Appendix C. Diagrams and Tables

1. Chest Pain

Reproduced from Snow et al., 2004.

Table 1. Clinical Classification of Chest Pain*

Typical angina (definite) 1) Substernal chest discomfort with a characteristic quality and duration that is 2) provoked by exertion or emotional stress and 3) relieved by rest or nitroglycerin
Atypical angina (probable) Meets 2 of the above criteria
Noncardiac chest pain Meets 1 or none of the above criteria

* Modified with permission from reference 2.

2. Unstable Angina

Reproduced from Anderson et al., 2007.

Table 4. Three Principal Presentations of UA

Class	Presentation
Rest angina*	Angina occurring at rest and prolonged, usually greater than 20 min
New-onset angina	New-onset angina of at least CCS class III severity
Increasing angina	Previously diagnosed angina that has become distinctly more frequent, longer in duration, or lower in threshold (i.e., increased by 1 or more CCS class to at least CCS class III severity)

* Patients with non–ST-elevated myocardial infarction usually present with angina at rest. Adapted with permission from Braunwald E. Unstable angina: a classification. Circulation 1989;80:410–4 (14).

CCS = Canadian Cardiovascular Society classification; UA = unstable angina.

Table 5. Grading of Angina Pectoris According to CCS Classification

Class	Description of Stage
I	"Ordinary physical activity does not cause . . . angina," such as walking or climbing stairs. Angina occurs with strenuous, rapid, or prolonged exertion at work or recreation.
II	"Slight limitation of ordinary activity." Angina occurs on walking or climbing stairs rapidly; walking uphill; walking or stair climbing after meals; in cold, in wind, or under emotional stress; or only during the few hours after awakening. Angina occurs on walking more than 2 blocks on the level and climbing more than 1 flight of ordinary stairs at a normal pace and under normal conditions.
III	"Marked limitations of ordinary physical activity." Angina occurs on walking 1 to 2 blocks on the level and climbing 1 flight of stairs under normal conditions and at a normal pace.
IV	"Inability to carry on any physical activity without discomfort—anginal symptoms may be present at rest."

Adapted with permission from Campeau L. Grading of angina pectoris (letter). Circulation 1976;54:522–3 (15).
CCS = Canadian Cardiovascular Society.

Figure 2. Algorithm for Evaluation and Management of Patients Suspected of Having ACS

