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IMPLEMENTATION SCIENCE & OPERATIONS MANAGEMENT

Preoperative respiratory intervention eliminated the operation cancelations of lobectomy surgery

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Abstract

In Nagasaki University Hospital, the patients undergoing surgery with abnormal respiratory function have been automatically referred to specialized clinic by Medical Support Center (MSC) since July 2016 to reduce surgery cancellations due to insufficient preoperative evaluation. Whether the MSC system decreased post-hospital surgery cancellation, variance rate, or length of hospital stays in patients received "lobectomy" were retrospectively compared between Period A (n = 264, before MSC introduction) and Period B (n = 264, after MSC introduction). Four patients' operations were cancelled after hospitalization in Period A, while 0 patients in Period B ($p < 0.05$). The length of hospital stay, operation time, anesthesia time, and postoperative extubation oxygen administration time were all shorten in Period B significantly. "Period B", "operation time", and "postoperation oxygenation time" were independent factors for "hospital days", but chronic obstructive pulmonary disease or age were not. The preoperative intervention eliminated the operation cancellation. Preoperative MSC interventions may have contributed to the reduction in hospital days even for the patients with pulmonary dysfunction.

Keywords COPD · Preoperative intervention · Internal intervention · Hospital days · Video-assisted thoracoscopic surgery · Clinical pathway

Introduction

Video-assisted thoracoscopic surgery (VATS) performed as a lobectomy for lung cancer is one of the safest operations and rarely causes surgery-related deaths [1, 2]. High age, smoking, worsen performance status, complication of chronic obstructive pulmonary disease (COPD) etc. were reported as the risk of postoperative complications [3–6]. The prevalence of COPD is even higher among surgical candidates compared with aged-matched population groups (e.g., 5–10% of COPD patients in general surgery, 10–12% in cardiac surgery and 40% in thoracic surgery vs. 5% of COPD patients in the general population) [7].

In Nagasaki University Hospital, about 150 cases of lung cancer resection are performed annually, and almost of them are proceeded according to the "Pulmonary Lobectomy Clinical Pathway" and there are few surgical-related deaths or severe complications. In some cases, after hospitalization, surgery is postponed or canceled due to lack of appropriate preoperative examination. The frequency of

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surgery-related deaths and postoperative complications varies widely between institutions [8]. Though preoperative evaluation systems vary at each facility [9], the importance of sharing mental through the nursing screening, patient education, preoperative physician and surgeon is gaining attention [10–12]. Wijeysundera DN et al. reported that one-third of surgical patients undergo preoperative medical consultation [13]. Based on these reports, our hospital introduced a preoperative intervention screening system by nurses at the Medical Support Center (MSC) for surgery with general anesthesia. MSC automatically refers the patients, with preoperative respiratory dysfunction abnormalities or obstructive pulmonary disorders, to specialized pulmonologists in accordance with an algorithm. After resolving respiratory problems, the patient was referred to an anesthesiologist, and this system was constructed to eliminate surgery cancellation after hospitalization. At the same time, it was expected that this system (adequate preoperative intervention) improves perioperative management, which may also reduce clinical pathway variance, hospital days, and operative time [6], which, however, is still controversial [14, 15].

In this study, we investigated whether preoperative interventions eliminated surgery cancellation after hospitalization and/or improved postoperative management in patients with VATS based on the "lobectomy clinical pathway" by MSC system introduction.

Methods

Objectives

Perioperative managements (surgery cancellation after hospitalization, anesthesia time, operation time, postoperative

