

Multidisciplinary Lung Cancer Tumor Board Connecting Eight General Hospitals in Japan via a High-Security Communication Line

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PURPOSE The complexity of lung cancer treatment is rapidly increasing, necessitating the use of multidisciplinary approaches for improving outcomes. Although it is common for institutions to have their own tumor boards, tumor boards connecting several general hospitals, and therefore allowing for more diverse opinions, are not prevalent.

MATERIALS AND METHODS A tumor board connecting eight hospitals was formed to discuss patients for whom formulating a treatment strategy was difficult. Physicians and hospital staff accessed a high-security communication line via LiveOn (Japan Media Systems Corporation, Tokyo, Japan), which is completely isolated from the Internet and password protected, that enables each hospital to share the electronic medical records and images of relevant patients at other hospitals on desktop computers in real time. The lung cancer tumor board began in April 2017 and has since been held every Tuesday evening for 1 hour. Preparatory records containing the age, sex, histology, TNM classification, background, and discussion points for each patient are created before each tumor board meeting. After the tumor board discussion, all conclusions and related articles used in the board are added to the minutes, which are finalized as Microsoft Word files, consolidated, and archived. These files can be retrieved later using key words.

RESULTS From April 2017 to June 2018, 202 patients were discussed. Although TNM classification was not changed for any patient, diverse opinions led to a change in the proposed strategy for 49 of 202 patients.

CONCLUSION The multidisciplinary tumor board was useful in obtaining various opinions from the perspectives of different experts. This should be evaluated in a prospective study.

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INTRODUCTION

Multidisciplinary tumor boards have become an indispensable aspect of the treatment of cancer.¹⁻⁷ They are universally adopted, which has been attributed to advances in cancer research. The increasing complexity and specialization in the delivery of precision medicine for every type of cancer requires updated and diverse opinions. These advances have not only been made in the fields of targeted therapies and immune checkpoint inhibitors, but also in the diagnosis of cancer, including immunohistochemistry and oncogenic driver mutations. As a result, attending physicians must constantly catch up with and evaluate the latest clinical trials and information on cancer diagnosis and treatment. Under these circumstances, multidisciplinary tumor boards provide a great opportunity to obtain various opinions from the perspectives of different experts. Multidisciplinary approaches have been noted to be effective for several types of cancers, particularly head and neck¹ cancers, as

well as esophageal,² breast,³⁻⁵ urologic,⁶ and lung⁷ cancers.

Progress in lung cancer treatment, in particular, has been so rapid that it is widening the gap between optimal and actual care of lung cancer, in part because of the ever-increasing number of therapeutic options available to physicians.⁸ Multidisciplinary approaches are therefore important for deciding the optimal treatment strategy for patients with lung cancer, which in turn helps to improve treatment, care, and outcomes.

Although individual institutions commonly have their own multidisciplinary tumor boards, these boards can be inadequate because not all hospitals have the necessary specialists and resources for treating a given patient. Although attempts have been made to overcome the disadvantage of single-institution tumor boards through central conferences involving multiple institutions in a given district or affiliated with nearby

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university hospitals, the accessibility to such conferences is limited because of their locations and the need to factor in travel time. To address this, it seemed necessary to create a Web-based tumor board that connected several hospitals. This board would be able to complement the tumor boards of institutions lacking in certain specialties, thereby facilitating more precise decision making and better outcomes. However, there are few such tumor boards in existence, and little research has been performed on their efficacy.⁹⁻¹³ The lack of such boards can be attributed to difficulties in the construction of Web-based conference platforms.

Most of the patients treated at community cancer centers are reported to benefit from multidisciplinary tumor boards.¹⁴ Thus, the creation of a platform for tumor boards connecting several hospitals is urgently needed to enable more appropriate decision making, treatment strategies, and care for patients with cancer. In this study, we developed a multidisciplinary lung cancer tumor board that connected eight general hospitals in Japan to provide better treatment of patients with lung cancer.

MATERIALS AND METHODS

Background of the Lung Cancer Tumor Board and the Selection of Hospitals

Tokushukai Medical Group consists of 71 hospitals in Japan, which include both urban areas with large hospitals and rural districts with small or medium-sized hospitals. Although there is a need for lung cancer treatment in medium-sized hospitals, some hospitals do not have respiratory physicians specializing in lung cancer treatment. Therefore, a Web-based lung cancer tumor board was needed to provide appropriate suggestions on the diagnosis and treatment strategy, as well as updated information.