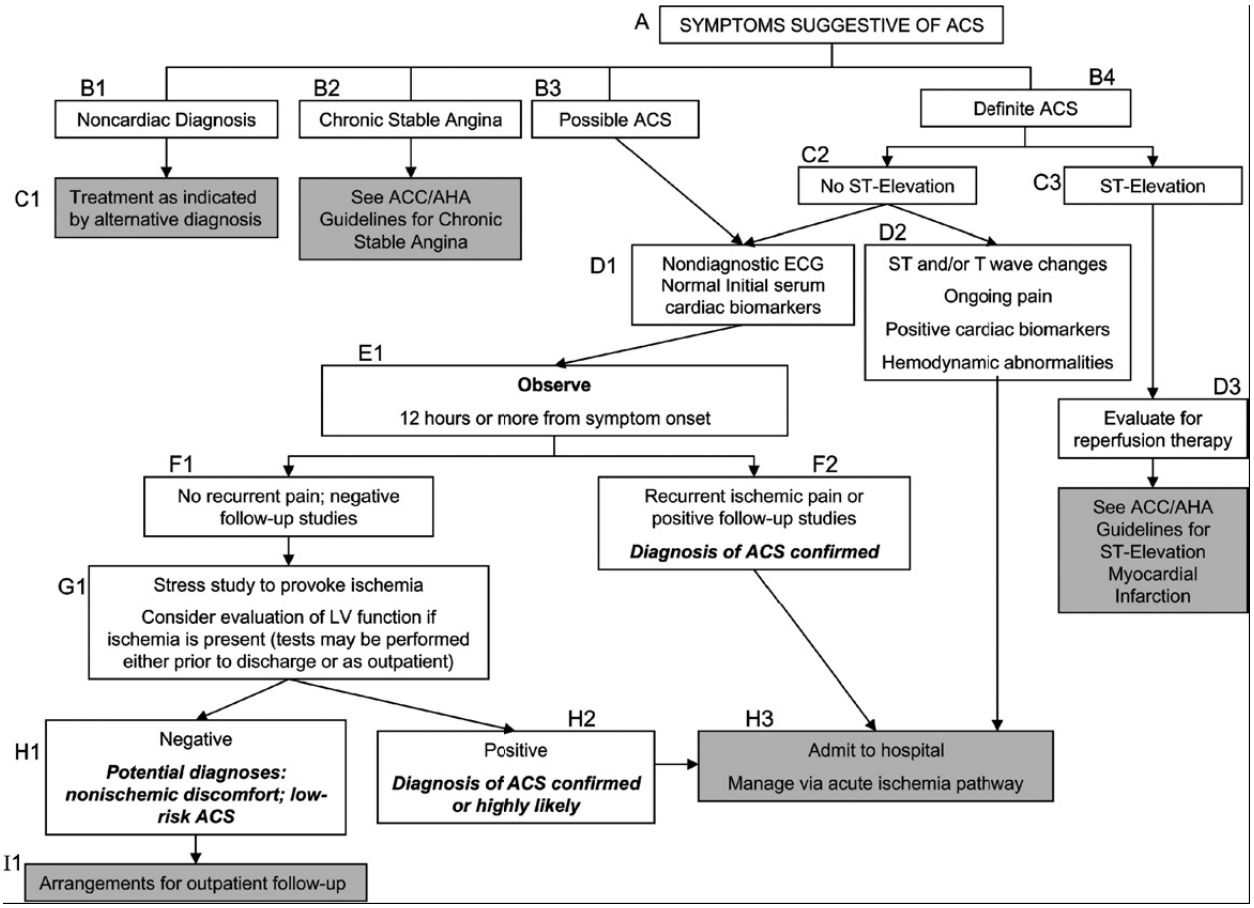


Table 6. Likelihood That Signs and Symptoms Represent an ACS Secondary to CAD

Feature	High Likelihood *Any of the following:*	Intermediate Likelihood *Absence of high-likelihood features and presence of any of the following:*	Low Likelihood *Absence of high- or intermediate-likelihood features but may have:*
History	Chest or left arm pain or discomfort as chief symptom reproducing prior documented angina Known history of CAD, including MI	Chest or left arm pain or discomfort as chief symptom Age greater than 70 years Male sex Diabetes mellitus	Probable ischemic symptoms in absence of any of the intermediate likelihood characteristics Recent cocaine use
Examination	Transient MR murmur, hypotension, diaphoresis, pulmonary edema, or rales	Extracardiac vascular disease	Chest discomfort reproduced by palpation
ECG	New, or presumably new, transient ST-segment deviation (1 mm or greater) or T-wave inversion in multiple precordial leads	Fixed Q waves ST depression 0.5 to 1 mm or T-wave inversion greater than 1 mm	T-wave flattening or inversion less than 1 mm in leads with dominant R waves Normal ECG
Cardiac markers	Elevated cardiac TnI, TnT, or CK-MB	Normal	Normal

Modified with permission from Braunwald E, Mark DB, Jones RH, et al. Unstable angina: diagnosis and management. Rockville, MD: Agency for Health Care Policy and Research and the National Heart, Lung, and Blood Institute, U.S. Public Health Service, U.S. Department of Health and Human Service, 1994. AHCPR publication no. 94-0602 (124).

ACS = acute coronary syndrome; CAD = coronary artery disease; CK-MB = MB fraction of creatine kinase; ECG = electrocardiogram; MI = myocardial infarction; MR = mitral regurgitation; TnI = troponin I; TnT = troponin T.

3. Unstable angina – Risk of short-term death

Reproduced from Anderson et al., 2007.

