboratory tests even on admission to the hospital appears to be relatively low, some of the factors that I have discussed in my previous grand rounds on Health Maintenance should be applied in determining which tests or which diseases to screen for.

The factors to consider in identifying diseases for which to screen were outlined by Frame and Carlson (30).

1. The condition is serious and occurs frequently enough to warrant the time and cost of the screening and follow up process.
2. The natural history of the disease suggests abnormalities are likely to appear prior to the development of symptoms.
3. Early detection makes a difference in the prognosis.
4. Available screening techniques must be sensitive enough to make detection likely.

5. The screening technique must be specific enough to make follow up to differentiate between false positives and true negatives worth the expense and risks.

To analyze the last two variables regarding specific screening procedures, one must understand the operating characteristics of the tests and procedures used. In order to effectively utilize the tests and procedures two fundamental questions need to be answered (30):

1. If the disease is present, what is the likelihood that the test result will be positive?
2. If the disease is not present, what is the likelihood that the result will be negative?

These questions reflect the sensitivity and specificity of a test which can be depicted as follows (31):

Figure 3.

	Disease		
	present	absent	total
pos	a true pos	b false pos	a+b
neg	c false neg	d true neg	c+d
Total	a+c	b+d	

$$\text{Sensitivity} = \frac{\text{true-positive results}}{\text{total patients with disease}} = \frac{a}{a+c}$$

$$\text{Specificity} \quad \frac{\text{true-negative results}}{\text{total patients without disease}} = \frac{d}{b+d}$$

The knowledge of the sensitivity and specificity of a test does not, per se, permit accurate interpretation of a test result, the ultimate task of the physician is to determine whether or not a particular disease is present. This leads to two more questions which must be addressed (32).

1. Given a positive test, what is the probability that the disease is present?
2. Given a negative test, what is the probability that the disease is absent?

The calculation of the positive and negative predictive values answer these questions. The binary table in figure 3 can be used to calculate these in the following manner.

Figure 4.

$$\text{predictive value of a positive} = \frac{\text{true positive results}}{\text{all patients with positive results}} = \frac{d}{a+b}$$

$$\text{predictive value of a negative} = \frac{\text{true negative results}}{\text{all patients with negative results}} = \frac{d}{c+d}$$

An example of using these principles was recently presented in the Annals of Internal Medicine (33). A screening test for cancer has an 80 percent sensitivity and a 90 percent specificity. The population being tested has 20 percent prevalence of the disease. Setting up the binary table and calculating predictive values in a population of 1000 patients result as follows:

Figure 5.

		Disease: present	absent	totals
test	pos	160	80	240
	neg	40	720	760
		200	800	

Probability of cancer if the test is positive $= \frac{160}{240} = 67\%$

Probablity of cancer if the test is negative $= \frac{40}{760} = 5\%$

If the test is positive there is a 67 percent chance that the patient has the disease. If the test is negative there is only a 5 percent chance that the patient has the disease. When similar problems are presented to medical students, housestaff and practicing physicians, less than 20 percent answer correctly (34). The majority greatly overestimated the risk of disease. This is the same sort of data physicians analyze daily in making clinical decisions. The application of the calculations of the probability of disease is very helpful in evaluating a positive result in a population with little likelihood of having a disease such as a screening population.

A final factor to consider in applying tests to a certain population is cost benefit. The costs of all the tests done must be divided by the number which improve patient outcome and some index of how that outcome is improved.

BENEFITS OF HOSPITAL ADMISSION TESTS

Many tests are ordered when a patient is admitted to the hospital with an acute illness. The majority of these are ordered because of abnormalities on the history and physical exam or suspected diseases. The results of these tests are invaluable in diagnosing, treating the patient and providing optimal care. However, the same group of tests is frequently employed upon admission regardless of what problem the patient has. For some of these tests certain groups of patients may gain little or no benefit. However, the tests will still add to the patient's hospital cost and may cause discomfort or concern in further evaluation of falsely abnormal values. Therefore to provide optimal patient care it is imperative for the physician to be aware of the clinical indications in the groups in which particular admission testing will provide benefit.

Durbridge et al. (26), employed a battery of tests upon hospital admission in a test group of 500 patients and provided results of these tests to the physician within three hours after admission. A second group of control patients had similar tests performed but the results were not made available to the physicians unless requested. A third such group had no tests performed except those that were requested by the physician. These tests were repeated on days three and eight of the patients' stay. Comparison between the result distributions in the two groups which received all of the tests reveal no significant difference on results of any admission tests. Several indices of inpatient progress were measured. These included length of hospital stay, mortality, two indices of patient disability, two indices of patient distress and the duration of abnormality of ten monitored clinical signs. No differences in any of these parameters were found among the three groups. In an assessment of patient dissatification, it was found that the screened patients felt that too many tests had been performed on them.

The results of ten tests were reported in the screened group. An average of three tests were requested by the physicians in the other two groups. The test group had 32 percent more repeats of the original screening tests than did the other two groups. There were 15 percent more subsequent tests ordered in the test group than in the other two groups. Overall by adding the additional requests to the tests performed on admission, the net effect was an increase of 78 percent in the number of tests in the group with reported admission screening.

Table 4.

Number of Investigation Reports[a]

Class (500 patients)	Test	Control	Dummy
Reported Screen	4343*	0	0
Discretionary requests			
Initial, for test in screen	89*	1490	1401
Subsequent repeats	1886*	1428*	1294
All other tests	2045*	1770*	1757
Total	8363*	4688*	4452

[a]The number of investigations reported to attending clinicians for all patients within a class is shown.
*P<.05.

This group also had 25 percent more consultations than the other two groups. There was a trend to the use of a wider range of drugs in the study group but this was not significant. There was no significant difference in any other aspect of patient management. As pointed out previously the costs of the additional tests performed on the study group was 64 percent greater than the other two groups. This added approximately 5 percent to their cost of hospitalization.

Korvin et al. (35), performed 20 chemical and hematological tests on 1,000 patients admitted to a general hospital. Overall there were 2,223 abnormal results, 675 of which were predicted on clinical assessment. Of the screening tests, 1,325 did not yield new diagnoses but confirmed previously known disease. Of the remaining 223 abnormal results 83 lead to new diagnoses in 77 patients. On evaluation of the new diagnoses the investigators felt that none were unequivocally beneficial to the patient. Approximately 30 patients might have benefited had the abnormal findings been followed up diligently, 39 others had findings or diagnoses of no lasting significance, and in 14 patients asymptomatic mild biochemical diabetes was discovered. They concluded that although screening tests may have a yield in terms of abnormal results, the overall clinical benefits were not significant.

This study points out that when evaluating the benefit of a test done on admission to the hospital, the fact that the test is abnormal cannot be considered the end point. Rather the effect of this abnormal value on patient care and its contribution to the outcome of that care must be scrutinized to say that it was worthwhile to perform in the first place.

Those tests that are frequently obtained routinely upon all patients upon admission to the medicine service at Parkland Memorial Hospital will be specifically addressed. These include chest x-ray, electrocardiogram, SMA-6 (creatinine, glucose, sodium, potassium, chloride, bicarbonate), complete blood count, urinalysis, and prothombin time. The costs for these procedures at Parkland Hospital are:

Chest radiograph	$24.50
Electrocardiogram	36.00
SMA-6	23.00
CBC	17.50
Urinalysis	17.00
Protime	10.00

CHEST X-RAY

Chest radiographs are the most frequently conducted x-ray examination in this country comprising 45 percent of the radiologic studies performed. In 1980, 52 million chest x-rays were obtained in U.S. hospitals (36,37). An estimated $1.5 billion dollars per year is spent on this procedure. Because of its cost and the exposure of the patient to radiation, the use of this procedure must be closely scrutinized and guidelines established.

