

**Routine Chest Radiography  
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
1. Kerr IH. The preoperative chest X-ray. <i>Br J Anaesth.</i> 1974;46(8):558-563.	Review/Other-Dx	N/A	No abstract available.	No abstract available.	4
2. Sagel SS, Evens RG, Forrest JV, Bramson RT. Efficacy of routine screening and lateral chest radiographs in a hospital-based population. <i>N Engl J Med.</i> 1974;291(19):1001-1004.	Review/Other-Dx	10,597 films	To determine if the elimination of some examinations or films often routinely obtained might be medically and economically justifiable.	Analysis of data from over 10,000 examinations suggests that routine screening CXRs, obtained solely because of hospital admission or scheduled surgery, are not warranted in patients under 20; the lateral projection, which can be eliminated from routine screening examinations in patients 20 to 39 years of age, should be part of the CXR examination whenever chest disease or a reasonable possibility of chest disease is suspected, and in screening examinations of patients 40 years of age or older.	4
3. Smetana GW, Lawrence VA, Cornell JE. Preoperative pulmonary risk stratification Smetana for noncardiothoracic surgery: systematic review for the American College of Physicians. <i>Ann Intern Med.</i> 2006;144(8):581-595.	Review/Other-Dx	145 studies	To systematically review the literature on preoperative pulmonary risk stratification before noncardiothoracic surgery.	Selected clinical and laboratory factors allow risk stratification for postoperative pulmonary complications after noncardiothoracic surgery.	4
4. Thomsen HS, Gottlieb J, Madsen JK, et al. [Routine x-ray examination of the thorax prior to surgical intervention under general anesthesia]. <i>Ugeskr Laeger.</i> 1978;140(14):765-768.	Review/Other-Dx	1,262	To determine the usefulness of routine preoperative radiographic examination of the thorax by review of the case-histories of 1,922 patients >40 years of age prior to surgery.	Postoperative radiographic examination of the thorax performed in 198/1,262 patients and 88 presented new abnormal radiological findings. Routine preoperative baseline CXR is not necessary.	4
5. Preoperative chest radiology. National study by the Royal College of Radiologists. <i>Lancet.</i> 1979;2(8133):83-86.	Review/Other-Dx	10,619	Eight hospitals in England, Wales, and Scotland took part in an investigation into the use of preoperative CXR in patients undergoing non-acute, non-cardiopulmonary surgery.	Preoperative CXR did not seem to influence the decision to operate or the choice of anesthetic; nor was there any evidence that preoperative CXR, at the levels of utilization observed in this study, would be of much value as a baseline against which subsequent radiographs in patients with postoperative pulmonary complications could be judged.	4
6. Working Party on the Effective Use of Diagnostic Cardiology. Guidelines on pre-operative chest x-ray. London: Royal College of Radiologists, 1982.	Review/Other-Dx	N/A	Guidelines on the effective use of diagnostic cardiology.	No results stated in abstract.	4