Table 7. Short-Term Risk of Death or Nonfatal MI in Patients With UA/NSTEMI*

Feature	High Risk *At least 1 of the following features must be present:*	Intermediate Risk *No high-risk feature, but must have 1 of the following:*	Low Risk *No high- or intermediate-risk feature but may have any of the following features:*
History	Accelerating tempo of ischemic symptoms in preceding 48 h	Prior MI, peripheral or cerebrovascular disease, or CABG; prior aspirin use	
Character of pain	Prolonged ongoing (greater than 20 min) rest pain	Prolonged (greater than 20 min) rest angina, now resolved, with moderate or high likelihood of CAD Rest angina (greater than 20 min) or relieved with rest or sublingual NTG Nocturnal angina New-onset or progressive CCS class III or IV angina in the past 2 weeks without prolonged (greater than 20 min) rest pain but with intermediate or high likelihood of CAD (see Table 6)	Increased angina frequency, severity, or duration Angina provoked at a lower threshold New onset angina with onset 2 weeks to 2 months prior to presentation
Clinical findings	Pulmonary edema, most likely due to ischemia New or worsening MR murmur S_3 or new/worsening rales Hypotension, bradycardia, tachycardia Age greater than 75 years	Age greater than 70 years	
ECG	Angina at rest with transient ST-segment changes greater than 0.5 mm Bundle-branch block, new or presumed new Sustained ventricular tachycardia	T-wave changes Pathological Q waves or resting ST-depression less than 1 mm in multiple lead groups (anterior, inferior, lateral)	Normal or unchanged ECG
Cardiac markers	Elevated cardiac TnT, TnI, or CK-MB (e.g., TnT or TnI greater than 0.1 ng per ml)	Slightly elevated cardiac TnT, TnI, or CK-MB (e.g., TnT greater than 0.01 but less than 0.1 ng per ml)	Normal

*Estimation of the short-term risks of death and nonfatal cardiac ischemic events in UA (or NSTEMI) is a complex multivariable problem that cannot be fully specified in a table such as this; therefore, this table is meant to offer general guidance and illustration rather than rigid algorithms. Adapted from AHCPR Clinical Practice Guidelines No. 10, Unstable Angina: Diagnosis and Management, May 1994 (124).

CABG = coronary artery bypass graft surgery; CAD = coronary artery disease; CCS = Canadian Cardiovascular Society; CK-MB = creatine kinase, MB fraction; ECG = electrocardiogram; MI = myocardial infarction; MR = mitral regurgitation; NTG = nitroglycerin; TnI = troponin I; TnT = troponin T; UA/NSTEMI = unstable angina/non–ST-elevation myocardial infarction.

3. Chronic Stable Angina

Reproduced from Gibbons et al., 2002.