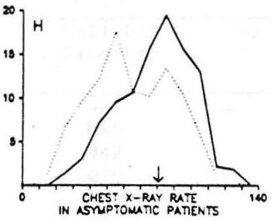
Dr. Robert Haley from this institution and his colleagues at CDC studied the use of chest X-rays in the SENIC project (38). One factor they analyzed was the chest X-ray rate in asymptomatic patients. They collected data from 500 adult patients admitted to general medicine or surgery in each of 338 hospitals in 1970. They repeated the data collection on a similar number of patients admitted to the same hospitals in a 12 month period in 1975-1976. They looked at several tests and the detection of infections.

To analyze screening chest X-rays they employed the following formula:

$$\text{Chest X-ray Rate in asymptomatic patients} = \frac{\text{No. of chest X-rays obtained for patients in the denominator}}{\text{No. of patients with no sign, symptom, or diagnosis of pneumonia, pulmonary embolism, or congestive heart failure.}}$$

They found that the median rate of obtaining chest X-rays among patients having none of these symptoms increased from 65 to 82 chest X-rays per 100 patients from 1970 to 1975/76.

Figure 6.



In addition, they found that the rate of chest X-rays in asymptomatic patients did not correlate with pneumonia rates. In fact, as the rate of screening chest X-rays increased over the period of time studied, the correlation decreased.

Table 5.
Association of diagnostic medical practice rates with observed nosocomial infection rates, 1970 and 1975-1976

Medical Practice Rate	Pneumonia Rates: Medical 1970	Medical 1975-1976	Postoperative 1970	Postoperative 1975-1976
Chest X-ray in symptomatic patients	0.26	0.08	0.14	0.04

Several studies have looked at the use of screening admission chest x-rays on specific groups of hospitalized patients. Sagel et al. (39) analyzed over 10,000 chest radiographs performed during 6 months at Barnes Hospital in St. Louis. The reason for the radiograph noted on the request form was categorized into routine, reasonable possibility of chest disease, or chest disease suspected groups.

The radiographs were interpreted by four radiologists into the categories of no serious abnormalities or serious abnormality suspected. The additional value of the lateral projection and whether a chest radiograph was performed in the last two weeks were also noted. Their results indicate a very low yield in selected groups of patients.

Table 6.

Age (Yr.)	Patients Examined	No. (%) with Serious Abnormality Suspected	
0-19	521	0	
20-29	894	9	(1.0)
30-39	942	22	(2.3)
40-49	928	66	(7.1)
50-59	883	179	(20.3)
60-69	977	290	(29.7)
70+	832	347	(40.7)
Total all ages	5,975	913	

Routine chest radiographs (hospital admission or preoperative) were performed on 521 patients under the age of 20. No serious abnormalities were demonstrated in any of these. The portion of routine screening films revealing a suspected serious abnormality ranged from 1 percent in persons age 20 to 29 to 40.7 percent in persons 70 years old or older. The most common abnormalities discovered on screening films were cardiomegaly, chronic obstructive pulmonary disease, and interstitial infiltrates or fibrosis. The effect of these findings on the clinical management or course were not stated.

Table 7.

Age (Yr.)	Patients with Lateral Projection Confirmatory or Clarifying	Patients in Whom Lateral Was Only Projection In Which Abnormality Was Seen
0-19	4	0
20-29	21	0
30-39	31	1 (0.1%)
40-49	63	3 (0.3%)
50-59	141	8 (0.9%)
60-69	169	10 (1.0%)
70+	223	12 (1.4%)
Total all ages	652	34 (0.6%)

The lateral projection was the only projection in which an abnormality was seen in 34 or 0.6 percent of all screening films. This ranged from 0.04 percent in persons less than 40 years old to 1.4 percent of films in persons 70 years old or older. Again, the clinical significance of these additional findings were not defined.

On the basis of their data Sagel's group concluded that routine chest radiographs were not indicated in patients under the age of 20 simply because these patients are admitted to the hospital. They also felt that the lateral projection did not contribute any additional benefit in patients under the age of 40.

In 1983, Rucker, Frye, and Staten (40) looked at the usefulness of screening chest radiographs in preoperative patients. They outlined specific risk factors for an abnormal chest x-ray which were considered indications for the study. Their specific risk factors include:

A. Medical History
   1. Cancer at any site
   2. Valvular heart disease
   3. Stroke
   4. Myocardial infarction
   5. Angina
   6. Asthma
   7. Tuberculosis
   8. Chronic obstructive pulmonary disease
   9. Cigarettes
   10. Occupational exposures: asbestos, fumes, ores
B. Review of Systems
   1. General: fever, chills, sweats or weight loss
   2. Paroxysmal nocturnal dyspnea
   3. Orthopnea
   4. Class 3 or 4 dyspnea
   5. Angina
C. Physical Findings
   1. Vital Signs: fever, tachycardia, hypertension, tachypnea
   2. Chest: abnormal breath sounds or dullness
   3. Cardiovascular: severe murmurs, S3 or displaced point of maximal impulse.
   4. Abdominal: tenderness, organomegaly,

They also considered age over 60 as being a risk factor. Of 905 patients admitted over a six month period for elective surgery, 368 patients had none of the risk factors outlined above. Of these 368 patients without risk factors, only one had a significant finding on the screening chest x-ray. This was an elevation of the left hemidiaphram. The patient had no perioperative complications and the abnormality was not pursued during the hospitalization. In this study older patients were not more likely to have a serious abnormality on screening chest x-ray. However, older patients were more likely to have risk factors for which a chest x-ray was indicated as noted in Table 8.

Table 8.

Chest Roentgenographic Abnormalities, by Age and Risk Group

	Patients With Risk Factors		Patients Without Risk Factors	
Age Yr.	Total No.	No. (%) With Serious Abnormalities on Chest Roentgenogram	Total No.	No. (%) With Serious Abnormalities on Chest Roentgeogram
<20	52	5 (10)	83	0 (0)
21-30	101	10 (10)	156	1 (0.6)
31-40	79	6 (8)	69	0 (0)
41-50	83	14 (16)	31	0 (0)
51-60	85	38 (45)	29	0 (0)
>60	104	41 (40)	0	0 (0)
Total	504	114 (22)	356	1 (0.3)

This group concluded that the chest x-ray should not be used as a routine preoperative examination in patients without risk factors for an abnormal chest x-ray.

This study had automatically concluded that age greater than 60 was a risk factor for an abnormal chest x-ray and had no screening x-rays in this group. Gupta and Gibbins studied routine chest radiography in patients admitted to an acute care geriatric department in-patient unit in Great Britain. One thousand patients were assessed. The investigators reviewed the patients' charts to determine: 1) Whether the patient had pulmonary or cardiovascular symptoms or signs or 2) Whether there were any clinical features in other systems which indicated the need for chest radiography. They then reviewed the chest radiographs to determine whether there were abnormal radiographic findings and subsequently if there were any therapeutic interventions resulting from a positive chest x-ray. The patients ages ranged from 55 to 103 years with an average of 78. No pulmonary or cardiovascular symptoms or signs or clinical features in other systems which indicated the need for chest radiography were present in 346 (35% of patients). It was assumed that the chest radiograph was a screening admission test in these patients. Of these 19 (5.5%) had positive X-ray findings.