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7. Archer C, Levy AR, McGregor M. Value of routine preoperative chest x-rays: a meta-analysis. <i>Can J Anaesth.</i> 1993;40(11):1022-1027.	Meta-analysis	21 reports	Meta-analysis. To estimate the frequency with which routine postoperative CXR lead to clinically relevant new information.	0.1% of preoperative CXR caused modification of management. Concludes that in North American or European populations when a reliable history and a clinical examination are carried out, the cost of test is so high in relation to the clinical information provided that it is no longer justifiable.	M
8. Bouillot JL, Fingerhut A, Paquet JC, Hay JM, Coggia M. Are routine preoperative chest radiographs useful in general surgery? A prospective, multicentre study in 3959 patients. Association des Chirurgiens de l'Assistance Publique pour les Evaluations medicales. <i>Eur J Surg.</i> 1996;162(8):597-604.	Observational-Dx	3,959 consecutive patients	Prospective, open multicenter study to determine the usefulness of routine preoperative CXR in general surgery.	912 (23%) of radiographs showed some abnormality. Preoperative radiographs were of some help in the management of about half the patients who developed postoperative cardiopulmonary complications. Preoperative CXR should be routine for patients about to undergo general and gastrointestinal operations with 3 or more risk factors, and done selectively for patients with 1 or 2. Routine preoperative radiographs are unnecessary for patients with no risk factors.	2
9. Charpak Y, Blery C, Chastang C, Szatan M, Fourgeaux B. Prospective assessment of a protocol for selective ordering of preoperative chest x-rays. <i>Can J Anaesth.</i> 1988;35(3 ( Pt 1)):259-264.	Review/Other-Dx	3,866 patients	Prospective evaluation of a protocol for selective ordering of preoperative CXR.	568 radiographs (52%) were abnormal. 166 (15%) were considered useful by the anesthesiologists. Routine ordering of preoperative CXR should be abandoned.	4
10. Gagner M, Chiasson A. Preoperative chest x-ray films in elective surgery: a valid screening tool. <i>Can J Surg.</i> 1990;33(4):271-274.	Review/Other-Dx	1,000 patients	Retrospectively review patients who had a preoperative CXR made and who underwent elective surgery.	5.8% of women and 10.5% of men (7.4% of all patients) had abnormal preoperative CXR. Abnormalities were more frequent (30%) in patients >50 years of age than in younger patients (3%). Guidelines recommended for selective ordering of preoperative CXR.	4
11. Rucker L, Frye EB, Staten MA. Usefulness of screening chest roentgenograms in preoperative patients. <i>Jama.</i> 1983;250(23):3209-3211.	Review/Other-Dx	905 surgical admissions	To develop clinical criteria for preoperative CXR.	368 had no risk factors. 1 patient (0.3%) of 368 had an abnormal radiograph. No material abnormalities were found in the remainder of the group without risk factors. 504 patients had identifiable risk factors. Of these, 114 (22%) were found to have serious abnormalities on preoperative CXR.	4

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12. Boghosian SG, Mooradian AD. Usefulness of routine preoperative chest roentgenograms in elderly patients. <i>J Am Geriatr Soc.</i> 1987;35(2):142-146.	Review/Other-Dx	136 charts	To determine whether clinical criteria alone are sufficient to identify patients who would not benefit from preoperative CXRs.	34% of the patients without risk factors and 62% of those in the high-risk group were found to have significant abnormalities on CXRs ( $P<0.05$ ). Postoperative complications occurred in 20% of patients in the high-risk group compared to 11% complication-rate in patients without clinical risk factors. The difference is not statistically significant. The prevalence of abnormal preoperative CXRs among those over the age of 70 years (49%) was not significantly different from the prevalence in those between the ages of 60 and 70 years (59%); however, the incidence of major postoperative complications was significantly higher in the older group (17% vs 4%, $P<0.01$ ).	4
13. Joo HS, Wong J, Naik VN, Savoldelli GL. The value of screening preoperative chest x-rays: a systematic review. <i>Can J Anaesth.</i> 2005;52(6):568-574.	Review/Other-Dx	14 studies	Systematically review the literature on the value of screening CXR and establish evidence to support guidelines for the use of preoperative screening CXR.	Association between preoperative screening CXR and decrease in morbidity and mortality not established.	4
14. Smetana GW, Macpherson DS. The case against routine preoperative laboratory testing. <i>Med Clin North Am.</i> 2003;87(1):7-40.	Review/Other-Dx	N/A	To guide physicians and facility policy makers regarding rational testing before surgery.	Clinicians should order only a small number of routine tests based on age as noted in Table 13. Selective use of other preoperative tests should be based on history and physical examination findings that identify subgroups of patients who are more likely to have abnormal results. In general, clinicians should order tests only if the outcome of an abnormal test will influence management. When an abnormal test results from such testing, it is critical that physicians document their thinking about the result. Most routine preoperative tests are neither expensive nor risky. For this reason, clinicians can have a low threshold for ordering these tests in patients for whom the frequency of abnormalities is increased compared with a healthy population.	4