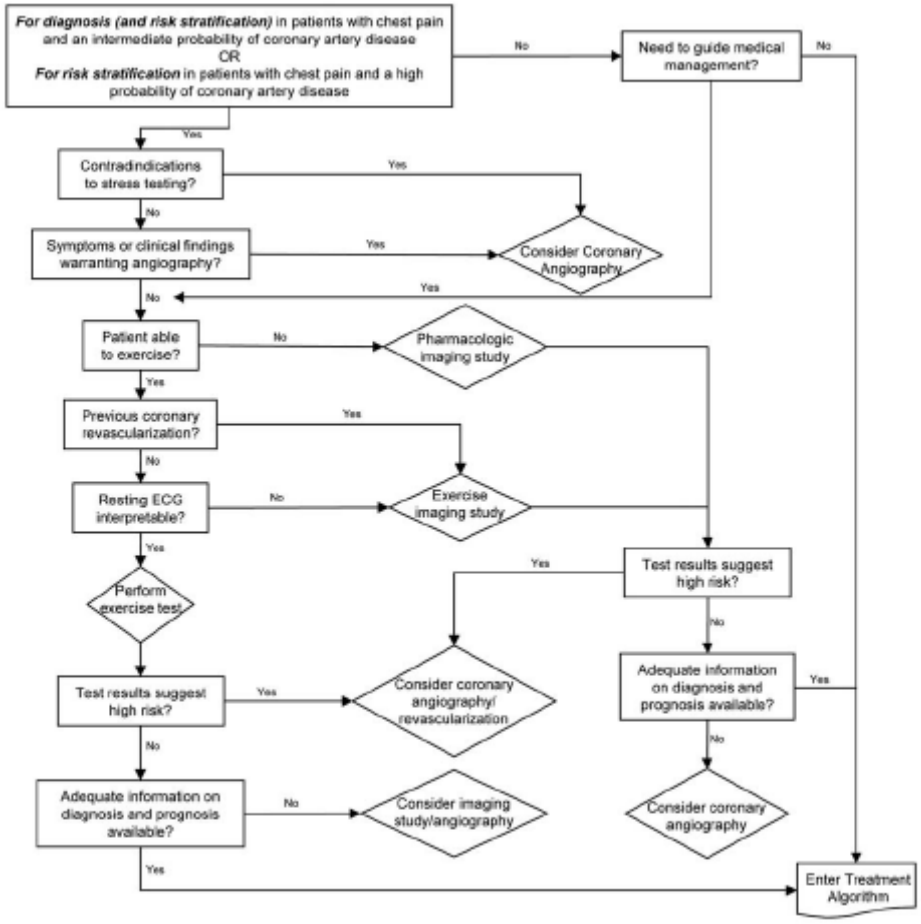


Figure 3. Stress testing/angiography. ECG indicates electrocardiogram.

4. Cardiovascular Imaging Quality Framework

Reproduced from Douglas et al., 2006.

