ABSTRACT

**Purpose** To assess whether multiphasic health testing and services (MHTS) using low-dose spiral CT can contribute to detecting small and early lung cancer, and subsequently decrease mortality.

**Methods and Materials** Starting April 1998, 8,978 individuals (7,243 men, 1,735 women; range 50-69 years; average age, 57 years) underwent first baseline low-dose spiral CT. Low-dose spiral CT parameters were 120 kV, 50 mA, 10-mm collimation, and 2:1 pitch. Each CT was read independently by two radiologists and a physician. When the two readers could not reach consensus, the final decision was made at a weekly conference. High resolution CT examination was performed for those under suspicion of lung cancer.

**Results** For 3 years from April 1998 through March 2001, the total number of the examinations amounted to 17,785 (males 14,050; females 3,735). Fifty three lung cancers were detected at the occasion of CT screening. Detection rate of lung cancer accounted for 0.457% in the baseline screening while the counterpart was 0.136% in the annual repeat screening.

**Conclusion** We have routinely performed low-dose spiral CT for all the participants at ages of more than 50 years upon the MHTS. Low-dose spiral CT is a potentially useful screening method in the detection of early lung cancer.

**Key Words** Multiphasic Health Testing and Services (MHTS); Lung Cancer; Low-Dose Spiral CT; Screening

INTRODUCTION

In advanced countries, lung cancer is the leading cause of deaths due to malignancy. The same is true in Japan, with lung cancer being ranked the top in terms of the cause of deaths among males presenting with malignancy in 1993. The surveys conducted by the Ministry of Health, Labor and Welfare revealed that death due to lung cancer was increased by 3.5 times in males and 2.7 times in females over the past 40 years, even though factors associated with elderly are excluded. It is anticipated that deaths due to lung cancer would exceed 100 thousand annually in Japan, indicating that effective countermeasures should be urgently mapped out.

In April 1998, the investigation team of the previous Ministry of Health and Welfare entitled “Study group on efficacy assessment of cancer screening” pointed out the following findings that annual repeat screening in domestic lung cancer screenings was indicative of its usefulness but the current procedures provide little efficacies. Based on these findings, this team recommended that “more efforts are required to attain earlier detection of lung cancer, for example, by employment of CT for mass screening programmes”.

Given all this, both domestic and foreign medical institutions have gradually employed thoracic CT screening with use of low-dose spiral CT. In our institute, CT has become available since April 1998. This report deals with clinical application of low-dose spiral CT to multiphasic health testing and services (MHTS), as well as related issues.

MATERIALS AND METHODS

In our institute, MHTS are provided to employees, the retired employees of Hitachi or their families, all of whom are members of Hitachi Employee’s Health Insurance Group. The MHTS are composed of various examinations in the morning and physician’s consultation and explanation about the results in the afternoon.

Previously, chest roentgenogram was conducted; however, it has been replaced with CT examination since April 1998. The subjects in this study were all the participants at the age of 50 years and over.

To all the participants, written explanation about the contents of CT screening for lung cancer was distributed in advance, followed by confirmation of their consent to CT examination on the that day. CT examination was performed only in the participants who showed consent to this study, while the participants who rejected to receive this study were subjected to usual chest roentgenogram.

Questionnaires were applied to all the participants, asking about smoking habits, presence or absence of hemosputum, respiratory symptoms including cough, sputum and breathlessness, past history of chest diseases such as tuberculosis, pleurisy, pneumoconiosis and bronchitis, as well as past working careers whether they were engaged in handling asbestos and chromium.

The apparatus was RADIX Turbo (Hitachi Medical Co., Tokyo, Japan). The scanning parameters included voltage 120 kV, current 50 mA, X-ray beam width 10 mm, and moving speed of bed 20 mm/rotation. (10 mm collimation, and 2:1 pitch) The participants climbed the bed to take supine position. The CT images were continuously obtained at the chest region from 20 mm cranial to supracranicular part to 30 cm caudal part in a single breath hold (about 15 s) at deep inspiration.

The images were read by means of double reading and comparative reading. Double reading was performed by two board-certified radiologists and one physician, separately. The findings were classified as follows: 1) normal, 2) abnormal but of little clinical significance, 3) abnormal with some clinical significance, 4) suspicion of lung cancer: necessity of high resolution CT (HRCT), 5) non-cancerous but suspicious active lung lesion: necessity of medication. In the cases who were judged by either of the two readers to need HRCT examinations, final decision was given by all the readers at the weekly conference.

According to the criteria for diagnosis of solitary pulmonary nodules in our institute, nodules measuring more than 8 mm in diameter should undergo HRCT in principle. When nodules with
11 mm or more in diameter was detected in HRCT, they were referred to specialized medical institutions, together with careful examinations including histological screenings. Nodules measuring 8 mm to 10 mm in diameter were subjected to follow-up with HRCT for the period from 3 months to 6 months. Whenever any changes such as increased size were observed, they were referred to specified medical institutions whereas cases without any changes were instructed to participate in the next MHTS. The same instruction was provided to the cases with nodules measuring less than 7 mm in diameter.

