Chest Radiography Screening Assessment Manual

Introduction

Plain chest radiography (CR) is an essential tool for health screening that requires low-dose exposure. Moreover, it is affordable and is convenient to perform. It facilitates the simultaneous visualization of the whole thoracic region, thereby immediately identifying the status of the lungs, mediastinum, and thorax and obtaining partial information of the neck and abdomen. CR reduces the number of deaths from lung cancer if it is performed accurately.[1-5]

There have been great progress in chest radiography since 2002 after the previous guideline was published[6]: prevailing digital imaging, such as CR, followed by filmless radiology at a later time.[7] In 2008, a questionnaire research performed on 514 member institutions of the Japan Society of Ningen Dock, where 267 institutions submitted the responses, indicated that digital imaging and filmless radiology were performed in 77.2% and 53.6% of institutions, respectively. Further use of such tools is expected at present.

In relation to such result, low-dose computed tomography (CT) lung scan for the screening of cancer is carried out nationwide.[8,9] Chest radiography screening and low-dose CT both rely on advances in digital technology. The prevalence of digital imaging in plain radiography has resulted in improved image quality and uniformization. In digital imaging, radiographic images are generated on films or displays with their density and automatic adjustment of contrast, resulting in good image quality without being significantly affected by radiograph conditions, which is contrary to the film-screen system. That is, low-quality radiographs that were considered as “a white rabbit in a snowy mountain” or “a crow in the dark” are almost obsolete. Although that is gladsome as a result of scientific advancement, on the other hand, radiographs indicating lowered lung field density (increasing blackness) that reflects pulmonary hyperinflation in typical chronic pulmonary emphysema rarely emerges now.

Although we are in an era in which uniform images can be easily obtained with good generality, an imaging condition that do no not overlook nodules is still important. Imaging with an exposure voltage of approximately 130 kVp in combination with a high-voltage Lysholm grid is advantageous as it can easily recognize shadows overlapping with bone/mediastinal shadows with lowered contrast. Radiograph conditions should be adjusted with a high voltage if possible. In filmless radiology, the use of a 3-megapixel display that matches the pixel number of the chest radiographic image is preferred. Positioning during radiography is also important, which include opening and closing the scapulae, which has a significant impact on the accuracy of interpretation.

Based on the TNM classification for lung cancer, T1 is defined as a mass ≤3 cm in size.[10] When this category is divided in two and compared with each other (T1a [≤2 cm] and T1b [2<, ≤3 cm]), the T1a group with smaller masses has better prognosis, with 10-year survival rates of 90.3% and 81.5%, respectively.[11] According to previous reports, the lung lesions detected in low-dose CT scan for the screening of lung cancer measured 1–2 cm,[12-15] which is associated with the best prognosis. By contrast, the mean size of the masses detected on plain radiography measured 3–4 cm, which include those overlapping with the mediastinum or other shadows. Nodal shadows in the lung field can be recognized with a tumor diameter of about 1 cm on radiographs obtained in good conditions. Thus, we should also work to achieve a high goal of diagnosing lung cancers as early as possible from plain radiography.

To achieve this goal, physicians with specialized knowledge must double check the radiographic images with correct positioning, in addition to ensuring that such images are of high quality, and they must confirm and describe changes, such as an increase or decrease in shadows via image comparisons if previous images are available. An accuracy management system supported by such technical and systematic improvement must be established.

Review of FY2002 Guideline

This manual aimed to revise the previous "Guidelines for Assessment of Health Screening Results and Post Hoc Instruction"[6] published in FY2002.

Terms of the sites (Table 1-1)

"Diaphragmatic area of the lung" is added as pleural plaques were observed in the diaphragmatic area of the lung. Because the images were obtained while the individual was in posteroanterior and lateral positions during health screenings and the findings in the "lateral view" may be described, the term "lateral view" is added to the terms of sites, and a schema of the lateral view is used as reference for interpretation.
"V. Extrapulmonary findings" is moved to the right field and indicated as "9. Extrapulmonary findings."
Although there was a dispute of whether to omit the "apical area" and integrate it into the "upper lung field" in light of the description mode of CT scan findings, we concluded that the "apical area" would be left on chest radiography because tuberculosis often occurs in this site and it has a historical significance.

Terms of findings (Table 2)

The previous items were changed in terms of their categories, terminological issues, frequency of use, overlaps between Findings field and Disease term field, and need for the addition of new items.