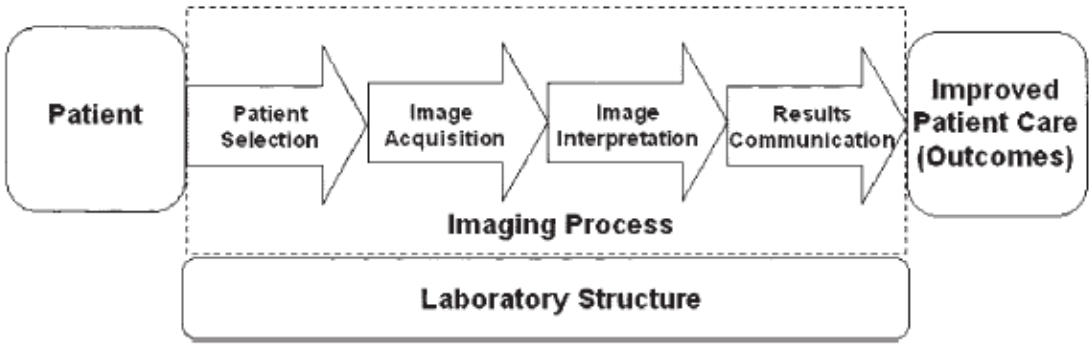


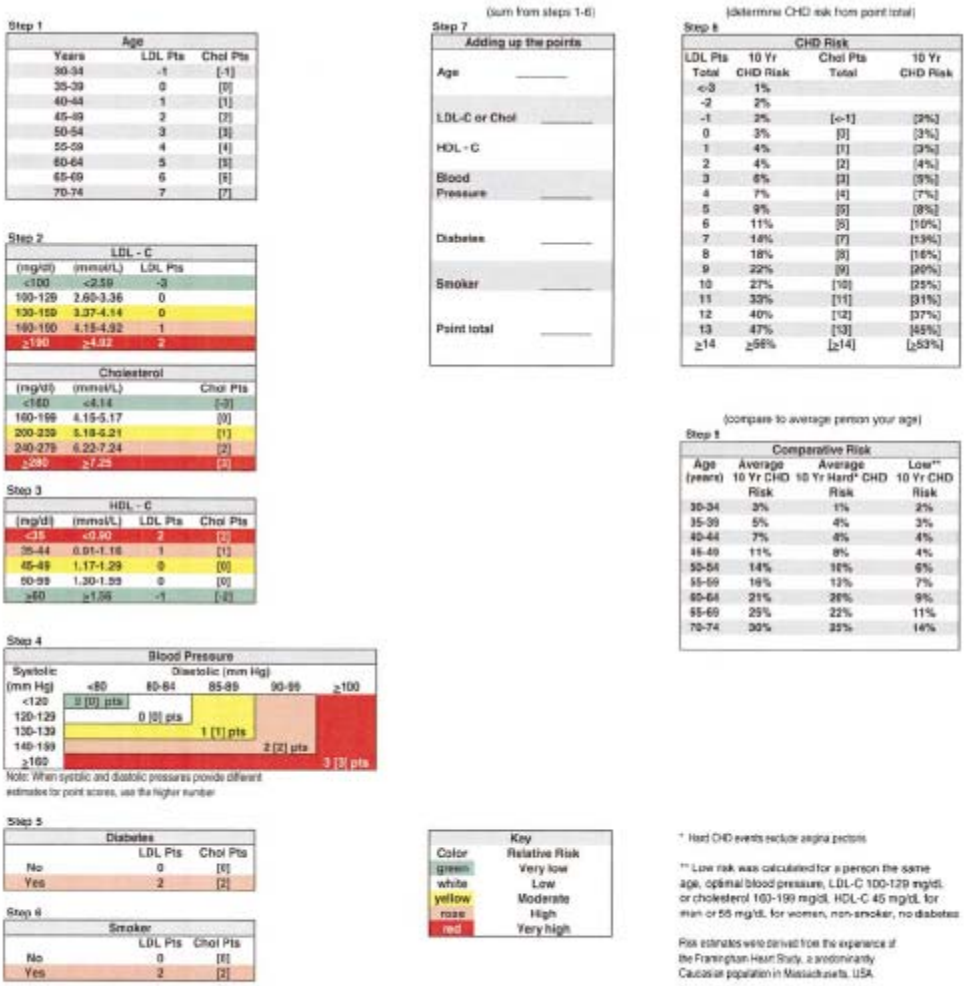
Figure 1. Dimensions of care framework for evaluating quality of cardiovascular imaging.

Table 2. Quality Goals and Action Items in the "Dimensions of Care" Framework for Cardiovascular Imaging

	Quality Goals	Action Items
Laboratory structure	Ensure baseline standards for equipment and staff proficiency	Mandate laboratory accreditation Develop physician training and certification requirements Support technologist certification Develop additional laboratory accreditation processes for all modalities
Patient selection	Appropriateness	Develop appropriateness criteria for all imaging modalities
Image acquisition	Diagnostic quality images Patient safety	Define key acquisition elements of imaging protocols and sequences
Image interpretation	Reproducibility Accuracy	Develop standard methods for determining inter-reader and intrareader variability
Results communication	Interpretability Clarity Definitiveness Completeness Timeliness	Develop timeliness criteria Develop standards for completeness and definitiveness Define key structured reporting data elements Create structured reports for all modalities
Improved patient care (outcomes)	Satisfaction Impact on clinical management Morbidity Mortality	Develop standard methods for determining cross-modality correlation Develop methods for measuring patient outcomes and impact on medical decision making

5. Framingham Risk Score

Reproduced from Wilson et al., 1998.



Step 1

Age			
	Years	LDL Pts	Chol Pts
	30-34	-1	[-1]
	35-39	0	[0]
	40-44	1	[1]
	45-49	2	[2]
	50-54	3	[3]
	55-59	4	[4]
	60-64	5	[5]
	65-69	6	[6]
	70-74	7	[7]

Step 2

LDL - C		
(mg/dl)	(mmol/L)	LDL Pts
<100	<2.59	-3
100-129	2.60-3.36	0
130-159	3.37-4.14	0
160-190	4.15-4.92	1
≥190	≥4.92	2

Cholesterol		
(mg/dl)	(mmol/L)	Chol Pts
<160	<4.14	[-3]
160-199	4.15-5.17	[0]
200-239	5.18-6.21	[1]
240-279	6.22-7.24	[2]
≥280	≥7.25	[3]