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15. Fritsch G, Flamm M, Hepner DL, Panisch S, Seer J, Soennichsen A. Abnormal pre-operative tests, pathologic findings of medical history, and their predictive value for perioperative complications. <i>Acta Anaesthesiol Scand.</i> 2012;56(3):339-350.	Review/Other-Dx	1,363 patients	To investigate the correlation of abnormal findings in preoperative tests and pathologic findings in the medical history with perioperative complications.	A total of 1,363 (56.1% female) patients were consecutively included in this study. The percentage of abnormalities in preoperative tests ranged from 1.6% (electrolytes) and 29.7% (echocardiography). 86 (6.3%) patients had at least 1 perioperative complication. The most frequent complications were hypo- or hypertension in 55 cases (4.0%), followed by 20 patients (1.5%) who suffered from hemodynamically relevant cardiac dysrhythmias such as supraventricular tachycardia, ventricular tachycardia, bradycardia and ventricular extrasystoles. The binary logistic regression analysis to identify predictors of perioperative complications showed significant results for age, invasiveness of the procedure, history of renal disease or anemia and abnormal ECG.	4
16. Silvestri L, Maffessanti M, Gregori D, Berlot G, Gullo A. Usefulness of routine pre-operative chest radiography for anaesthetic management: a prospective multicentre pilot study. <i>Eur J Anaesthesiol.</i> 1999;16(11):749-760.	Experimental-Dx	6,111 patients	To assess the influence of a routine preoperative CXR on anesthetic management and to characterize which patients might benefit from it.	Abnormal preoperative CXRs were reported in 1,116 patients (18.3%). Pre-operative CXR altered the anesthetic management (ie, useful preoperative CXR) in 313 patients (5.1%). Male sex, age >60 years, ASA classes ≥3, respiratory diseases, and the presence of 2 or more co-existing diseases were significantly related to the probability of a useful preoperative CXR using multivariate analysis ( $P<0.01$ ).	1
17. Munro J, Booth A, Nicholl J. Routine preoperative testing: a systematic review of the evidence. <i>Health Technol Assess.</i> 1997;1(12):i-iv; 1-62.	Review/Other-Dx	N/A	Systematically review evidence on the value of routine preoperative testing in healthy or asymptomatic adults.	Available evidence does not support policy of preoperative CXR for all patients.	4

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18. Agostini P, Cieslik H, Rathinam S, et al. Postoperative pulmonary complications following thoracic surgery: are there any modifiable risk factors? <i>Thorax</i> . 2010;65(9):815-818.	Review/Other-Dx	234 patients	To assess the incidence and impact of postoperative pulmonary complications and to identify potentially modifiable independent risk factors.	34/234 subjects (14.5%) had clinical evidence of postoperative pulmonary complication. The postoperative pulmonary complication patient group had a significantly longer length of stay in hospital, high dependency unit longer length of stay, higher frequency of intensive care unit admission and a higher number of hospital deaths. Older patients, body mass index $\geq 30$ kg/m(2), preoperative activity <400 m, American Society of Anesthesiologists (ASA) score $\geq 3$ , smoking history, chronic obstructive pulmonary disease, lower preoperative forced expiratory volume in 1 s (FEV(1)) and predicted postoperative FEV(1) were all significantly ( $P < 0.05$ ) associated with postoperative pulmonary complication on univariate analysis. Multivariate analysis confirmed that age >75 years, body mass index $\geq 30$ kg/m(2), ASA $\geq 3$ , smoking history and chronic obstructive pulmonary disease were significant independent risk factors in the development of postoperative pulmonary complication ( $P < 0.05$ ).	4

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19. Dindo D, Muller MK, Weber M, Clavien PA. Obesity in general elective surgery. <i>Lancet</i> . 2003;361(9374):2032-2035.	Review/Other-Tx	6,336 patients	To investigate how obesity affects surgical outcome in elective general surgery in a cohort of more than 6,000 patients followed prospectively in a single center over 10 years.	The cohort consisted of 6,336 patients, of whom 808 (13%) were obese, 569 (9%) were mildly obese, and 239 (4%) had severe obesity. The morbidity rates in patients who were obese compared with those who were not were much the same (122 [15.1%] of 808 vs 901 [16.3%] of 5,528; $P=0.26$ ), with the exception of an increased incidence of wound infections after open surgery in patients who were obese (17 [4%] of 431 vs 92 [3%] of 3,555, $P=0.03$ ). Incidence of complications did not differ between patients who were mildly obese (91 [16.0%] of 569), severely obese (36 [15.1%] of 239), and non-obese (901 [16.3%] of 5528; $P=0.19$ ). In multivariate regression analyses, obesity was not a risk factor for development of postoperative complications. Of note, the additional medical resource use as estimated by a new classification of complications showed no differences between patients who were and were not obese.	4
20. Ramaswamy A, Gonzalez R, Smith CD. Extensive preoperative testing is not necessary in morbidly obese patients undergoing gastric bypass. <i>J Gastrointest Surg</i> . 2004;8(2):159-164; discussion 164-155.	Observational-Dx	193 patients	Analyze prospectively collected data to assess value of preoperative CXR in morbidly obese patients having weight loss surgery.	Preoperative testing identified abnormalities on 8 CXR (4%) and 29 ECGs (15%), none of which required preoperative intervention. Small number of abnormalities on CXR, none required preoperative intervention.	3