1) Items moved to another category

Three items in [Airway lesions], namely, "bulla or cystic shadows," "enhanced transparency in the lung field," and "pulmonary hyperinflation," were moved to [Intrapulmonary lesions] to improve consistency.

2) Changes in literal items

"Isolated nodular shadow" → "Nodular shadow:" to be simpler and more versatile. Used for shadows ≤3 cm in size.
"Round shadow" → "Tumor shadow" to contrast with and supplement nodular shadow
"Cavitary shadow" → "Cavity shadow:" simplified term (in Japanese)
"Localized infiltrative shadow" → "Infiltrative shadow"
"Linear/thick linear shadows" → Divided into "linear shadow" and "thick linear shadow"
"Shadow of cured inflammation" → "Scar shadow"
"Silhouette sign" → Written in Japanese characters
"Dilatation of pulmonary arterial trunk" → "Pulmonary arterial dilatation:" for versatility
"Abnormal pulmonary vascular shadow" → "Abnormal pulmonary vascular route:" scimitar syndrome, pulmonary arteriovenous fistula, pulmonary sequestration, etc.

“Bulla or cystic shadow” → “Cystic shadow (bulla)”

“Round back/scoliosis” → Divided into “scoliosis” and “round back”

“Pacemaker device” → “Medical devices”: pacemaker, ICD (Implantable Cardioverter Defibrillators), and CRT-D (Cardiac Resynchronization Therapy)

3) Deleted items

“Diffuse reticular shadows”

“Enhanced transparency in the lung field” was deleted because it is challenging to recognize on digital images.

“Tumor shadow in the thoracic wall” was deleted from [Thorax/thoracic wall lesions] because it is extremely rare.

4) Additional items

“Reticular shadows,” “decreasing pulmonary vascular shadows,” “pleural plaque,” “esophageal hiatus hernia,” “spinal compression fracture,” and “stenting” were added. [Hilar diseases] are newly defined and included “hilar lymphadenopathy” and “pulmonary arterial dilatation.” “Lymph node calcification” was added to [Others].

5) Items moved from Disease term field

“Inverted organs” were corrected as “visceral inversion” and moved to the Findings field.

“Post-breast operation” was moved from the Disease term field to [Postoperative change]. It corresponds to total/partial mastectomy.

Disease terms (Table 3)

Similar to the Findings field, the previous items were changed in terms of their categories, terminological issues, frequency of use, overlaps between the Findings field and Disease term field, and need for the addition of new items.

1) Items moved to the Findings field

As described in 2) E), “inverted organs” were corrected as “visceral inversion” and were moved to the Findings field. “Post-breast operation” and “postoperative change” were moved to the Findings field to [Postoperative changes] for integration.

2) Changes in literal items

“Lung benign tumor” → “Benign lung tumor”

“Interstitial pneumonia (pulmonary fibrosis)” → “Interstitial pneumonia/pulmonary fibrosis”: morphologic findings regardless of the cause.

“Pneumoconiosis” → “Pneumoconiosis (e.g., asbestosis and silicosis)”

3) Deleted items

"Round back/scoliosis," "funnel chest," "azygos lobe," "right aortic arch," and "dextrocardia" were deleted because they overlap with the items in the Findings field.

"Cardiac hypertrophy" and "valvular heart diseases" were deleted because they cannot be assessed on chest radiogram. An enlarged medical finding was described as "enlarged cardinal shadow."

4) Additional items

"Nontuberculous mycobacteriosis" and "pulmonary aspergillosis": both were added below "pulmonary tuberculosis."

"Pleural mesothelioma" was added to [Pleural lesion].

5) Items that were considered for addition

"Pulmonary edema" described in the International Classification of Diseases, Tenth Revision (ICD-10) is not indicated as an item, and similar findings will be classified as "cardiac failure."

Parallel description of disease terms along with the terms of findings

In the health screening phase, it is usually challenging to obtain a definite diagnosis from abnormal findings detected during screening. Therefore, disease terms are not often used as radiographic findings in the health screening phase. However, if a suspected pathological condition requires an immediate thorough examination or treatment, such as pulmonary tuberculosis, lung abscess, and lung cancer with "cavitary shadow" or acute pneumonia with "infiltrative shadow," diseases terms may be described along with findings, such as "suspected cavitary shadow/pulmonary tuberculosis" to encourage a client to undergo a thorough examination.