No tumor board connecting several hospitals had existed in Japan because extreme caution is required to share the medical records of the patients in other hospitals under Japanese laws to protect personal information. Therefore, four large hospitals were initially selected to develop the platform of the tumor board to confirm the security as well as the quality of images to be shared. After confirming the feasibility of the tumor board meeting on a regular basis for 6 months with four hospitals, the hospitals lacking lung cancer specialists and other large hospitals started to participate in the tumor board.

Platform of the Lung Cancer Tumor Board

Physicians and staff at each hospital were given access to a high-security communication line via LiveOn (Japan Media Systems Corporation, Tokyo), which is completely isolated from the Internet and is password protected (the passwords are changed regularly). Managing the shared desktop image was tentatively given to the first hospital to present the consulting patient, which was named as a tentative initiative. LiveOn enabled each participating hospital to share on a desktop computer the electronic

medical records of the hospital holding the tentative initiative in real time via verbal communication. More specifically, the physician at the hospital with the tentative initiative could display the medical record of the discussed patient, indispensable key images of the patient, and the patient's histopathology. In this way, the medical staff of all participating hospitals could access this information in real time via LiveOn. After the presentation and discussion of the relevant patient at the first hospital, the tentative initiative was moved to the next hospital with patients requiring discussion by a tumor board, and the process was repeated.

The specialties of the participating physicians were respiratory medicine, thoracic surgery, diagnostic radiology, radiation therapy, and clinical pathology. The attending nurses, pharmacologists, nutritionists, and medical social workers at the outpatient chemotherapy center of each hospital were also allowed to participate in the board and discuss relevant patients within the context of their specialties.

Patients Subject to the Lung Cancer Tumor Board

Patients with all forms of thoracic malignancy and for whom decision making about treatment was difficult were permitted to be included in tumor board discussions. Physicians, nurses, and pharmacologists at each hospital surveyed the patients with thoracic malignancies weekly and chose the relevant patients for discussion.

Preparation for the Lung Cancer Tumor Board

The attending physicians who primarily took care of the relevant patients were asked to create records of preparatory proceedings before each meeting. These records contained information on the patients, including their age, sex, histology, TNM classification, and background, as well as any discussion points. References to past literature relevant to the discussion were attached, when needed. The records were then uploaded to a cloud system of Tokushukai Medical Group, protected with high-security passwords to be shared with all participants before the tumor board meeting. References could be added by other participants when deemed important enough.

Procedure of the Lung Cancer Tumor Board

The following procedure was used to discuss patients at each tumor board meeting. Ten minutes were principally allocated to each patient. The attending physicians first explained the status of the patient, including his or her symptoms, Eastern Cooperative Oncology Group performance status, blood test results, and disease work-up to date. They also displayed key computed tomography (CT), magnetic resonance, and positron emission tomography images, as well as relevant histologic images. After presenting the clinical stage of the patient, they consulted with the other participants on the difficult points of treatment. Participants could request that the chief medical physicians

provide additional information, such as the status of the oncogenic driver mutations and the programmed death-ligand 1 expressions, as well as more detailed histologic images (eg, immunohistochemistry). Comments about the CT, magnetic resonance, and positron emission tomography/CT images as well as the histopathologic details could be added by radiologists and pathologists, when needed. Note that neither the radiologic nor the histologic images presented to the board were PowerPoint slideshows or snapshots of the relevant images; they were the original and complete images available in the electronic medical records of the hospital where the patient was treated.

The discussion points typically focused on the medical aspects of the patient, such as their treatment and diagnosis (eg, “Which drug should be used for this patient?” and “Which is the most appropriate strategy to appropriately diagnose this patient?”). Treatment guidelines from the American Society for Clinical Oncology and National Comprehensive Cancer Network, along with published journal articles related to the patient’s condition, were presented and discussed to ensure the optimal solution. The care and social aspects of the patient were also discussed by nurses, pharmacologists, nutritionists, and medical social workers, when needed.

After the discussion, the conclusions reached and the related articles used in the board meeting were added to the minutes, which were in turn finalized in the form of Microsoft Word (Microsoft Corporation, Redmond, WA) files, consolidated, and archived. The information could thereafter be easily accessed in the archived file through a key word search, which was expected to aid in the decision making of physicians who encountered similar patients in the future.

Analysis of the Change in Diagnostic or Treatment Strategy by the Lung Cancer Tumor Board

The number of patients for whom the tumor board recommended different strategies from those proposed by the attending physicians were retrospectively calculated through the archived file.