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21. Poirier P, Alpert MA, Fleisher LA, et al. Cardiovascular evaluation and management of severely obese patients undergoing surgery: a science advisory from the American Heart Association. <i>Circulation</i> . 2009;120(1):86-95.	Review/Other-Dx	N/A	Guideline on the cardiovascular evaluation and management of severely obese patients undergoing surgery.	The challenge for the clinician before surgery is to identify the severely obese patient who is at higher perioperative cardiovascular risk. Cardiac symptoms such as exertional dyspnea and lower-extremity edema are nonspecific in obesity, and the severely obese patient with poor functional capacity should receive careful clinical evaluation. Physical examination often underestimates cardiac dysfunction in severely obese patients. Most patients with obesity cardiomyopathy have diastolic dysfunction, but some patients exhibit both left ventricular diastolic and systolic dysfunction. There are numerous respiratory abnormalities associated with obesity. The obtainment of a 12-lead ECG and a CXR is reasonable in all severely obese patients under consideration for surgery. Severely obese patients with 3 coronary heart disease risk factors or diagnosed coronary heart disease may require additional noninvasive testing if the clinician believes that the results will change management. Functional capacity, cardiac risk factor assessment, and the presence or absence of potential cardiovascular symptoms will determine whether formal evaluation beyond a comprehensive medical history, physical examination, ECG, and CXR is necessary.	4
22. Murphy TP, Dorfman GS, Becker J. Use of preprocedural tests by interventional radiologists. <i>Radiology</i> . 1993;186(1):213-220.	Review/Other-Dx	1,238 members	A survey undertaken to determine the current practices and appropriateness of current routine use of preprocedural tests.	The response rate was 34%, representing a cumulative annual volume of 322,208 cases. The practice of performing routine preprocedural tests is common among interventional radiologists. Data provided by this survey suggest that use of these tests is excessive. Adherence to suggested proposals derived from previously reported experience would result in an annual estimated savings of \$20.0-\$34.9 million (extrapolated for all procedures performed by SCVIR members in 1989).	4

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23. Malone DE, Becker CD, Muller NL, Burhenne HJ. Is routine chest radiography required with biliary lithotripsy? <i>AJR Am J Roentgenol.</i> 1989;152(5):987-989.	Review/Other-Dx	75 patients 107 lithotripsy sessions	Retrospective study to determine need for routine preoperative and postoperative CXR in patients undergoing lithotripsy.	No pulmonary disease detected before or after procedure. Routine prelithotripsy and postlithotripsy CXR are not necessary in patients undergoing biliary lithotripsy.	4
24. Grier DJ, Watson LJ, Hartnell GG, Wilde P. Are routine chest radiographs prior to angiography of any value? <i>Clin Radiol.</i> 1993;48(2):131-133.	Review/Other-Dx	240 patients	Prospective study to determine role of CXR prior to angiography.	116 radiographs were normal. 117 abnormalities on radiographs of 104 patients, mainly cardiac enlargement and heart failure. Preangiography radiographs had no effect on the practice of peripheral angiography. Routine CXR is not necessary.	4
25. Goldstein LB. Stroke code chest radiographs are not useful. <i>Cerebrovasc Dis.</i> 2007;24(5):460-462.	Review/Other-Dx	113 patients	Retrospective study to examine value of routine CXR in acute stroke.	CXR were completely normal in 70% with 25.2% having incidental and 3.8% having potentially relevant findings. Routine CXR not recommended.	4
26. Gupta SD, Gibbins FJ, Sen I. Routine chest radiography in the elderly. <i>Age Ageing.</i> 1985;14(1):11-14.	Review/Other-Dx	1,000 consecutive admissions	To determine if CXR is necessary in geriatric unit admissions based on a prospective survey.	35%–50% had little or no clinical indication for CXR examination. Radiography did not contribute to management.	4
27. Hubbell FA, Greenfield S, Tyler JL, Chetty K, Wyle FA. The impact of routine admission chest x-ray films on patient care. <i>N Engl J Med.</i> 1985;312(4):209-213	Review/Other-Dx	294 patients	Review charts of patients to evaluate the impact of routine admission CXR on patient care.	Abnormalities noted in 106 (36%) of 294 patients. Treatment was changed because of CXR results in 12 (4%) of patients. Impact of routine admission CXR on patient care is very small, even in a population with a high prevalence of cardiopulmonary disease. Recommend that such radiographs not be ordered solely because of admission.	4
28. White CS, Austin JH, Lubetsky HW, Cole RP. The impact of routine chest radiography on the management of patients admitted from an emergency service. <i>Invest Radiol.</i> 1990;25(6):720-723.	Observational-Dx	188 patients	To assess the clinical course of patients admitted to an adult medical service from the emergency area of an inner city hospital.	Each of the patients underwent CXR examination, ie, the only indication for the examination was admission to the hospital. 4 subpopulations considered to be at high risk for treatment-altering radiographic abnormalities were defined prospectively: age of 65 years or older, cigarette smokers, altered mental status, and human immunodeficiency virus positivity. CXR examination abnormalities were significantly more common in the subpopulations at high risk (104/127, 82%) than in the population at low risk (37/61, 61%) ( $P<0.01$ ). Abnormalities on CXR examination led to altered treatment in 5 (3%) of the 188 inpatients. Each of these 5 patients was a member of a subpopulation at high risk (5/127, 4%).	4