Table 9.

Positive X-Ray Findings in Patients with No Indications for Chest X-Ray Examination

Condition	Number of Patients	Treated Yes	Treated No
Increased heart size ± heart failure	10	1	9
Pneumonia	1	1	0
Left basal collapse	2	0	2
Asbestosis	1	0	1
Fracture of rib	1	0	1
Apical scarring	1	0	1
Paget's disease of bone	1	0	1
Aortic aneurysm	1	0	1
Hilar enlargement	1	0	1

Of these 19, 9 patients had cardiomegaly and three patients had left basilar collapse. One patient had cardiomegaly and radiologic evidence of heart failure and one patient had radiologic evidence of asbestosis. The remaining 5 patients each had a variety of problems including rib fracture, apical scarring without evidence of active disease, Padget's disease of the bone, aortic aneurysm, pleural thickening, and possible hilar mass which was not present on a repeated film. Of these 19 patients, 2 received therapy for their abnormal chest x-ray findings. The patient with cardiomegaly and congestive heart failure received diuretics with improvement. One patient with left basilar collapse was treated for pneumonia but subsequently died. The patient with asbestosis was not treated but was referred for possible compensation. Therefore in only 3 (less than 1%) of the 365 patients who had admission screening chest x-rays was the result considered significant. This group concluded that routine chest radiography should not be carried out in the elderly solely on the basis of age. Again, it should be done only in those patients who have clinical indications for a chest radiograph.

Patel et al. (42) looked at 170 patients over the age of 65 admitted to an acute geriatric ward. Routine admission chest radiography showed abnormal results in 9 (5.3%) of this group. They concluded that as a result routine chest x-ray should be mandatory in the age group above 65 years. Three of their patients were confused and unable to give a history and 5 of the remaining 6 had some of the clinical risk factors outlined by Rucker for an abnormal chest x-ray. Therefore only one patient who presented with DVT of the left leg and was found to have a consolidation of the right lower lobe actually had no indications at the time of admission for chest x-ray.

Two groups have evaluated routine admission chest x-ray films at the Veterans Administration Medical Center in Long Beach, California (43,37) Fink, Fang and Wile looked at the results of 103 admission chest x-ray films obtained during a one month period in 1980. They did not determine whether the x-rays were done for routine admission screening or for clinical indications. Abnormalities were found in 52 (50%) of the 103 films.

Table 10.

Routine Admission Chest X-ray Films

Age, yr	No. of Patients With CXR Done	Serious Abnormality Suspected on Chest X-ray Film
0-19	0	--
20-29	3	1
30-39	6	1
40-49	10	3
50-59	38	20
60-69	22	12
70-79	13	5
80-89	11	10
Total	103	52

Fourteen patients had pulmonary infiltrates and 11 had cardiomegaly. They concluded that in their population a screening chest x-ray was indicated because of the high incidence of the occurrence of abnormal findings.

Table 11.

Distribution of the Most Frequent Abnormal Roentgenographic Findings

Age, yr	Pneumonic Infiltrate	Cardio-megaly	COPD*	Infiltrate, Effusion	Bone Mets†	Pulmonary Nodule	Bone Fracture
0-19	...	...	...	...	...	...	...
20-29	1	...	...	...	...	...	...
30-39	1	...	...	...	...	...	...
40-49	2	...	1	...	...	...	...
50-59	3	6	1	4	...	3	...
60-69	4	2	...	2	1	...	1
70-79	1	1	1	...	1	...	1
80-89	2	2	...	4	1	...	...
Total	14	11	3	10	3	3	2

However, they did not address the question of whether the chest X-ray was clinically indicated on admission and whether the discovery of the abnormality resulted in clinical intervention.

Subsequently, Hubbell et al. (37), evaluated 742 admissions during a ten week period at the same hospital. These were patients admitted to the general medical service through the emergency room. Upon admission the emergency room housestaff were asked to indicate whether the chest x-ray was being ordered as an admission or baseline study or as a diagnostic study. In addition three faculty members reviewed the information obtained on admission to determine whether housestaff indications were correct. The faculty members also reviewed the results of the chest x-ray films and the medical records of the patient to determine what impact the results had on patient care. Reviews were carried out on 491 patients with a mean age of 60.1 years. The housestaff had indicated that the chest x-ray film was ordered as an admission or baseline study in 294 patients. Abnormalities were found in 106 (36%) of the 294 patients with admission or baseline films.

Table 12

Findings on Routine Chest X-Ray Films Ordered on Admission in 294 Patients

Finding	Patients No.*	Patients Percent
Normal or clinically unimportant	188	64
Abnormal	106	36
Cardiomegaly only	33 (1)	
COPD	17	
Congestive heart failure	13 (6)	
Interstitial infiltrates	12	
Pulmonary nodule(or nodules)	10 (1)	
Pneumonic infiltrate	6 (5)	
Pulmonary mass (or masses)	5 (3)	
Pleural effusions	2 (2)	
Hilar adenopathy	2	
Osteoblastic metastases	2	
Pulmonary-artery enlargement	1 (1)	
Cavitary disease	1	
Aortic aneurysm	1	
Rib fractures	1 (1)	

*The numbers in parentheses indicate the number of patients in whom the finding represented either a new abnormality or worsening of a previously diagnosed abnormality.

In 86 of these 106 patients the findings were chronic and stable; only 20 patients had new abnormalities or worsening of previously diagnosed chest disease.

In reviewing subsequent care the faculty reviewers found that follow up studies were ordered in 27 of the 86 patients with chronic stable findings on admission. None of these resulted in changes of treatment. In 8 of the 20 patients with new abnormalites or deterioration, treatment was not changed because of these findings. Therefore, 12 of the 20 patients with new abnormalities or deterioration on chest x-ray could have had changes in therapy as a result of the findings. Congestive heart failure was found in 6 of the 12 patients, pulmonary infiltrates in 5 and a solitary pulmonary nodule in 1. The faculty chart review showed clinical evidence of acute cardiac or pulmonary disease in 8 of the 12 patients. Therefore retrospectively those patients had clinical indications and had not received routine admission or baseline films.

As a result only four patients (0.8%) actually had abnormal screening admission or baseline chest x-ray films which necessitated follow up treatment. One of these patients was an 89-year-old man with senile dementia who was brought to the hospital because he would not eat. Although his physical exam was reported as normal, the chest x-ray film was consistent with congestive heart failure. A second patient was a 36-year-old man with fever and headache who was admitted to rule out meningitis. His lumbar puncture was normal but a chest x-ray revealed an infiltrate in the left lower lobe. A third patient was a 66-year-old man with a history of alcohol abuse who was admitted to the ICU because of an acute episode of upper gastrointestinal bleeding. His heart and lung exams were normal, but the chest x-ray revealed an infiltrate in the left lower lobe consistent with aspiration and pneumonia. The fourth patient was a 63-year-old man admitted to the hospital with a history of palpitations and paroxysmal supraventricular tachycardia. An admission chest x-ray film revealed a nodule in the upper right lobe that was 5 x 5 cm. Further work up revealed large cell carcinoma of the lung. The patient died 8 months after the diagnosis of his lung cancer.

Table 13.