Findings/disease terms should be presented in a manner that the clients will understand. However, in such cases, the use of disease terms will likely cause anxiety. For example, the use of the term "lung cancer" should be considered prudently. In addition, one should consider selecting a disease term to be presented that corresponds to the obtained finding, which includes disease terms, such as pulmonary tuberculosis/old inflammation/lung cancer for a nodular shadow. Thus, the client will not experience extreme anxiety. Presenting multiple suspected disease terms for one finding should be avoided.

For coordination with blood test data, infiltrative shadow on a radiographic image along with advanced CRP (C-reactive protein) value is likely to indicate pneumonia. However, whether blood test data can be immediately obtained while interpreting radiographic images differs according to the system in each institution, and it is challenging to unify. However, clinical symptoms must be considered, and blood test data should be assessed if available when making assessments.

Although disease terms could be matched with ICD codes, health screening can only present suspected disease terms, and real-time diagnosis cannot be made in many cases.

Assessment categories

Characteristics of the assessment categories

For assessment categories, the status of diagnosis and treatment may differ according to the timing of

medical checkup even for the same finding with the same disease term particularly in repeaters. In a new patient or a patient with a newly developed finding, it seems to be relatively easy to unify assessment categories. Even in a new patient, it is likely that the category may be selected taking into consideration the findings, clinical symptoms, blood test data, and policy of the institution. For example, if "pneumonia" is suspected, the result could be "D2," which indicates the need for thorough examination and treatment, "D1," which requires direct treatment, or "D," which includes both intentions. Thus, it is unrealistic to define uniform assessment categories.

For other items, extremely mild "scoliosis" is often encountered in routine clinical practice, and it may be better than the abovementioned criterion, which is the condition considered as the finding. The School Health Act defines the criterion for scoliosis as ≥15º of lateral curvature of the spine, and a criterion ≥20º may be used in adults. In addition, "enlarged cardiac shadow" is generally diagnosed when the cardiothoracic ratio of an individual is ≥50%. However, the website of Disability Pension Hot Line shows that the Recipient Qualification for Disability Pension includes individuals "older than 20 years" and those with "CTR ≥60%." However, the Recipient Qualification is comprehensively assessed based on activities of daily living and other test results. Findings that include "D2" should be selected based on a comprehensive consideration.

"Diaphragmatic elevation" may be initiated due to the accumulation of visceral fat, and disease category correlated to lifestyle improvement can be considered.

Introduction of risk factors

In view of how to reflect the disease categories to secondary disease prevention, the risk factor should be actively introduced to assessment categories. In clients with pulmonary diseases with high incidence of complication due to lung cancer, such as pulmonary cyst (bulla), chronic obstructive pulmonary disease (COPD), interstitial pneumonia, etc., resulting to need for chest CT scan may be useful for the early detection of lung cancer, which can be detected with low-dose CT scan. The concurrent use of chest CT scan with information collected via medical interview, such as smoking, medical, occupational, and family history, is also useful.

In low-dose CT scan for the screening of lung cancer, findings, such as COPD, have a strong impact on patients; therefore, they are considered more receptive to the recommendation of smoking secession than recommendation provided in usual health screening, with the expectation of secondary prevention by smoking secession.

It would be expected in the future that the introduction of risk factors into the assessment categories would have a favorable effect on the secondary prevention of lung cancer.

If the number of COPD cases continuously increases, then there will be a problem regarding on how to deal with the additional steps in the workflow of assessment. However, as the health screening system is used nationwide, the different medical interview data will be ready for use while interpreting chest radiographs in the future, thereby resolving the current problems.

Conclusion

Based on the abovementioned discussions, the manual has been revised with amendments in the sites of

findings, terms of findings, disease terms, and assessment categories.

1. Sites of findings

The basic structure was not changed with the addition of “lateral side” and “diaphragmatic area of the lung” in the table. A schema of the lateral view has been prepared as a reference for interpretation.

2. Terms of findings/disease terms

Based on the board discussion, some terms have been revised/added, and deletion has been proposed. Some categories have been revised/moved, which include cystic shadow, and some terms have been moved from the Disease term field to the Findings field.