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29. Gomez-Gil E, Trilla A, Corbella B, et al. Lack of clinical relevance of routine chest radiography in acute psychiatric admissions. <i>Gen Hosp Psychiatry</i> . 2002;24(2):110-113.	Review/Other-Dx	200 patients	To assess value CXR in acute psychiatric admissions. Records of the 332 first consecutive admissions to the psychiatric ward were assessed and CXR requested in 200 patients (60%).	Radiograph normal in 81.5% of patients. CXR in acute psychiatric inpatients is not necessary.	4
30. Malnick S, Duek G, Beilinson N, et al. Routine chest X-ray on hospital admission: does it contribute to diagnosis or treatment? <i>Isr Med Assoc J</i> . 2010;12(6):357-361.	Observational-Dx	675 patients	To examine the current role of the routine admission CXR in patient management in a university-affiliated department of medicine.	There were 675 patients whose mean age was 64.5 +/- 17.2 years. In 19.6% (130 cases) CXR was not performed. Of the 545 CXRs done, 260 (48%) were normal. In only 128 (23.5%) did the admission CXR make a major positive contribution to diagnosis or treatment. In 61 (11.2%) it provided a minor positive contribution and in 153 (28.1%) a major negative contribution. In 184 patients (33.8%) the CXR did not affect either diagnosis or management. It made a major positive contribution to management in patients for whom there was an indication for performing the CXR (odds ratio 10.3, $P<0.0005$ ) and in those with a relevant finding on physical examination (odds ratio 1.63, $P=0.110$ ). For the 329 patients who had neither a clinical indication for performing a CXR nor an abnormal chest examination the admission CXR contributed to patient management in only 12 cases (3.6%).	4
31. Verma V, Vasudevan V, Jinnur P, et al. The utility of routine admission chest X-ray films on patient care. <i>Eur J Intern Med</i> . 2011;22(3):286-288.	Review/Other-Dx	229 patients	To evaluate the utility of routine admission CXRs on patient care in patients admitted to The Brooklyn Hospital center.	CXRs were noted to be done in 229 patients on admission. CXRs of 100 (43.6%) patients were deemed medically necessary because of the presenting complaints which included cough (15.2%), fever (13.1%), dyspnea (6.1%), hemoptysis (1.7%), and combined symptoms (7.4%). Routine CXRs were done in 129 (56.3%) patients to rule out occult findings in the absence of any symptoms. CXRs abnormalities were noted in 56/129 (43.4%) patients. In 51/56 patients, abnormalities were chronic, stable and previously known and did not contribute to patient care. In only 5/129 (3.87%) patients, there were findings which necessitated a change in patient care.	4