Step 3

HDL - C			
(mg/dl)	(mmol/L)	LDL Pts	Chol Pts
<35	<0.90	2	[2]
35-44	0.91-1.16	1	[1]
45-49	1.17-1.29	0	[0]
50-59	1.30-1.59	0	[0]
≥60	≥1.60	-1	[-2]

Step 4

Blood Pressure					
Systolic (mm Hg)	Diastolic (mm Hg)				
	<80	80-84	85-89	90-99	≥100
<120	2 [0] pts				
120-129		0 [0] pts			
130-139			1 [1] pts		
140-159				2 [2] pts	
≥160					3 [3] pts

Note: When systolic and diastolic pressures provide different estimates for point scores, use the higher number

Step 5

Diabetes		
	LDL Pts	Chol Pts
No	0	[0]
Yes	2	[2]

Step 6

Smoker		
	LDL Pts	Chol Pts
No	0	[0]
Yes	2	[2]

(sum from steps 1-6)

Step 7

Adding up the points	
Age	_____
LDL-C or Chol	_____
HDL - C	
Blood Pressure	_____
Diabetes	_____
Smoker	_____
Point total	_____

(determine CHD risk from point total)

Step 8

CHD Risk			
LDL Pts Total	10 Yr CHD Risk	Chol Pts Total	10 Yr CHD Risk
<-3	1%		
-2	2%		
-1	2%	[<-1]	[2%]
0	3%	[0]	[3%]
1	4%	[1]	[3%]
2	4%	[2]	[4%]
3	6%	[3]	[5%]
4	7%	[4]	[7%]
5	9%	[5]	[8%]
6	11%	[6]	[10%]
7	14%	[7]	[13%]
8	18%	[8]	[16%]
9	22%	[9]	[20%]
10	27%	[10]	[25%]
11	33%	[11]	[31%]
12	40%	[12]	[37%]
13	47%	[13]	[45%]
≥14	≥56%	[≥14]	[≥53%]

(compare to average person your age)

Step 9

Comparative Risk			
Age (years)	Average 10 Yr CHD Risk	Average 10 Yr Hard* CHD Risk	Low** 10 Yr CHD Risk
30-34	3%	1%	2%
35-39	5%	4%	3%
40-44	7%	4%	4%
45-49	11%	8%	4%
50-54	14%	10%	6%
55-59	16%	13%	7%
60-64	21%	26%	9%
65-69	25%	22%	11%
70-74	30%	25%	14%

Key	
Color	Relative Risk
green	Very low
white	Low
yellow	Moderate
rose	High
red	Very high

* Hard CHD events exclude angina pectoris

** Low risk was calculated for a person the same age, optimal blood pressure, LDL-C 100-129 mg/dl, or cholesterol 160-199 mg/dl, HDL-C 45 mg/dL for men or 55 mg/dL for women, non-smoker, no diabetes

Risk estimates were derived from the experience of the Framingham Heart Study, a predominantly Caucasian population in Massachusetts, USA

Figure 3. CHD score sheet for men using TC or LDL-C categories. Uses age, TC (or LDL-C), HDL-C, blood pressure, diabetes, and smoking. Estimates risk for CHD over a period of 10 years based on Framingham experience in men 30 to 74 years old at baseline. Average risk estimates are based on typical Framingham subjects, and estimates of idealized risk are based on optimal blood pressure, TC 160 to 199 mg/dL (or LDL 100 to 129 mg/dL), HDL-C of 45 mg/dL in men, no diabetes, and no smoking. Use of the LDL-C categories is appropriate when fasting LDL-C measurements are available. Pts indicates points.