Abnormal Chest X-Ray Necessitating Treatment

Patient	Chief Complaint/ Admitting Diagnosis	CXR Result	Therapy
1. 89 yo man	stopped eating/ senile dementia	CHF	diuretics
2. 36 yo man	headache,fever/ R/O meningitis	LLL infiltrate	antibiotics
3. 66 yo man	UGI bleed alcoholism	LLL infiltrate	antibiotics
4. 63 yo man	palpitations/ PSVT	RUL mass 5 X 5 cm	XRT

Retrospectively applying Rucker's criteria, all four of these patients would have probably had chest X-rays early in their admission and received appropriate therapy. The efficacy of the detection of lung cancer on screening X-rays has not been established. A case could be made that the ultimate outcome of the patient with carcinoma was not altered.

This group concluded that although a large number of chest film abnormalities maybe found in a population with a high prevelance of cardiopulmonary disease, the impact of these findings on patient care may be very small. They agree that chest x-ray films should not be ordered solely because of hospital admission.

The National Center for Devices and Radiologic Health of the Federal Drug Administration has published a pamphlet entitled "The Selection of Patients for X-Ray Examinations: Chest X-Ray Screening Examinations" (36). On the basis of the data outlined above they conclude that "routine chest radiographs should not be required solely because of hospital admission". They go on to state that "this recommendation should not be construed as precluding or advising against the ordering of chest x-ray examinations (1) on the basis of history and physical examinations or specific diagnositic testing or (2) in selected patient populations in which a significant yield has been previously substantiated or has been considered highly likely pending a substantiation".

From the evidence available in the literature to date routine hospital admission chest x-rays can probably be omitted in patients not fulfilling the clinical criteria outlined by Rucker, et al. (40), on page 14.

ELECTROCARDIOGRAM

A twelve lead electrocardiogram is often routinely done on patients admitted to a general medical service. This test is quick, safe, and imposes no risk to the patient. The major reason for determining the value of routine admission screening electrocardiograms to the care of the patient is that of its contribution to health care costs. At Parkland Memorial Hospital an electrocardiogram costs $36. In fiscal year 1985, there were 7,800 admissions to the medical service at Parkland Hospital. The total cost if an electrocardiogram was performed on each patient upon admission was $280,500.

The most thorough evaluation of screening electrocardiography has been on patients admitted to the hospital for surgical procedures. Rabkin and Horne (44) evaluated 812 patients who underwent routine preoperative electrocardiography when a baseline electrocardiogram was available. They found that the preoperative ECG was normal in 47.9% of the patients. Of those with an abnormal ECG, 39% showed abnormalities that had not been present on a baseline electrocardiogram within the last three years. Although they did not correlate the finding of an abnormal ECG with the patient's history or risk of heart disease, they found that patients 60 years of age or older and those whose previous ECG tracing was more than two years earlier were more likely to have new abnormalities on their ECG.

Table 14.

Classification of Findings in Preoperative Electrocardiogram (ECG) by Patient's Age, Interval Between Obtaining of Previous and Preoperative ECGs and Findings in Previous ECG

Variable	New Abnormality In Preoperative ECG Yes	No	Total
Patients Age (Year)			
less than 60	42	267	309
greater than 60*	123	380	503
Interval (Year) Between Obtaining of ECGs			
less than 2	99	450	549
greater than 2*	66	197	263
Previous ECG			
Normal	60	312	372
Abnormal*	105	335	440

*The probability of a new abnormality was significantly greater ($P < 0.05$) in these groups of patients.

The most common abnormalities were nonspecific T Wave abnormalities and ST Segment abnormalities. New Q Waves and arrhythmias, two abnormalities that have been shown to be relevant to the assessment of operative risk, were only present in about 2% of all the patients.

Table 15.

Distribution of New ECG Abnormalities

Abnormality*	Age <60 (n=309) no. (%)	>60 (n=503) no. (%)
T-wave abnormalities	21 (6.8)	37 (7.4)
ST-segment abnormalities	13 (4.2)	29 (5.8)
Arrhythmias SVT or VEA	3 (1.0)	15 (3.0)
Others	4 (1.3)	7 (1.4)
Axis deviation	2 (0.6)	22 (4.4)
LVH	8 (2.6)	11 (2.1)
Q-wave abnormalities	5 (1.6)	10 (2.0)
Conduction defects	4 (1.3)	15 (3.0)

*The abnormalities were not mutually exclusive.

From this preliminary study, the authors concluded that although relevant new abnormal findings on the ECG were rare in persons under 60 years of age or who had a normal previous ECG, they could not broadly recommend deleting screening in these groups.

A cost analysis was performed on the use of the electrogardiogram in this situation. They assumed the direct costs of an ECG as $8.46 at that time (1976) in their hospital. As expected the greatest cost effectiveness was in those patients over the age of 60 with a previous abnormal ECG.

Table 16.

Cost Analysis of Preoperative Electrocardiograhy by Patient's Age and By Type of Previous ECG

Variable	Age (Yr) <60	>60	All Ages
Previous ECG abnormal			
No. of patients			
Total	129	311	440
With new abnormalities	24	81	105
With new relevant abnormalities	1	14	15
Cost ($)			
Per ECG	8.46	8.46	8.46
Per patient with a new abnormality	45.47	32.48	35.45
Per patient with a new relevant abnormality	1091.34	187.93	248.16
Previous ECG normal			
No. of patients			
Total	180	192	372
With new abnormalities	18	42	60
With new relevant abnormalities	7	10	17
Cost ($)			
Per ECG	8.46	8.46	8.46
Per patient with a new abnormality	84.60	38.67	52.45
Per patient with a new relevant abnormality	217.54	162.43	185.12

Applying the same analysis with the cost of the Parkland patient charges for an ECG the results would be as follows:

Table 17.

	Age <60	Age >60	All Ages
Previous abnormal ECG			
Cost/patient with new abnormality	193.50	138.22	150.86
Cost/patient new relevant abnormality	4464.00	799.71	1056.00
Previous normal ECG			
Cost/patient with new abnormality	360.00	164.57	223.20
Cost/patient new relevant abnormality	925.71	691.20	787.76

Subsequently the same authors reviewed the charts of the 165 patients who had new abnormalities on their ECG (45). The purpose of this review was to determine how the ECG changes affected the surgery planned for the patient. They found that the surgery was never delayed or cancelled as a result of the ECG abnormalities. They did find that the electrocardiographic results may have influenced the choice of anesthesia in two of the cases. Although this study focused only on preoperative ECG's when a baseline ECG was available, it was felt that the preoperative ECG contributed little information which affected patient management in this group.

A group headed by Moorman (46) studied the yield of the routine admission electrocardiogram to the general medical service at Duke University Medical Center. A total of 1,410 patients admitted to the general medicine service over a ten month period were evaluated. The mean age of the population was 53.2 years. The major reasons for admission to the general medicine service were cardiac disease (34%), hematologic or malignant disease (16%), and pulmonary disease (13%). Within 24 hours each patient was evaluated by one of the investigators for history or symptoms suggesting heart disease or a risk for coronary artery disease and the patient's medications. Each patient was also examined for evidence of cardiac disease. One thousand fifty (74%) of the 1,410 electrocardiograms showed abnormalities. The specific abnormal findings are outlined below, the most common being nonspecific repolarization abnormality, left ventricular hypertrophy, and old and age indeterminate infarction.