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32. Mangura BT, Reichman LB. Periodic chest radiography: unnecessary, expensive, but still pervasive. <i>Lancet</i> . 1999;353(9149):319-320.	Review/Other-Dx	N/A	Review of periodic screening by CXR.	Health-care interventions have to meet criteria of cost effectiveness as well as scientific soundness based on authoritative data. Routine periodic chest radiography in follow-up, or as a screening tool for tuberculosis, does not meet these criteria and should not be continued.	4
33. Robin ED, Burke CM. Routine chest x-ray examinations. <i>Chest</i> . 1986;90(2):258-262.	Review/Other-Dx	N/A	To review the risks and benefits of routine CXR.	No results stated in abstract.	4
34. Moyer VA. Screening for lung cancer: U.S. Preventive Services Task Force recommendation statement. <i>Ann Intern Med</i> . 2014;160(5):330-338.	Review/Other-Dx	N/A	Recommendations from the U.S. Preventive Services Task Force on screening for lung cancer.	The USPSTF recommends annual screening for lung cancer with low-dose computed tomography in adults aged 55 to 80 years who have a 30 pack-year smoking history and currently smoke or have quit within the past 15 years. Screening should be discontinued once a person has not smoked for 15 years or develops a health problem that substantially limits life expectancy or the ability or willingness to have curative lung surgery.	4
35. Tigges S, Roberts DL, Vydareny KH, Schulman DA. Routine chest radiography in a primary care setting. <i>Radiology</i> . 2004;233(2):575-578.	Review/Other-Dx	N/A	To determine the frequency, diagnostic yield, outcomes, cost, and rate of false-positive results of routine CXR performed in asymptomatic patients in the primary care setting.	Of 3,812 radiographs obtained at the primary care clinic, 1,282 (34%) were ordered for routine or screening purposes by the referring physician. 922 radiographs were obtained in male patients and 360 were obtained in female patients; their mean and median age was 49 years (age range, 4–87 years). 15 CXRs showed major abnormalities. No patient younger than 40 years had a major abnormality. 14 of the 15 findings of major abnormalities proved to be false-positive. No disease requiring treatment was diagnosed as a result of radiographic findings. The total cost for follow-up radiography and computed tomography was US dollar 46,609.49.	4

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36. Oken MM, Hocking WG, Kvale PA, et al. Screening by chest radiograph and lung cancer mortality: the Prostate, Lung, Colorectal, and Ovarian (PLCO) randomized trial. <i>Jama</i> . 2011;306(17):1865-1873.	Experimental-Dx	154,901 participants	To evaluate the effect on mortality of screening for lung cancer using radiographs in the Prostate, Lung, Colorectal, and Ovarian (PLCO) Cancer Screening Trial.	Screening adherence was 86.6% at baseline and 79% to 84% at years 1 through 3; the rate of screening use in the usual care group was 11%. Cumulative lung cancer incidence rates through 13 years of follow-up were 20.1 per 10,000 person-years in the intervention group and 19.2 per 10,000 person-years in the usual care group (rate ratio; 1.05, 95% CI, 0.98–1.12). A total of 1,213 lung cancer deaths were observed in the intervention group compared with 1,230 in usual care group through 13 years (mortality rate ratio, 0.99; 95% CI, 0.87–1.22). Stage and histology were similar between the 2 groups. The rate ratio of mortality for the subset of participants eligible for the NLST, over the same 6-year follow-up period, was 0.94 (95% CI, 0.81–1.10).	1
37. Schwartz GL, Krakoff LR. Diagnostic evaluation: Initial evaluation: laboratory testing. <i>J Am Soc Hypertens</i> . 2014;8(9):677-679.	Review/Other-Dx	N/A	To provide the recommended initial laboratory tests and their purposes by the American Society of Hypertension.	No results stated in abstract.	4
38. Kristensen BO. Assessment of left ventricular hypertrophy by electrocardiography, chest roentgenography and echocardiography, a review. <i>Scand J Clin Lab Invest Suppl</i> . 1989;196:42-47.	Review/Other-Dx	N/A	Autopsy review of LVH comparing sensitivity, specificity and accuracy to CXR, electrocardiography and echocardiography.	Electrocardiography: sensitivity 25%–50%, specificity 69%–94%, accuracy 30%–69%. Echocardiography: sensitivity 88%–100%, specificity 84%–86%. CXR: sensitivity 7%, specificity 67%.	4
39. Frohlich ED. Hypertension 1986. Evaluation and treatment--why and how. <i>Postgrad Med</i> . 1986;80(7):28-36, 41-26.	Review/Other-Dx	N/A	Review major findings on hypertension research and evaluation of patients with elevated blood pressure.	In patients with LVH, degree of cardiac enlargement can be easily quantified by CXR and electrocardiography. Routine CXR are worthwhile for any chronic illness.	4