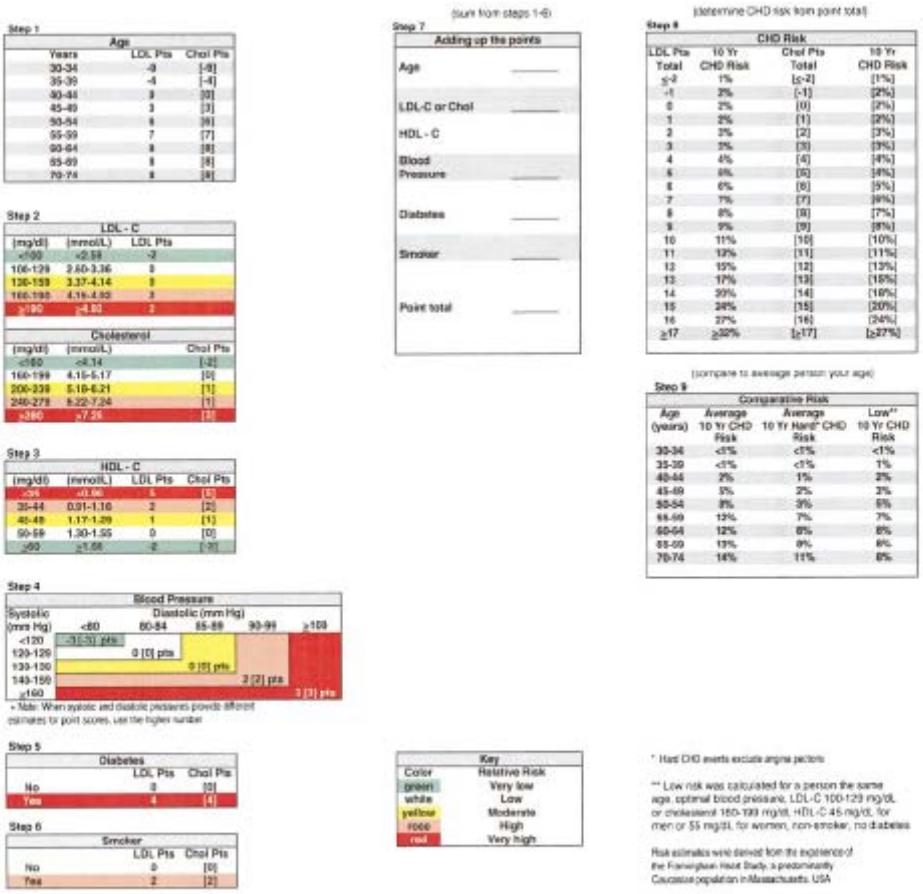


Figure 4. CHD score sheet for women using TC or LDL-C categories. Uses age, TC, HDL-C, blood pressure, diabetes, and smoking. Estimates risk for CHD over a period of 10 years based on Framingham experience in women 30 to 74 years old at baseline. Average risk estimates are based on typical Framingham subjects, and estimates of idealized risk are based on optimal blood pressure, TC 160 to 199 mg/dL (or LDL 100 to 129 mg/dL), HDL-C of 55 mg/dL in women, no diabetes, and no smoking. Use of the LDL-C categories is appropriate when fasting LDL-C measurements are available. Pts indicates points.

6. Radiation Information from the FDA (http://www.fda.gov/cdrh/ct/risks.html).

What are the Radiation Risks from CT?

As in many aspects of medicine, there are both benefits and risks associated with the use of CT . The main risks are those associated with

1. abnormal test results, for a benign or incidental finding, leading to unneeded, possibly invasive, follow-up tests that may present additional risks and
2. the increased possibility of cancer induction from x-ray radiation exposure.

The probability for absorbed x rays to induce cancer is thought to be very small for radiation doses of the magnitude that are associated with CT procedures. Such estimates of the cancer risk from x-ray exposure have a broad range of statistical uncertainty and there is some scientific controversy regarding the effects from very low doses and dose rates as discussed below. Under some rare circumstances of prolonged, high-dose exposure, x rays can cause other adverse health effects, such as skin erythema (reddening), skin tissue injury, genetic effects, and birth defects. But at the exposure levels associated with most medical imaging procedures, including CT, these other adverse effects would not occur.

Because of the rapidly growing use of pediatric CT and the potential for increased radiation exposure to children undergoing these scans, special considerations should be applied when using pediatric CT. Doses from a single pediatric CT scan can range from about 5 mSv to 60 mSv. Among children who have undergone CT scans, approximately one-third have had at least three scans. The National Cancer Institute and The Society for Pediatric Radiology developed a brochure, *Radiation Risks and Pediatric Computed Tomography: A Guide for Health Care Providers*, and the FDA issued a Public Health Notification, *Reducing Radiation Risk from Computed Tomography for Pediatric and Small Adult Patients*, that discuss the value of CT and the importance of minimizing the radiation dose, especially in children.