3. Assessment categories

For assessment categories, the status of diagnosis and treatment may differ according to the timing of medical checkup even for the same finding with the same disease term particularly in repeaters. Even in a new client or a client with a newly developed finding, it is likely that the category may be selected considering the findings, clinical symptoms, blood test data, policy of the institution, etc.; thus, it seems unrealistic to narrow down to a specific assessment category.

4. Introduction of risk factors to assessment categories

Although positive opinions were presented in the board discussion, for the introduction, whether the health screening systems facilitate the identification of requirements, such as smoking habits, medical history, occupational history, family history, etc. on the site during interpretation of radiograms is quite important. Considering the future status, health screening systems with such features can be used nationwide.

As a reference, the literature included in “pulmonary complications” in the Diagnosis and Treatment Guideline for COPD version 4 2013 that was edited by the Japanese Respiratory Society and listed at the end of the current document.

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I-H-2. lung cancer

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I-H-2. Pulmonary fibrosis associated with emphysema

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Table 1 Description of the results

Table 1-1 Site of the findings

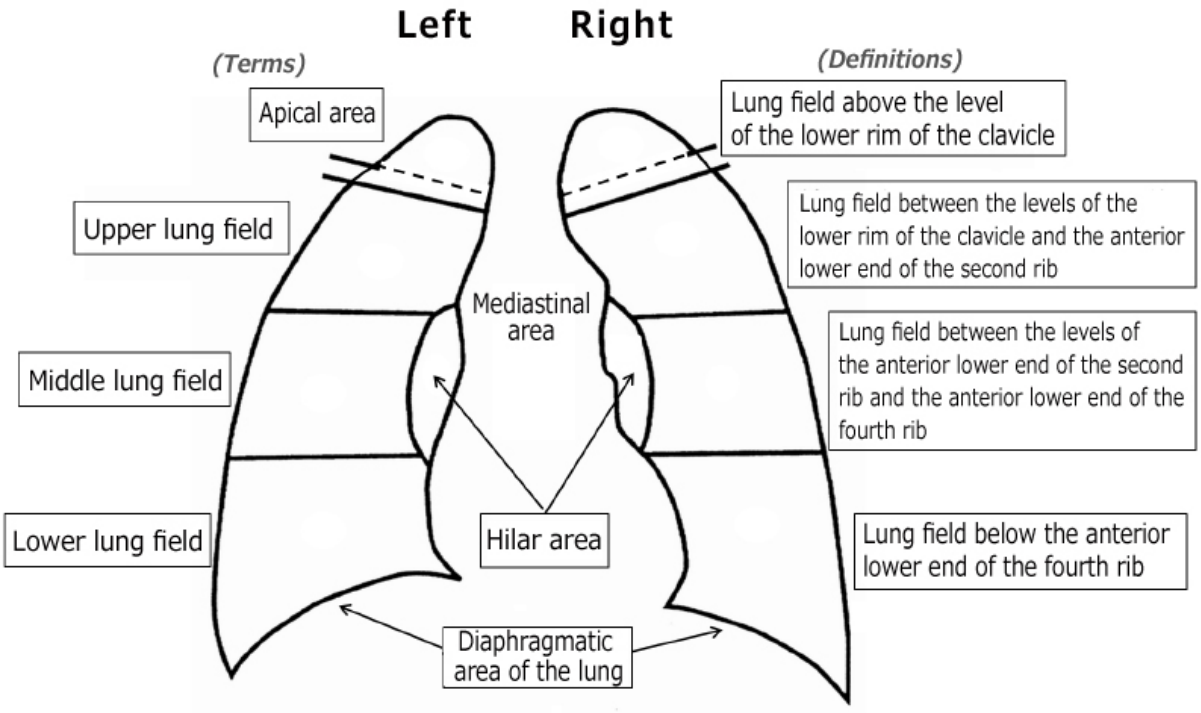
I Right	1. Apical area
II Left	2. Upper lung field
III Bilateral	3. Middle lung field
IV Lateral (newly added)	4. Lower lung field
	5. Whole lung field
	6. Hilar area
	7. Mediastinal area
	8. Diaphragmatic area of the lung (new)
	9. Extrapulmonary area

Table 1-2 Definition of the assessment category

A	Normal
B	Mild abnormality
C	Need for follow-up (specify the retest period)
D	Need for medical care
D1	Need for treatment
D2	Need for a thorough examination
E	Under treatment