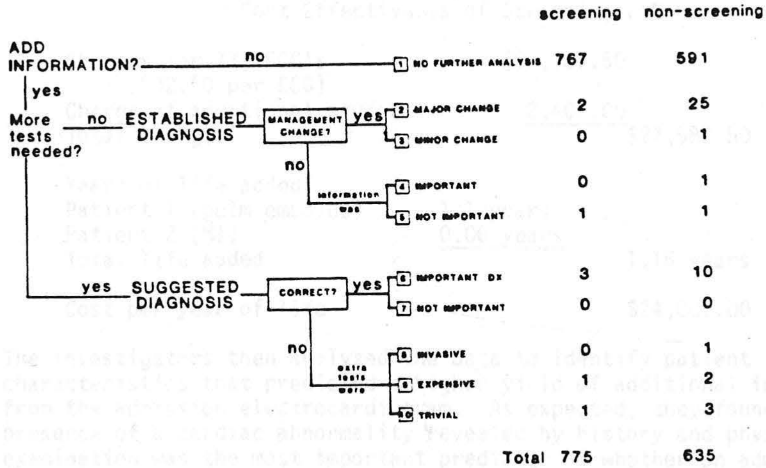
Table 18.

Abnormal Findings in 1410 Admission Electrocardiograms

Finding	Overall Prevalance	Added Information
	n (%)	
Non specific repolarization abnormality	435 (28)	0
Left ventricular hypertrophy	268 (17)	0
Old and age-indeterminate infarction	197 (13)	7 (12)
Arrhythmias	183 (12)	21 (37)
Acute ischemia	113 (7)	19 (33)
Bundle-branch block	56 (4)	2 (4)
Miscellaneous	314 (20)	8 (14)

Seven hundred and seventy-five patients had no evidence by history and physical exam of cardiac abnormalities. They were considered to have screening admission electrocardiograms. Of these, eight (1.0%) added clinical information. These electrocardiograms were further evaluated to determine whether they established or suggested a diagnosis. Two of those which established a diagnosis caused a major change in patient management and one was not important. Five of the electrocardiograms suggested a diagnosis, three of which were subsequently proven to be correct and an important diagnosis. Two required further evaluation, one of which had extra tests costing $100 or more.

Figure 7.



The investigators then went on to do a cost benefit analysis of the screening electrocardiograms. The total charges for electrocardiograms for 775 screening examinations was $25,187.50. Followup evaluation of the eight abnormal electrocardiograms generated further testing with an additional charge of $2,400 for a total of $28,000. Two patients were felt to have benefitted by the screening electrocardiogram. One was an elderly patient who had an unsuspected pulmonary embolus suggested by ST Segment and T Wave changes. Second, was a 49-year-old man with pancreatitis who had artifact on a baseline electrocardiogram which was otherwise felt to be normal. This prompted a repeat electrocardiogram two days later which showed an acute anterior myocardial infarction. It was felt that the elderly patient's life was prolonged by 1.1 years by diagnosis and treatment of the pulmonary embolus and the second patient's life was prolonged by three weeks by treatment with beta blockers post myocardial infarction. This yielded a sum of 1.16 years of prolongation of life which cost $24,000 per year of life saved.

Table 19.

Cost Effectivness of Screening ECG

Charges for 775 ECG's ($32.50 per ECG)	$25,187.50	
Charge of additional studies	2,400.00	
Total Charges		$27,587.50
Years of life added		
Patient 1 (pulm embolus)	1.1 years	
Patient 2 (MI)	0.06 years	
Total life added		1.16 years
Cost per year of life		$24,000.00

The investigators then analyzed the data to identify patient characteristics that predicted a higher yield of additional information from the admission electrocardiogram. As expected, they found that the presence of a cardiac abnormality revealed by history and physical examination was the most important predictor of whether an admission electrocardiogram would add information. Overall the electrocardiogram was more often helpful in patients of 45 years of age, but this was of only borderline statistical significance when adjusted for the presence of a cardiac abnormality. In patients who were under 45 years of age with no evidence of cardiac abnormalities, only 0.4% had abnormal electrocardiograms.

If routine electrocardiograms upon admission to the hospital are to be omitted, they should probably be omitted in the group of patients under 45 years of age with no cardiac abnormality ascertained upon history and physical exam.

Multichannel Chemistry Testing

An SMA-6 consisting of sodium, potassium, chloride, bicarbonate, glucose, and creatinine is routinely obtained on patients admitted to the medicine service of Parkland Memorial Hospital. Additional chemistries, especially liver function tests, magnesium, and phosphorus are frequently obtained early in the admission.

Murata et al. (24), studied the reasons outlined by physicians for obtaining serum electrolytes on patients admitted to Cedars-Sinai Medical Center in Los Angeles. In addition the housestaff were asked to indicate (1) the probability of an abnormality among the tests ordered; (2) which of the tests would be abnormal and (3) for what reason the test was ordered.

The housestaff predicted that 94.4 percent of the patients would have abnormal chemistries. The probabilities ranged from less than 25 percent to 75-100 percent. The actual members of abnormalities in these groups are outlined below:

Table 20.

Correlation Between Predictions and Outcomes

Probability of an abnormality	No. of responses	Clinical Abnormalities No. (frequency)
75-100%	44	21 (47.7%)
50-74%	66	17 (25.8%)
25-49%	98	14 (14.3%)
0-24%	181	14 (7.7%)
No opinion	23	

The housestaff had a tendency to overestimate the risk of high risk patients for abnormal values. However 26 percent of the abnormal tests were felt by the housestaff to have a less than 50 percent chance of being abnormal. The accuracy of prediction per specific test is noted below.

Table 21.

Prediction of Individual Test Results

Study	No. of studies ordered	No. of abnormalities suspected	No. of abnormalities found	Accuracy of physician prediction*
Sodium	387	105	29	73.6%
Potassium	394	198	36	55.1%
Chloride	384	42	17	85.7%
Bicarbonate	384	100	21	73.2%
Calcium	254	91	8	65.0%
Phosphorus	224	40	11	82.6%
Magnesium	155	22	11	83.9%

*Accuracy = number of correct predictions number of studies ordered.

Overall 17.7 percent of patients had a clinical electrolyte abnormality. Only 9.45 percent of the patients had new electrolyte diagnoses made. The remainder documented previously known disorders. Seventy-three percent of the patients did have diagnoses that can be associated with electrolyte disorders. Although the overall yield of electrolyte abnormalities was low, the housestaff were poor predictors of which patients would have abnormal values.

In his analysis of preoperative screening of 2000 patients, Kaplan et al. (47) found that one third of the 514 six-factor (sodium, potassium, chloride, total carbon dioxide content, BUN, and creatinine) did not meet the following indications:

1) 60 years of age or greater
2) renal disease
3) other fluid/electrolyte abnormalities
4) potentially relevent abnormalities (e.g., seizures)

Of these one (0.2%) was abnormal. This was a patient with a creatinine of 1.8. This did not change the surgical procedure or its outcome, but may have affected drug dosages which required adjustment for renal insufficiency.