Informed Consent

Because the purpose of the tumor board was to improve the treatment outcomes of patients and patient anonymity was assured in the records of the board proceedings and archives, written informed consent from each patient was not necessary. When personal data had to be handled, patients were eligible to opt out (on the basis of advisory comments from the lawyers of Tokushukai Medical Group).

RESULTS

The Current Status of the Lung Cancer Tumor Board

The first meeting of the tumor board was held on April 4, 2017, with four hospitals (Uji-Tokushukai Medical Center, Yao-Tokushukai General Hospital, Chiba-Nishi General Hospital, and Osumikanoya Hospital; Fig 1). Since then, board meetings have been held every Tuesday evening for approximately 1 hour. Currently, approximately eight hospitals participate in the tumor board. Between April 2017 and June 2018 (a period of 15 months), the multidisciplinary lung cancer tumor board met 63 times. On average, there were 10 participants in each session, and one to eight patients were presented per session. Although there were technical challenges in the use of the LiveOn system early on, participants gradually became accustomed to using it, including the tentative initiative.

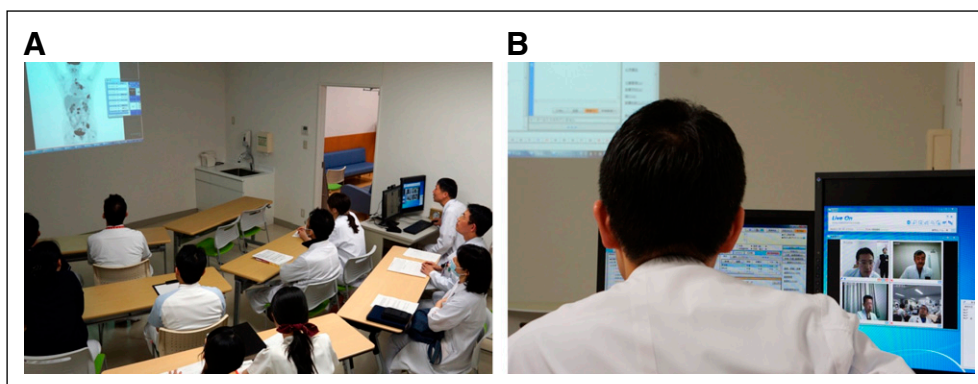


FIG 1. Photographs of the lung cancer tumor board taken at Uji-Tokushukai Medical Center on April 4, 2017. (A) Physicians and staff participating in the board discussion. The desktop images are projected onto a screen, and all participants can read the patients’ medical records and computed tomography, magnetic resonance, positron emission tomography, and histopathology images. These desktop images of the hospital with a tentative initiative are shared with other participating hospitals in real time. (B) The representative physicians for each participating hospital are projected on the desktop screen (the representative physicians for the initial four hospitals are projected on the right monitor display). They mainly discuss the relevant patients and integrate several opinions delivered by other participants at each hospital.

Patient Characteristics

A total of 202 patients (66 females and 136 males) were discussed (Table 1). The average number of discussed patients per tumor board session was 3.2 (range, 1 to 8). The median age of the patients was 70 years (range, 29 to 88 years).

The histology of the consulted patients varied from primary thoracic malignancies, including primary lung cancers, thymic cancer, and malignant lymphoma, to metastatic lung cancers or locally invasive cancers from an adjacent organ. The histologic features of the primary lung cancers were adenocarcinoma (n = 131; 64.9%), squamous cell carcinoma (n = 31; 15.3%), adenosquamous carcinoma (n = 1; 0.5%), pleomorphic carcinoma (n = 3; 1.5%), carcinosarcoma (n = 1; 0.5%), non-small-cell lung cancer not otherwise specified (n = 5; 2.5%), large-cell neuroendocrine cancer (n = 4; 1.9%), and small-cell lung cancer (n = 15; 7.4%). Five patients (2.5%) had malignant lymphoma, and one (0.5%) had thymic cancer. As for the

metastatic lung cancers, the origins were renal cell carcinoma (n = 2; 1.0%) and colon cancer (n = 1; 0.5%). One patient (0.5%) with endobronchial metastasis from breast cancer and one (0.5%) with tracheal invasion of esophageal cancer were also discussed. The oncogenic driver mutations in nonsquamous non-small-cell lung cancer were epidermal growth factor receptor mutation (n = 24; 11.9%) and anaplastic lymphoma kinase fusion (n = 10; 5.0%).