Table 1-3 Description of interpretation/assessment

Site of findings		Findings	Diagnosis/suspected disease		Assessment Category
				a. Suspected	
				b. Definite	
				a. Suspected	
				b. Definite	
				a. Suspected	
				b. Definite	


Left
Right
(Terms)
(Definitions)
Apical area
Lung field above the level of the lower rim of the clavicle
Upper lung field
Lung field between the levels of the lower rim of the clavicle and the anterior lower end of the second rib
Mediastinal area
Middle lung field
Lung field between the levels of the anterior lower end of the second rib and the anterior lower end of the fourth rib
Lower lung field
Hilar area
Lung field below the anterior lower end of the fourth rib
Diaphragmatic area of the lung

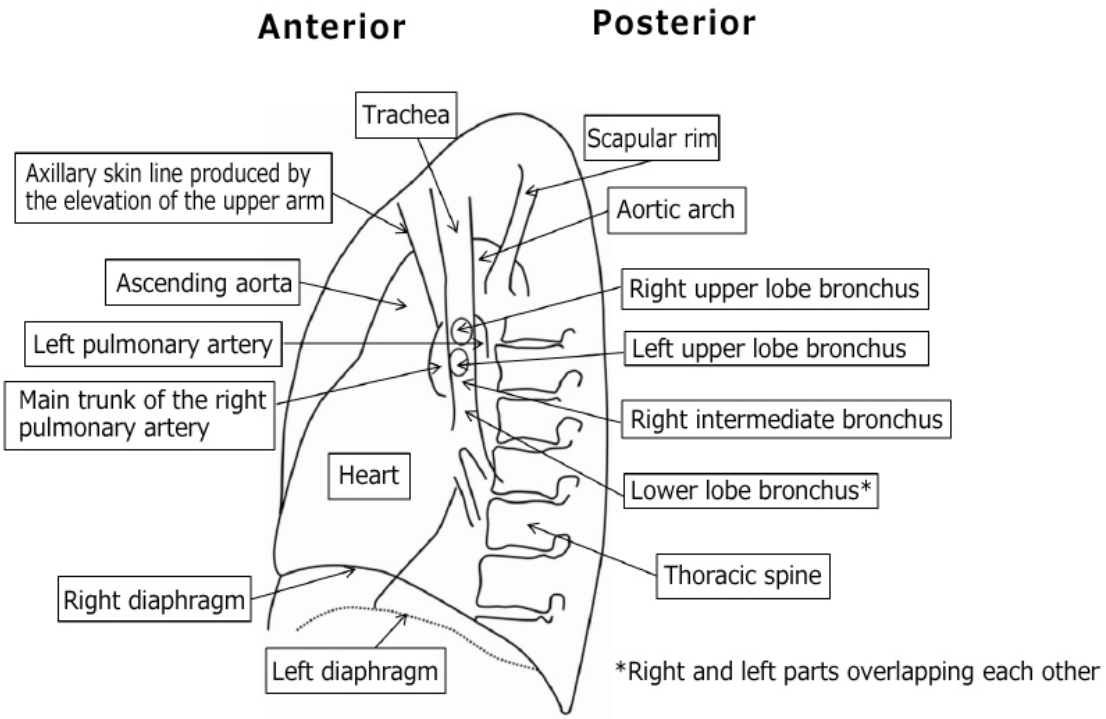

Anterior
Posterior
Trachea
Scapular rim
Axillary skin line produced by the elevation of the upper arm
Aortic arch
Ascending aorta
Right upper lobe bronchus
Left pulmonary artery
Left upper lobe bronchus
Main trunk of the right pulmonary artery
Right intermediate bronchus
Heart
Lower lobe bronchus*
Thoracic spine
Right diaphragm
Left diaphragm
*Right and left parts overlapping each other

Table 2 Findings

Findings	Category
[Intrapulmonary lesions]	
Nodular shadow	D2
Tumor shadow	D2
Cavitary shadow	D2
Infiltrative shadow	D2
Linear shadow	B
Thick linear shadow	C, D2
Scar shadow	B
Calcification shadow	B
Atelectasis	D2
Silhouette sign	D2
Increased markings	B, C
Abnormal vascular route	B, D2
Decreasing pulmonary vascular shadow	B, D2
Multiple nodular shadows	D2
Patchy shadow	D2
Granular shadows	D2
Reticular shadows	D2
Multiple annular shadows	D2
Cystic shadow (bulla)	C, D2
Pulmonary hyperinflation	D2
[Hilar diseases]	
Hilar lymphadenopathy	D2
Pulmonary arterial dilatation	C, D2
[Airway lesions]	
Tracheostenosis	D2
Tracheal deviation	D2
Bronchial wall thickening	C, D2
Bronchiectasis	C, D2
[Mediastinal lesions]	
Mediastinal tumor shadow	D2
Mediastinal enlargement	D2
Mediastinal lymphadenopathy	D2
Mediastinal emphysema	D2
Mediastinal calcification	B
Esophageal hiatus hernia	B, C