Glucose determinations were made in 464 of Kaplan's patient, 75% of whom did not meet the following clinical indications:

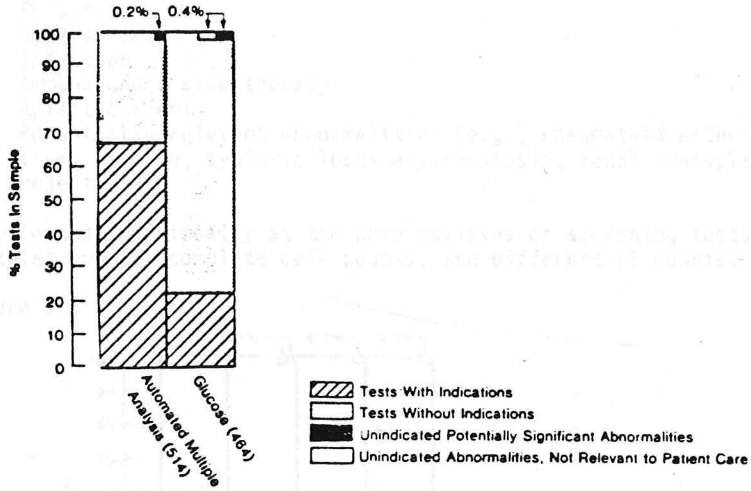
1)	Diabetes mellitus	5)	Pituitary disease
2)	Steroid therapy	6)	Hypothalamic disease
3)	Hypoglycemia	7)	Adrenal disease
4)	Pancreatic disease		

Four of these screening results were abnormal. One was a spurious level of 35 mg/dl which was 100 mg/dl when repeated. A second was 188 mg/dl, which was 136 mg/dl when repeated and required no therapy. The others were 203 mg/dl and 184 mg/dl and were not acknowledged in the record, treated or repeated.

In Korvin's study of 1000 patients who had admission screening testing, glucose, urea, electrolytes, protein, albumin, total bilirubin, and aspartate aminotransferase were performed regardless of clinical indication. Fourteen patients with new diagnoses of diabetes were found. Nine of these had glucose levels less than 165 mg/dl. None of the fourteen required therapy with medications.

Thirty patients had elevated bilirubin or transaminase values. Although the results of one patient were not received until after surgery for a fracture, he was advised not to undergo halothane anesthesia. The remainder had several diagnoses including alcohol liver disease (7 patients), probable Gilberts disease (4 patients), and chronic liver disease, undiagnosed (6 patients). None of these were felt to have benefited by finding their abnormalities on screening but long term follow up was not done.

Figure 8.



Generally, the yield of screening chemistries on hospitalized patients is low. But as pointed out by Murata, physicians are not able to accurately predict which patients will be likely to have abnormal values. Therefore screening chemistries should continue until groups with an extremely small chance of having significant abnormalities can be defined.

COMPLETE BLOOD COUNT

A complete blood count along with or without a differential white blood cell count has become a commonly accepted routine hospital admission screening procedure. No large studies on the efficacy of these tests on unselected patients admitted to a general medical ward has been undertaken. However, studies of selected tests on selected groups of patients have been carried out.

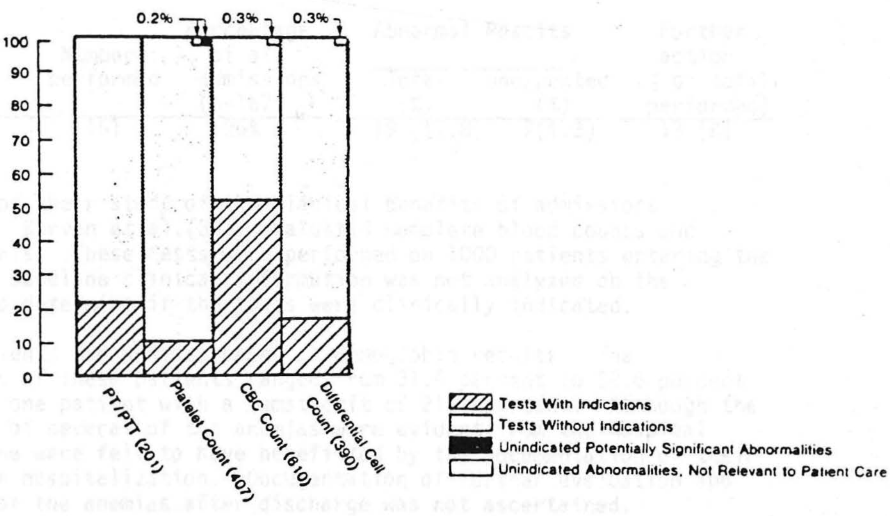
Kaplan et al. (47) looked at platelet counts, complete blood cell counts and differential cell counts in their analysis of the usefulness of preoperative laboratory screening. They felt that indications for these studies included:

1. A potentially bloody operation.
2. Chronic renal failure
3. History of anemia
4. Bleeding disorder
5. Hemorrhage

6. Hematologic malignancy
7. Radiation/chemotherapy
8. Platelet abnormality
9. Purpura
10. Hypersplenism
11. Infection
12. Immunosuppressive therapy
13. Aplastic anemia
14. Potentially relevant abnormalities (e.g., rheumatoid arthritis, liver disease, systemic lupus erythematosis, renal transplant rejection).

They looked individually at the abnormalities on screening tests of platelet counts, complete cell counts, and differential counts.

Figure 9.



Of the 407 platelet counts ordered they felt that 90% were not indicated according to their criteria. Two abnormalities (0.5%) were found. Neither abnormality affected the surgical procedure or was felt to be clinically significant for the patient. Complete blood cell counts were ordered on 610 patients studied, 48% of which did not meet the above clinical criteria. Two of these (0.3%) were abnormal. One of these was a laboratory error and the second was an elevated white blood cell count which was not felt to be clinically significant. Eighty-three percent of the 390 differential cell counts were screening tests. One of these (0.3%) was abnormal. This was a report of two nucleated red blood cells in the differential which were not present on repeated differential cell counts. As a result this group concluded that complete blood cell counts, platelet counts and differential white blood cell counts on preoperative patients without clinical indications for these did not contribute to the clinical care. The benefit of documenting normal baseline values in these tests was not addressed by this group.

Colgan and Philpot (48) looked at the use of routine testing in elderly psychiatric patients. In their study 161 complete blood counts were performed on 167 patients. Nineteen (11.5%) of these were found to be abnormal. Of these 19 abnormalities 7 (4.3% of the total tests done) were found in patients without clinical indications for the test. Further action was taken to evaluate or treat 13 of the abnormalities. The investigators did not indicate whether any of these were in the screening group. The group does include a CBC in its recommendations for routine screening of elderly psychiatric patients.

Table 22.

Screening Tests

Test	Number performed	Percentage of all admissions (n=167)	Abnormal Results: Total (%)	Abnormal Results: Unexpected (%)	Further action (% of total performed)
Full Blood Count	161	96%	19 (11.8)	7(4.3)	13 (8)

As a part of their study of the clinical benefits of admissions screening. Korvin et al.(35), evaluated complete blood counts and differentials. These tests were performed on 1000 patients entering the hospital. Baseline clinical information was not analyzed on the patients to determine if the tests were clinically indicated.

Eleven patients had anemias based on hemoglobin results. The hematocrits of these patients ranged from 31.4 percent to 38.6 percent except for one patient with a hematocrit of 21.1 percent. Although the etiologies of several of the anemias were evident from the hospital record, none were felt to have benefitted by the documentation of their anemia upon hospitalization. Documentation of further evaluation and treatment of the anemias after discharge was not ascertained.

In a study evaluating emergency tests on acute medical admissions, Sandler looked at 555 such patients (49). Forty hemoglobins and 50 white blood cell counts were carried out emergently. Forty-five percent of the hemoglobins and 22 percent of the white blood cell counts were abnormal. Five percent of the hemoglobin results and 36 percent of the white blood cell counts helped treatment. The hemoglobin was most helpful in patients with gastrointestinal bleeding. In all of these patients the hematologic tests were clinically indicated.