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40. Rayner BL, Goodman H, Opie LH. The chest radiograph. A useful investigation in the evaluation of hypertensive patients. <i>Am J Hypertens.</i> 2004;17(6):507-510.	Observational-Dx	72 hypertensive and 77 age- and sex-matched normotensives	To determine the usefulness of the CXR in the assessment of target organ damage in hypertensive patients.	72 hypertensive and 77 age- and sex-matched normotensives were evaluated. There was a highly significant difference in the aortic knob width between the normotensive and hypertensive patients (3.28 cm vs 3.69 cm, $P<.0001$ ). The aortic knob width was significantly correlated with age in normotensive and hypertensive patients, systolic and diastolic blood pressure, and all markers of target organ damage except the ECG voltage. The cardiothoracic ratio was also significantly correlated with age and other markers of target organ damage, but not clinic blood pressure. Multiple regression analysis revealed that only the cardiothoracic ratio ( $r = 0.34, P<.02$ ) and the ECG voltage ( $r = 0.58, P<.00005$ ) were independently correlated with left ventricular mass.	3
41. Stokes J, 3rd, Kannel WB, Wolf PA, D'Agostino RB, Cupples LA. Blood pressure as a risk factor for cardiovascular disease. The Framingham Study--30 years of follow-up. <i>Hypertension.</i> 1989;13(5 Suppl):113-18.	Review/Other-Dx	5,070 men and women	To summarize the contribution of blood pressure to the incidence of coronary heart disease, transient ischemic attacks, stroke, and congestive heart failure based on 30 years of follow-up of the 5,070 men and women of the original Framingham cohort.	Data from 30 years of follow-up of the original Framingham Study cohort of 5,070 men and women aged 30–62 years who were first examined during the period 1948-1952 and who were free of cardiovascular disease reveal that blood pressure is a strong and consistent predictor of the development of coronary heart disease, stroke, transient ischemic attack, and congestive heart failure. Other factors related to blood pressure like obesity, LVH as demonstrated on ECGs, and heart enlargement as shown by radiography made several selective additional independent contributions to risk; heart enlargement by radiography was the best predictor of congestive heart failure.	4

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42. Tsakiris A, Doumas M, Nearchos N, Mavrokefalos A, Mpatakis N, Skoufas P. Aortic calcification is associated with age and sex but not left ventricular mass in essential hypertension. <i>J Clin Hypertens (Greenwich)</i> . 2004;6(2):65-70.	Review/Other-Dx	290 patients	To investigate the prevalence of aortic calcification in patients with essential hypertension and its relationship with age, sex, and LVH.	A CXR and an echocardiograph were performed. Aortic calcification was observed in 74/290 (25.5%) patients. Patients with calcification were mostly female (67.6%) and older (71.8+1.9 years), whereas patients without calcification were younger (59.0+0.79) and of both sexes (51.85% female). Left ventricular mass index in male patients with aortic calcification was 147.3+4.32 g/m(2) and without calcification was 132.7+2.28 g/(2) ( $P=0.023$ ). Female patients' values were 131.9+4.32 g/m(2) with calcification and 121.2+2.85 g/m(2) without calcification ( $P=0.025$ ). Left ventricular mass was independently associated with age and sex but not with aortic calcification. The prevalence of aortic calcification in essential hypertension is considerably higher compared to the general population. Essential hypertension and age seem to contribute to the concurrent appearance of aortic calcification and increased left ventricular mass.	4