For readings of the CT images, diagnostic console (CT-DC-1A, Hitachi Medical Co. Tokyo, Japan) and 14-inch cathode ray tube (CRT) monitors were used, followed by observation on cine-display image of 1 mm interpolation. Handling of a track ball allowed the readers to chase the target lesion voluntarily by movement of the slice. Basic conditions for observation included WW1400/WL-700 for lung field and WW400/WL60 for mediastinum; however, these conditions could be easily altered. In and after the second year, a new image analyzer and another 14-inch CRT were additionally installed to compare the data with the previous ones. Currently, both the latest images and the previous ones were read in a parallel way.

The results from readings were input into a personal computer by the reader. The personal computer was also used for storage of the questionnaires’ results and out put of the notification about the results. The CT image findings were classified into 40 items including suspicious lung cancer, suspected tuberculosis and inflammatory lesions. Furthermore, we recorded location of the lesion, classification, comments from the reader, and comments entered onto the notification of the results to the participants. All of these data are easily accessed at the next examination.

Requirement of HRCT was informed to the participants by phone, besides the visiting date being reserved. HRCT imaging was conducted approximately 1 month later and was conducted in our institute by using detail spiral CT. At the weekly conference, final measures including referral to appropriate medical institutions or follow-up at our institute were decided.

RESULTS

For 3 years from April 1998 through March 2001, the total number of the examinations amounted to 17,785 (14,050 men, 3,735 women). The total number of days for examinations reached 714 days, indicating 24.9 individuals per day in average.

The first baseline screening were 8,978 individuals (7,278 men, 1,735 women), with the mean age of 57 years old. When stratified by ages, males at the age of 50 s amounted to 5,664, accounting for 63% of the whole individuals.

Fifty three lung cancers were detected at the occasion of CT examinations. Detection rate of lung cancer accounted for 0.457% in the baseline screening while the counterpart was 0.136% in the annual repeat screening.

For operation of this system, engaged in CT examinations were one radiological technologist, two physician as readers (1 in the morning and 1 in the afternoon) and one personnel as the window-function. The dates required for examinations amounted to 230 days per year. However, MHTS using low-dose spiral CT were performed only in the morning, with HRCT being conducted in the afternoon.

Various preparatory works including registration of individual date in the apparatus were completed, thereby contributing to shortening the time for examinations to as short as about 3 minutes on the test day. Thanks to extremely short period required to complete whole examinations, operations of MHTS were not hindered following introduction of this system.

The CT findings obtained on the same day were read by the first reader in the morning. Cine-display images on CRT were used for reading. In and after the second year, additional CRT was purchased for the benefits of comparative readings. It took about 3–5 minutes from reading to input of the results. In the afternoon on the same day, another reader performed double reading.

In the MHTS, the results were informed to the examinees on the same day of examinations whereas the results on CT examinations could not be provided to them on the same day because it took longer time to reach the final decision through double reading and assessment in the evaluation conference. The results were mailed to the participants later; however, efforts were centered to have the participants receive the results within 2 weeks at the latest.

DISCUSSION

To our best knowledge, there is no report so far from any institutions except ours, which have routinely performed low-dose spiral CT for all the participants at ages of more than 50 years upon MHTS. Nevertheless, it is postulated that current chest roentgenogram shall be probably replaced with CT examination at the time of MHTS, if many reports indicative of usefulness of CT in detection of incipient lung cancer are documented from lots of medical institutions.

Possible issues associated with incorporation of CT imaging into MHTS under the present situations are of economical aspects including expenses related to purchasing of CT apparatuses and their maintenance, as well as labor costs.

In actuality, the price of single slice CT apparatus was sharply decreased from the previous ones, indicating that running costs rather than apparatus itself would be more problematic. To tell the truth, we calculated the running costs based on our initial assumption that one X-ray tube would suffice for one year operation. However, for about 3 years since initiation of our CT examinations, X-ray tube uneventfully worked. The total number of rotations reached as many as 36,000 rounds. Such an unexpected tolerability was mainly attributed to its use under conditions with less loading on the tube. When the expenditures for the tube were divided by the number of participants, the per capita expenditure for the tube was estimated to be approximately 500 yen.

In addition, CT images were read on CTR, indicating that hard films were not required for duplication. Copying on hard films was limited to the cases (about 10%) who were judged to undergo HRCT and to be assessed at the weekly conference. In other words, 90% of the development fees of the films would be reduced. Notable labor cost was the expenses for readers. To read the CT images of 30 participants in average per day, approximately 2 hours and 30 minutes were required. What’s worse, double reading was to be performed independently.

To reduce this expense, expectation was placed on introduction of computer-aided detection (CAD) system. This CAD system is now under development mainly in the USA and Japan. In future, employment of CAD system permits replacement of one reader...
with a computer; therefore, one reader would make final decision by referring to the results from computer analysis.

In the present report, we reviewed operation of MHTS as well as relevant issues when low-dose spiral CT was used. It is conceivable that quality of the MHTS becomes more and more important. In particular, upon introduction of highly sophisticated medical instrument, it is important to secure adequate accountability and transparency of examination contents.

REFERENCES


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