Analysis of the Change in Diagnostic or Treatment Strategy

The tumor board recommended different diagnostic or treatment strategies for 49 of 202 patients (Table 2). Consultation was made on diagnostic approach and treatment strategy for 15 patients (7.4%) and 187 patients (92.6%), respectively. Different strategies were recommended for four patients (26.7%) for diagnostic and 45 patients (24.1%) for treatment strategies.

Case Presentation of the Representative Patient Who Benefited From the Lung Cancer Tumor Board

A 68-year-old woman with a previous history of breast cancer was discussed among the lung cancer tumor board. She underwent left mastectomy 9 years before the discussion, which was followed by treatment with an aromatase inhibitor, exemestane. Recurrence was observed 7 years after surgery, with multiple lung and liver metastases. Subsequently, she received anti-estrogen toremifene for 2 years. She had symptoms of dry cough and dyspnea, and a chest CT revealed a tumor with low contrast enhancement arising from the posterior membranous tracheal wall (Fig 2). Because the tumor caused approximately 75% luminal stenosis of the trachea, a transbronchial biopsy via a fiberoptic bronchoscopy was risky, considering that the edema or bleeding after biopsy could have led to total occlusion of the trachea. The chief physician planned to conduct the biopsy by preparing a tracheal stent to avoid this complication. After the presentation, one participating physician asked why hormone therapies had been chosen for the patient and about the status of her estrogen receptor, progesterone receptor, and human epidermal growth factor receptor 2 (HER2) expression. The patient's medical record revealed overexpression of HER2, as well as positive estrogen receptor and progesterone receptor. The administration of trastuzumab instead of a transbronchial biopsy was then recommended, considering that the configuration and contrast enhancement pattern of the tumor was consistent with an endobronchial metastasis of breast cancer. Furthermore, a suggestion was made to give priority to anti-HER2 therapy over an invasive histologic examination. This patient was chosen for presentation because the diagnostic and therapeutic strategies were substantially changed by the tumor board, which would not have occurred in a single-institution tumor board.

TABLE 1. Patient Characteristics (N = 202)

Characteristic	No. (%)
Age, years	
Median	70
Range	29-88
Sex	
Female	66 (32.7)
Male	136 (67.3)
Histology	
Adenocarcinoma (lung)	131 (64.9)
Squamous cell carcinoma (lung)	31 (15.3)
Adenosquamous carcinoma (lung)	1 (0.5)
Pleomorphic carcinoma (lung)	3 (1.5)
Carcinosarcoma (lung)	1 (0.5)
NSCLC-NOS (lung)	5 (2.5)
Large-cell neuroendocrine cancer (lung)	4 (1.9)
Small-cell lung cancer (lung)	15 (7.4)
Malignant lymphoma (lung)	3 (1.5)
Malignant lymphoma (trachea)	2 (1.0)
Thymic cancer (sqCC)	1 (0.5)
Metastatic lung cancer	3 (1.5)
Breast cancer (endobronchial metastasis)	1 (0.5)
Esophageal cancer (tracheal invasion)	1 (0.5)
Oncogenic driver mutation (non-sqNSCLC)	
EGFR mutation	24 (11.9)
ALK fusion	10 (5.0)

Abbreviations: ALK, anaplastic lymphoma kinase; EGFR, epidermal growth factor receptor; non-sqNSCLC, nonsquamous non-small-cell lung cancer; NOS, not otherwise specified; NSCLC, non-small-cell lung cancer; sqCC, squamous cell carcinoma.

TABLE 2. Changes in Diagnostic or Treatment Strategy

Reason for Consultation	No. (%)	Change in Strategy, No. (%)
Diagnostic approach	15 (7.4)	4 (26.7)
Treatment strategy	187 (92.6)	45 (24.1)
<i>EGFR</i> mutation	22 (10.9)	6 (27.3)
<i>ALK</i> fusion	7 (3.5)	2 (28.6)

Abbreviations: *ALK*, anaplastic lymphoma kinase; *EGFR*, epidermal growth factor receptor.

DISCUSSION

The advent of new diagnostic and treatment strategies has led to increasing complexity in delivering precision medicine to patients with cancer. This has led to widespread recognition of the need for multidisciplinary approaches to cancer treatment.

Although single-institution tumor boards have become common, there are few tumor boards connecting several hospitals. More diverse opinions and discussion are expected in such boards, which would be beneficial for both patients with cancer and medical staff. Although attempts have been made to overcome the disadvantage of single-institution boards through central conferences, the accessibility to such conferences is limited.