Connelly et al.(50), looked at the use of differential white cell counts for inpatient case finding. Of 2682 differentials performed within the first day of admission, 1736 (64.7%) had at least one component in the abnormal range. Of the patients with abnormal findings, 177 charts were reviewed. Thirty (17%) did not meet the clinical criteria outlined below and were therefore considered screening tests.

Table 23.

Clinical Indication Criteria

- Disease Condition
  - Infectious process
  - Anemia
  - Other Blood disease
  - Malignancy
  - Parasitic infestation
  - Allergy
  - Non-peptic abdominal pain
- Therapeutic Monitoring Conditions
  - Treated infectious process
  - Chronic disease associated with abnormal differential leukocyte count (e.g. rheumatoid arthritis, Felty's and Sjogren's syndrome)
  - Chemotherapy, radiotherapy, immunotherapy protocol
- Miscellaneous Conditions
  - Preoperative study
  - Follow up differential count after abnormal leukocyte count
- Assocated Symptoms,
  - Fever, malaise, weakness
  - Malaise, weakness, dizziness
  - Malaise, weakness, bruisability, nose bleed
  - Malaise, weakness, new adenopathy
  - Recent foreign travel or immigration
  - Rhinorrhea, sneezing, wheezing, asthma
  - Lower- and mid-abdominal pain

This compared to 32 percent screening cases of 110 charts reviewed of patients with normal differential counts.

In 23 (77%) of abnormal screening differential counts the result was acknowledged in the chart. None of these was felt to be clinically significant, when defined as leading to an unexpected diagnosis or problem or serve as a baseline for further decisions.

Overall, a complete blood cell count may serve as a useful screening procedure upon selected groups of patients admitted to the hospital. Subgroups in whom the procedure can be safely deleted have not yet been defined. Until that time, it should be performed on all patients admitted to the general medical service.

The differential white blood cell count on the other hand has been characterized as a nonspecific imprecise, error-prone, labor intensive, and expensive test to perform. Connelly has demonstrated that is is unlikely to be helpful if performed in the absence of clinical indications. As is current practice at Parkland, the differential should continue to be employed only in those patients with the clinical indications outlined above. A complete blood count can be recommended on all general medicine admissions until further definition of groups in which it can be safely discontinued.

URINALYSIS

Forty years ago clinical laboratories could analyze very few biochemical constituents in plasma or serum. Urine testing was widely used as an aid to diagnosis (51). This testing was usually done on the ward often using out of date or ill prepared reagents, with misleading test results. In the early 1960s the validity of the results of urinalyses was so doubtful that their diagnostic value was compared to that of palmistry (52). Over the years, sensitive plasma or serum assays have been developed which can detect changes associated with mild disease. These might have reduced the need for urine testing. However, reagent strips for more sensitive and accurate urine testing have been developed making biochemical urine testing very easy. In addition to biochemical testing, microscopic examination is generally performed. This takes a considerable amount of technical time in the laboratory. The urinalysis is one of the cheaper routine laboratory tests performed, but its cost is not insignificant and it should be evaluated for efficacy and cost effectiveness.

Nanji et al. (53) had an opportunity to look at the value of urinary sediment examinations upon routine admission to the hospital. They had implemented a change at Vancouver General Hospital whereupon urine sediments were not performed unless reqested by the physician. However, during the study they continued to perform the urine sediments whether the result was requested or not in an attempt to determine if there was an increased yield of the urine sediment abnormalities if the examination took place because a physician wanted it done.

In a group of 442 patients in whom urine sediment examinations were done but not ordered, they found that abnormalities of the urine sediment were present in 28 percent. They correlated this with the specific gravity of the urine specimen and found no relationship which allowed the specific gravity to be used as a screen. Subsequently they performed microscopic urinalyses on 282 patients which were requested by the physician. Abnormalities were found in 24 percent of these. Half of these were abnormalities of white blood cells. The remainder had red blood cells, greater than ten hyaline casts per high power field, granular casts, cellular casts or mixed abnormalities.

Since the microscopic sediment abnormalities were present in 24 percent when the test was specifically requested by the physician compared with 28 percent when not requested, the physicians appeared to perform poorly in predicting abnormal results. They also found that if the sediment examination was restricted to those patients who had biochemical abnormalities 15 to 20 percent of the abnormal sediments would be missed. This group did not look at the clinical implications of the abnormal urinary sediment findings, but recommended that urinary sediments continue to be done on all urinalyses submitted to the lab since a significant number of abnormalities were missed when a physician order for urinary sediment examination was relied upon.

Shaw et al. (54) studied two commercially available urine dipsticks for their sensitivity and specificity in picking out urine samples with abnormal sediment findings. They studied 1,839 urinalyses of which 769 (43%) were found to have abnormal urinary sediments on microscopic exams. They compared Multistix and Chemstrip reagent dipsticks. They found that microscopically abnormal urine sediments were missed by negative dipstick results in the following percent of urinalyses:

1. 16% using Multistix with trace blood and 1+ protein readings
2. 13% using Multistix with trace blood and trace protein readings
3. 3.9% using Chemstrip with trace blood, 1+ protein and trace leukocyte readings
4. 3.3% using Chemstrip with trace blood, trace protein and trace leukocyte readings.

Sixty-one cases fell in the 3.3% falsely negative Chemstrip results. Thirty-six of these cases had microscopic hematuria with 29 exhibiting only 1 to 3 red blood cells per high power field. Clinical data was reviewed for 21 of the 36 cases and there was no cinical evidence of either upper or lower urinary tract disease. Microscopic hematuria could be explained by menstrual contamination or catheter induced hematuria in these cases. Twenty-five of the 61 cases had likely urinary tract disease, representing a false negative rate of 1.4%. Information is not available on the clinical significance of the urinalyses result.

This study included both inpatients and outpatients presenting to the Los Angeles County University of Southern California Medical Center. The false negative rate may be even lower if applied to presumably healthy individuals as only a screening procedure.

The investigators felt that if the physician could indicate whether there was a likelihood of urinary tract abnormality, perhaps the chemstrip followed by microscopic urinalysis only if there were abnormalities could be employed in those individuals with a lower likelihood of urinary tract disease.

At the present time there is not enough information available to recommend discontinuation of routine admission urinalysis on individuals not suspected of having urinary tract disease. Several groups are currently evaluating the efficacy of urinalysis in groups without specific indications (55). This information should be available in the near future. At present microscopic analysis of the sediment can probably be discontinued on patients in whom the physician indicates a low likelihood of urinary tract disease and only be done if a sensitive dipstick test is positive.

PROTHROMBIN TIME

Measurement of the prothrombin time is a useful test of hepatic synthetic function in patients with liver disease and of coagulation abnormalities in patients having a bleeding disorders. The value of the prothrombin time as a screening test to detect liver disease and coagulation defects has not generally been studied. Eisenburg and Goldfarb (56) looked at the utility of the prothrombin time as a screening test upon admission to the general medical service at a Veterans Administration Hospital. They found that in a survey of four medical services at VA Hospitals across the country, 78 percent of the patients had their prothrombin time measured upon admission. In their study prothrombin time and liver function tests were performed on each patient admitted to the medical service at the Philadelphia VA Hospital over a two month period. Houseofficers then completed a questionnaire indicating the presence of a history or physical finding suggestive of liver disease or coagulation disorder.