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EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
43. Chikos PM, Figley MM, Fisher L. Correlation between chest film and angiographic assessment of left ventricular size. <i>AJR Am J Roentgenol.</i> 1977;128(3):367-373.	Observational-Dx	76 patients	To correlate CXR and angiographic measurements in subjects with normal and enlarged left ventricles.	Of the 18 normal cases, only Rigler's B measurement correlated with left ventricular volume (r = .64). However, this correlation was not statistically significant. Of the 58 patients with isolated aortic valve disease, 19 had increased left ventricular mass (hypertrophy) and 39 had both increased left ventricular end-diastolic volume and mass (hypertrophy and dilatation). In the hypertrophy group, plain film heart volume was the most sensitive detector of an enlarged left ventricle (21% false negative rate) and correlated with left ventricular end-diastolic volume (r = .62). Using stepwise discriminant analysis, the combination of heart volume, leftness of the heart, apex position, and roundness of the left ventricle decreased the false negative rate to 5%. In the hypertrophy and dilatation group, plain film heart volume had the highest correlation with left ventricular volume and mass (r = .66) and a false negative rate of 8%. No single variable or combination of variables could usefully discriminate between the hypertrophy and hypertrophy and dilatation groups. These data support the conclusion that plain film heart volume is the best single measurement for detecting left ventricular enlargement.	3
44. Hoffman RB, Rigler LG. Evaluation of Left Ventricular Enlargement in the Lateral Projection of the Chest. <i>Radiology.</i> 1965;85:93-100.	Review/Other-Dx	205 cases	To define 2 measurements easily obtained from the lateral CXR and to determine their degree of efficacy in evaluating left ventricular size.	No results stated in abstract.	4
45. Kannel WB, Cobb J. Left ventricular hypertrophy and mortality--results from the Framingham Study. <i>Cardiology.</i> 1992;81(4-5):291-298.	Review/Other-Dx	N/A	To evaluate data on the prognostic implications of LVH in the Framingham Study based on routine ECG, echocardiogram and X-ray determination with 36 years of follow-up.	No results stated in abstract.	4

**Routine Chest Radiography  
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
46. Koren MJ, Devereux RB, Casale PN, Savage DD, Laragh JH. Relation of left ventricular mass and geometry to morbidity and mortality in uncomplicated essential hypertension. <i>Ann Intern Med.</i> 1991;114(5):345-352.	Observational-Dx	253 patients	To assess the prognostic significance of left ventricular mass and geometry in initially healthy persons with essential hypertension.	Left ventricular mass exceeded 125 g/m <sup>2</sup> in 69/253 patients (27%). Cardiovascular events occurred in a higher proportion of patients with than without LVH (26% compared with 12%; $P=0.006$ ). Patients with increased ventricular mass were also at higher risk for cardiovascular death (14% compared with 0.5%; $P<0.001$ ) and all-cause mortality (16% compared with 2%; $P=0.001$ ). Electrocardiographic LVH did not predict risk. Patients with normal left ventricular geometry had the fewest adverse outcomes (no cardiac deaths; morbid events in 11%), and those with concentric hypertrophy had the most (death in 21%; morbid events in 31%). In a multivariate analysis, only age and left ventricular mass—but not gender, blood pressure, or serum cholesterol level—independently predicted all 3 outcome measures.	3
47. Hartford M, Wikstrand J, Wallentin I, Ljungman S, Wilhelmson L, Berglund G. Non-invasive signs of cardiac involvement in essential hypertension. <i>Eur Heart J.</i> 1982;3(1):75-87.	Review/Other-Dx	120 patients	To determine the prevalence of noninvasive signs of cardiac involvement at different blood pressure levels and to compare the frequencies obtained by the various methods.	In the hypertensive groups a lower proportion of subjects with signs of cardiac involvement were identified by conventional ECG and CXR than by the other methods. A significant association between the prevalence of pathological findings and level of blood pressure ( $P<0.05-0.01$ ) was found for conventional and corrected orthogonal ECG and apexcardiography/phonocardiography. With echocardiography, concomitant increased thickness (>12 mm) of both the interventricular septum and left ventricular posterior wall, but not of one structure alone, was significantly associated with BP ( $P<0.05$ ).	4

## Evidence Table Key

### Study Quality Category Definitions

- *Category 1* The study is well-designed and accounts for common biases.
- *Category 2* The study is moderately well-designed and accounts for most common biases.
- *Category 3* There are important study design limitations.
- *Category 4* The study is not useful as primary evidence. The article may not be a clinical study or the study design is invalid, or conclusions are based on expert consensus. For example:
  - a) the study does not meet the criteria for or is not a hypothesis-based clinical study (e.g., a book chapter or case report or case series description);
  - b) the study may synthesize and draw conclusions about several studies such as a literature review article or book chapter but is not primary evidence;
  - c) the study is an expert opinion or consensus document.
- M = Meta-analysis

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Dx = Diagnostic

Tx = Treatment

## Abbreviations Key

CI = Confidence interval

CXR = Chest radiograph

ECH = Electrocardiogram

LVH = Left ventricular hypertrophy