Risk Estimates

In the field of radiation protection, it is commonly assumed that the risk for adverse health effects from cancer is proportional to the amount of radiation dose absorbed and the amount of dose depends on the type of x-ray examination. A CT examination with an effective dose of 10 millisieverts (abbreviated mSv; 1 mSv = 1 mGy in the case of x rays.) may be associated with an increase in the possibility of fatal cancer of approximately 1 chance in 2000. This increase in the possibility of a fatal cancer from radiation can be compared to the natural incidence of fatal cancer in the U.S. population, about 1 chance in 5. In other words, for any one person the risk of radiation-induced cancer is much smaller than the natural risk of cancer. Nevertheless, this small increase in radiation-associated cancer risk for an individual can become a public health concern if large numbers of the population undergo increased numbers of CT screening procedures of uncertain benefit.

It must be noted that there is uncertainty regarding the risk estimates for low levels of radiation exposure as commonly experienced in diagnostic radiology procedures. There are some that question whether there is adequate evidence for a risk of cancer induction at low doses. However, this position has not been adopted by most authoritative bodies in the radiation protection and medical arenas.

Radiation Dose

The effective doses from diagnostic CT procedures are typically estimated to be in the range of 1 to 10 mSv. This range is not much less than the lowest doses of 5 to 20 mSv received by some of the Japanese survivors of the atomic bombs. These survivors, who are estimated to have experienced doses only slightly larger than those encountered in CT, have demonstrated a small but increased radiation-related excess relative risk for cancer mortality.

Radiation dose from CT procedures varies from patient to patient. A particular radiation dose will depend on the size of the body part examined, the type of procedure, and the type of CT equipment and its operation. Typical values cited for radiation dose should be considered as estimates that cannot be precisely associated with any individual patient, examination, or type of CT system. The actual dose from a procedure could be two or three times larger or smaller than the estimates. Facilities performing "screening" procedures may adjust the radiation dose used to levels less (by factors such as 1/2 to 1/5 for so called "low dose CT scans") than those typically used for diagnostic CT procedures. However, no comprehensive data is available to permit estimation of the extent of this practice and reducing the dose can have an adverse impact on the image quality produced. Such reduced image quality may be acceptable in certain imaging applications.

The quantity most relevant for assessing the risk of cancer detriment from a CT procedure is the "effective dose" . Effective dose is evaluated in units of millisieverts (abbreviated mSv; 1 mSv = 1 mGy in the case of x rays.) Using the concept of effective dose allows comparison of the risk estimates associated with partial or whole-body radiation exposures. This quantity also incorporates the different radiation sensitivities of the various organs in the body.

Estimates of the effective dose from a diagnostic CT procedure can vary by a factor of 10 or more depending on the type of CT procedure, patient size and the CT system and its operating technique. A list of representative diagnostic procedures and associated doses are given in Table 1 that is adapted from a report of the European Commission.

Table I. - Radiation Dose Comparison

Diagnostic Procedure	Typical Effective Dose (mSv)[1]	Number of Chest X rays (PA film) for Equivalent Effective Dose[2]	Time Period for Equivalent Effective Dose from Natural Background Radiation[3]
Chest x ray (PA film)	0.02	1	2.4 days
Skull x ray	0.07	4	8.5 days
Lumbar spine	1.3	65	158 days
I.V. urogram	2.5	125	304 days
Upper G.I. exam	3.0	150	1.0 year
Barium enema	7.0	350	2.3 years
CT head	2.0	100	243 days
CT abdomen	10.0	500	3.3 years

1. Effective dose in millisieverts (mSv).

2. Based on the assumption of an average "effective dose" from chest x ray (PA film) of 0.02 mSv.

3. Based on the assumption of an average "effective dose" from natural background radiation of 3 mSv per year in the United States.