Three hundred and one patients had protimes measured and 44 (14.6%) had abnormal values. Of the 301 patients 107 (35.6%) had neither a history nor physical exam suggestive of liver disease or coagulation disorder and therefore the procedure was considered screening. Two of these patients (1.9%) had prolonged prothrombin time. One of these was repeated and found to be within normal limits and therefore felt to be laboratory error. In the second patient the prothrombin time was not repeated and was not mentioned in the clinical record.

Table 24.

Subdivision of Patient Population by Presence of a Pertinent History or Physical Examination, and Results Prothrombin Time Testing ($P>0.0001$)[a]

Patient group	Total	No. with abnormal prothrombin time
I. Negative history, negative physical	107	2
II. Positive history alone	112	13
III. Positive history and physical	73	25
IV. Positive physical alone	9	4
	301	44

[a]A "pertinent" history was one of liver disease, ethanol abuse, use of anticoagulants, or a history indicative of a bleeding disorder. A "pertinent" physical examination was one with findings indicative of liver disease or ease of bleeding.

In another group of 73 patients who had a history of alcohol abuse but no history consistent with liver disease, coagulation disorder and no findings of these suggested on physical exam, the yield of screening protime was low. In 1 (1.4%) of these patients was the protime felt to be abnormal. However, this was not felt to be clinically significant and was not mentioned in the medical record.

Table 25.

Subdivision of Patients by Type of History Presented
(P>0.0001)

Type of History	Group II Positive history, negative exam: No. Patients	Group II: Abnormal Prothrombin Time	Group III Positive history, and exam: No. Patients	Group III: Abnormal Prothrombin Time
Alcoholism only	73	1	26	3
Liver disease	15	2	41	19
Anticoagulant	13	8	3	3
Bleeding	11	2	3	0
Total	112	13	73	25

Of the remaining 121 patients who had a history and/or physical exams suggestive of liver disease of coagulation disorder, 41 (33.9%) had an abnormal prothrombin time. Prothrombin time was abnormal in only 2 patients who had normal liver function studies.

Therefore, even in a Veterans Administration patient population, where an unusual frequency of liver disease exists among its patients, the usefulness of routine screening prothrombin time was very low. It should not be used as a screening test, but should be reserved for those groups with a history and or physical exam suggestive of liver disease, (other than a history of alcohol abuse alone) or of coagulation disorders.

ALTERING PHYSICIAN BEHAVIOR

Once it has been determined that routine hospital admission screening tests can be omitted in certain groups without adversely affecting the quality of their care, measures should be undertaken to affect physician behavior in omitting these investigations. Myers and Schroeder (11) have outlined several strategies that have been employed to alter physician behavior in the ordering of tests. These include education, audit with feedback, restrictions or rationing, and positive incentives.

Educational efforts to modify physician's patterns of service use have generally focused either on the appropriateness of care or on the cost of tests and procedures. These are based on the assumption that physicians would choose to change their ordering behavior if they understood better the costs and benefits of each service. These programs have yielded mixed results with generally some benefit shown early on after the education, but a diminution of these effects over the long term, when studied.

Physicians learning the appropriate indications for prothrombin time and thyroid function tests temporarily demonstrated lower use of these tests than physicians who received no such education (57,58). Rhyne and Gelbock performed a six month follow up of the same physicians and found that they had resumed their previous test ordering patterns. Eisenberg et al. found no effect on the rate of overuse of serum lactate dehydrogenase after educating housestaff on the criteria for this test. The failure was attributed to the lack of incentives for the housestaff to change their ordering patterns and lack of support from attending physicians. Klein, et al.(59) demonstrated a 40 percent reduction in the cost of care for urinary tract infections after teaching appropriate therapy compared with the concurrent control group which received no education.

Several groups (60,62) have taught the cost of services such as laboratory tests, x-ray, electrocardiograms, electroencephalograms, and hospital charges and found a reduction in the ordering of these tests at least on a short term basis.

At the Strong Memorial Hospital, Griner et al. (63) undertook an extensive educational effort which appeared to curtail the use of chemistry tests and chest x-rays and reduce the rate of growth in use of hematology determinations and microbiology cultures. This was monitored over a seven year period and compared with national averages and the use of these services at a nearby affiliated teaching hospital. This study appears to show that ongoing active efforts at education regarding laboratory and radiologic services are beneficial in maintaining more appropriate use.

In audit with feedback, physician's use of services are reviewed by senior physicians. Their performances compared with that of others and the results of the comparison are shared with the physician. This approach is especially successful among physicians who have higher than usual use or cost of services (64,65). Martin et al. (66) demonstrated that housestaff at the Peter Bent Brigham Hospital who underwent audits of their laboratory use ordered significantly fewer tests than housestaff in a control group or those in a group offered rewards to lower their laboratory use. After one such audit at the George Washington University Medical Clinic, overall mean annual laboratory charges declined by 29 percent. The previous high cost physicians lowered their laboratory charges by 42 percent.

Another means to reduce use of hospital services is to place limits on the number of the tests or services that can be ordered. Housestaff that are required to consult a laboratory hematology resident before ordering thrombin/prothrombin, and partial thromboplastin tests reduced their ordering of these tests markedly (67). Other attempts to ration services at teaching hospitals have been abandoned as being too difficult to maintain.

Little information exists on the effectiveness of positive incentives in altering physician's ordering behavior. Martin et al. (65) undertook a project at the Peter Bent Brigham Hospital which provided incentives in the form of journal subscriptions and textbooks for reducing the use of specified laboratory tests. These incentives were not effective.

Overall it appears that audit with feedback and education have the greatest potential for affecting physician behavior in ordering tests on hospitalized patients. Although not well studied restrictions, rationing and positive incentives have questionable feasability.

Undoubtedly as increased economic pressure results from DRG's, broader attempts will be made at instiuting and evaluating methods to alter physician behavior and thereby reduce hospital costs. Any efforts in this direction in addition to monitoring the effect on ordering and costs, must evaluate its effect on the outcome of patient care.

SUMMARY

As a result of the relatively high cost of medical care there are increasing pressures for reducing costs without compromising the quality of patient care. Hospital costs have come under close scrutiny with the institution of prospective payment by diagnostic related groups. The costs of tests performed in the hospital have been targeted as an area in which costs might be reduced without reducing the quality of patient care.

To appropriately utilize tests in any clinical setting the physician must be aware of and utilize the methods for determining the probability of disease based on the result of a given test. This allows the physician to more appropriately utilize and interpret that test in the care of the patient. In addition particularly in screening tests the physician must be aware of the relationship of the cost of testing to their yield regarding improved patient outcome.

In this discussion I have focused on hospital admission tests. Admission testing can be very helpful in guiding the care of the patient. However, these tests should be chosen and employed on the basis of the problems with which the patient presents. I have reviewed the clinical indications for the following tests upon admission to the hospital:

1. Chest x-ray
2. Electrocardiogram
3. SMA-6
4. CBC
5. Urinalysis
6. Prothrombin time

The chest x-ray, elecardiogram, and prothrombin time should not be utilized in all patients as an admission screening test. I have outlined specific clinical indications for each of these tests and groups in which testing is probably not cost beneficial. Such groups have not yet been defined for the use of the SMA-6, CBC, and Urinalysis. In the near future there are likely to be studies providing similar indications for these tests and groups in which they can be omitted.

As the indications for the application of tests upon hospital admission are defined, physicians must be educated regarding their indications. Subsequently feedback to the physicians regarding their test ordering habits and the impact on the outcome of care of their patients and the cost for their patients must be provided. In this manner the physician can most wisely and economically employ cost effective testing habits that will assure optimal care of the patient.

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