[Pleural lesions]	
Pleural effusion	D2
Pneumothorax	D2
Pleural tumor shadow	D2
Pleural thickening	B
Pleural adhesion	B
Pleural calcification	B, D2
Pleural plaque	D2
[Diaphragmatic lesions]	
Diaphragmatic hernia	D2
Diaphragmatic elevation	B
Diaphragmatic tumor shadow	D2
[Rib lesions]	
Rib tumor shadow	D2
Broken rib shadow	D2
Rib bone sclerosis	B
Rib bone island	B
Rib fracture/post-rib fracture	B
Rib malformation/deformity	B
[Thorax/chest wall lesions]	
Scoliosis	B
Round back	B
Funnel chest	B
Osteoarthritis of the spine	B
Spinal compression fracture	C, D2
Thoracic deformity	B
Clavicle fracture/post-clavicle fracture	B
Abnormal clavicle shadow	C, D2
[Cardiac/large vascular lesions]	
Enlarged cardiac shadow	C, D2
Aortic dilatation	D2
Aortic arch protrusion	B
Aortic tortuosity	B
Aortic calcification shadow	B
[Congenital lesions]	
Azygos lobe	B
Right aortic arch	B
Dextrocardia	B

Visceral inversion	B
[Postoperative changes]	
Post-thoracoplasty	B
Post-lobectomy/pneumonectmy	B
Post-pneumothorax	B
Post-sternal splitting incision	B
Postoperative change	B
Post-breast operation	B
[Others]	
Lymph node calcification	B
Foreign body	B, C
Remaining contrast medium	B
Medical devices	B
Stenting	B
Shunt tube	B
No abnormal findings	A

Table 3 Disease term

Disease term	Category
[Intrapulmonary lesions]	
Pneumonia	D2, D1
Pulmonary suppuration	D2, D1
Pulmonary tuberculosis	D2, D1
Nontuberculous mycobacteriosis	D2, D1
Pulmonary aspergillosis	D2, D1
Pulmonary tumor	D2, D1
Metastatic pulmonary tumor	D2, D1
Benign lung tumor	B
Interstitial pneumonia/pulmonary fibrosis	D2, D1
Pneumoconiosis (e.g., asbestosis and silicosis)	D2, D1
Sarcoidosis	D2, D1
Old pulmonary tuberculosis	C
Old lung lesion	B
Pulmonary emphysema	C, D2
Pulmonary cystic disease	C, D2
[Airway lesions]	
Chronic bronchitis	D2, D1
Diffuse panbronchiolitis	D2, D1

Bronchiectasis	D2, D1
Middle lobe syndrome	D2, D1
[Mediastinal lesions]	
Mediastinal tumor	D2
Mediastinal emphysema	D2
[Pleural lesions]	
Pleurisy (pleural effusion)	D2
Pneumothorax	D2
Pleural tumor	D2
Prior pleurisy	BC
Pleural mesothelioma	D2, D1
[Diaphragmatic lesions]	
Diaphragmatic eventration	B
Diaphragmatic tumor	D2
[Rib lesion]	
Rib tumor	D2
[Thorax/chest wall lesion]	
Chest wall tumor	D2
[Cardiovascular lesions]	
Aortic aneurysm	D2
Arteriosclerosis	C
Cardiac failure	D2

Japan Society of Ningen Dock

Chest Radiography Screening Assessment Committee

Chief Commissioner **Hirotaka Takizawa** (Kashiwado Memorial Foundation)

Members **Hitoshi Sasamori** (Makita General Hospital)

Ikko Hashizume (Hamamatsu Medical Center)

Masayuki Hatakeyama (Nara City Medical Association)

External Evaluation Committee Members

Katsushi Kurosu (Chiba University Hospital)

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