A Web-based tumor board connecting several institutions offers a distinct advantage over central conferences in terms of accessibility and lower cost, which can better satisfy the needs of health care providers.¹⁵ Of course, Web-based tumor boards require an adequate information infrastructure, particularly in terms of security and ease of use. This is arguably the most challenging obstacle in establishing such a system. The cost of creating that infrastructure is also a major impediment. This is likely why tumor boards connecting several institutions are relatively rare and tend to be held less frequently.⁹⁻¹³

Since its development, the tumor board described in this study has been held on a regular basis without cessation. We expect that this is due to its high accessibility compared with central conferences. The tumor board was initially started connecting four large hospitals to confirm its feasibility for 6 months. The resolution of technical problems, most of which were overcome by practice and participation in the board during the confirmation period, was instrumental in its continuation. A total of 202 patients were discussed during a 15-month period, with 49 recommendations for strategical change, evaluating more patients than the previous reports.⁹⁻¹³

Actually, despite recognition of the need for multidisciplinary approaches, there are few studies examining their efficacy.¹⁶⁻¹⁸ Furthermore, there have been no studies evaluating Web-based multidisciplinary tumor boards consisting of multiple institutions.

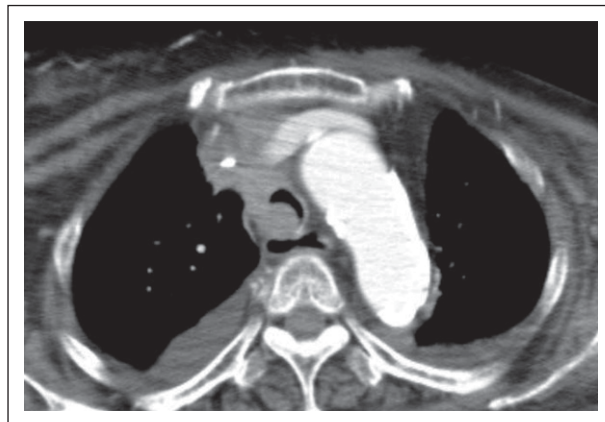


FIG 2. Chest computed tomography scan demonstrating a tumor with low contrast enhancement that arose from the posterior membranous tracheal wall. The tumor caused approximately 75% luminal stenosis of the trachea.

In this study, we analyzed the number of patients in which the decision of the tumor board was different from the proposed strategy by the attending physicians, which partly indicates the efficacy of the Web-based tumor board. However, this analysis does not demonstrate the complete investigation of its efficacy, because we could not evaluate whether each decision by the tumor board was finally adopted in the relevant institutions and benefited the relevant patient. Therefore, prospective studies are urgently needed to evaluate the actual impact of such boards on decision making and treatment strategies. Verification of concordance between suggested and delivered treatments is also necessary. The final goal of Web-based tumor boards should be the improvement of patients' overall survival and quality of life.

One of the marked aspects of the tumor board is the generation of finalized documents as Microsoft Word files. These archived documents not only facilitate referencing of requisite information via key word searches but also enable us to retrospectively reevaluate the discussed patients in the future. The archived documents could be useful in distributing questionnaires to the relevant hospitals asking whether there existed discrepancy between suggested and delivered treatments, and whether the suggestions by the tumor board were helpful.

However, the concept of the shared desktop is one of the prominent features of the Web-based tumor board, which is different from previous reports in that the images presented to the board were neither PowerPoint slideshows^{11,12} nor snapshots⁹ and were also different from the transmission of chest x-rays and CT scans between two hospitals.¹³ The shared desktop enabled us to access in real time the original and complete images as well as any other critical information in the electronic medical records of each hospital when needed, which were unavailable by the previously reported methods.^{9,11-13}

Of course, there is room for improvement in the tumor board. First, because little information was available on the establishment of multidisciplinary tumor boards connecting multiple institutions, we ended up using the LiveOn system, which is not universally adopted. Still, the Web-based tumor boards using this system have been held securely and with ease owing to the platform described in Materials and Methods. Second, incomplete follow-up made it difficult to investigate the concordance between the delivered and

suggested strategies. This should be evaluated in a prospective study as stated previously.

In conclusion, this multidisciplinary lung cancer tumor board connecting eight general hospitals can be considered useful in obtaining diverse expert opinions for difficult-to-treat patients. The platform on which it is based has helped feed health care providers considerable information and suggestions to help improve the treatment outcomes of patients with lung cancer.

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AUTHORS' DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST

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