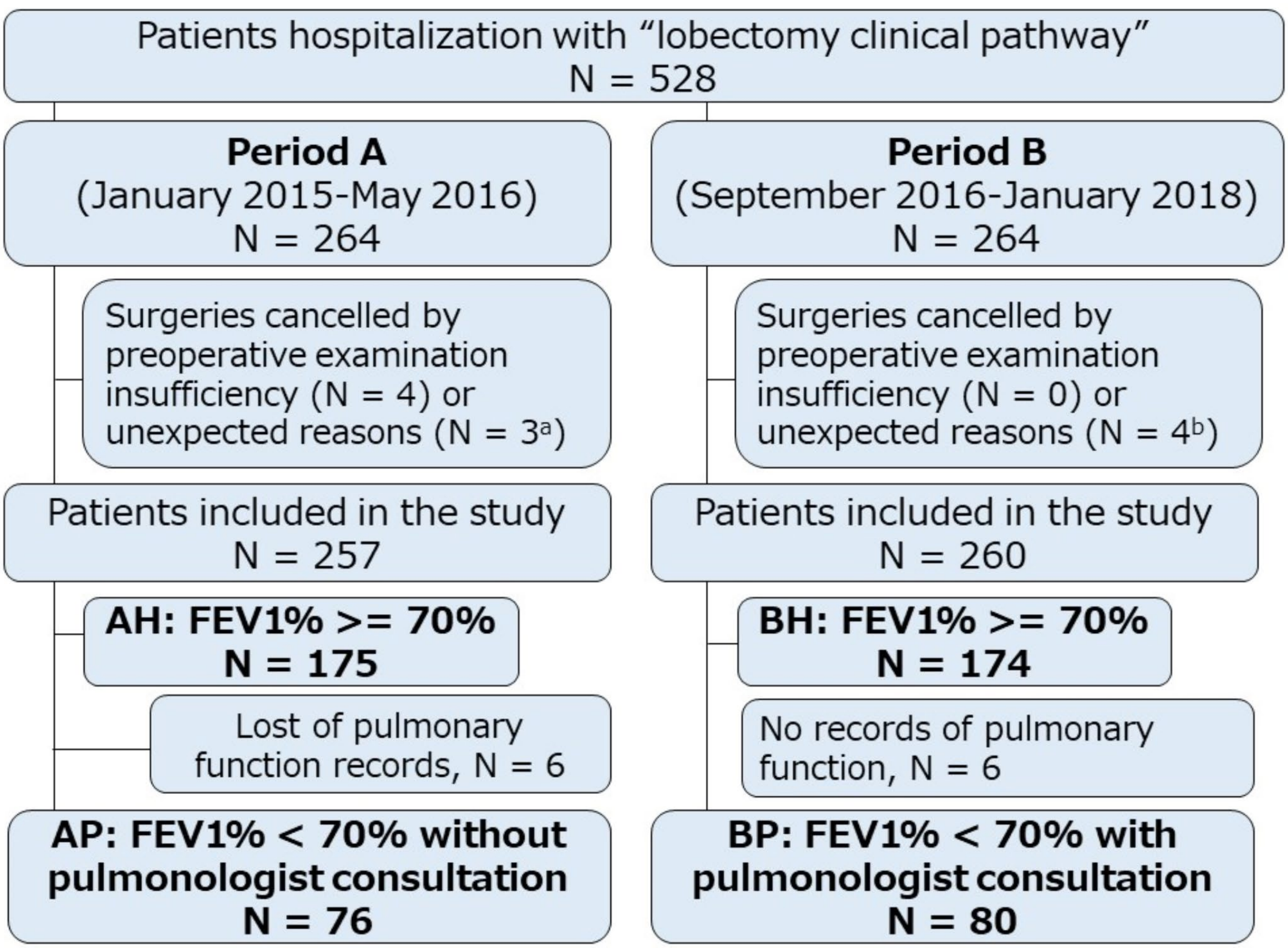

Fig. 1 Grouping algorithm. Four patients' operations were cancelled after hospitalization due to insufficient preoperative examination in Period A, while 0 patients in Period B. The number of discontinuations that could not be predicted was 3 for Period A and 4 for Period B. In Period B, 80 patients (30.8%) were referred as having obstructive pulmonary dysfunction and/or a history of obstructive disorder. Various interventions were performed. All of the patients in Period B received the VATS

oxygenation time after extubation, hospital days, pathway variances) of 528 cases of VATS based on the "lobectomy clinical pathway" at Nagasaki University Hospital were compared between Period A (From January 2015 to May 2016, one year and four months before the introduction of preoperative MSC intervention (July 2016)) and Period B (from September 2016 to January 2018, one year and four months) retrospectively (Period A, n = 257, female/male = 95 / 162, age (mean ± SD), 67.4 ± 12.3 years; Period B, n = 260, 107 / 153, 68.0 ± 11.3 years; Fig. 1). There was no change in surgical frequency or procedure between Period A and B. No significant differences were found in background factors (age, gender ratio, smoking rate, incidence of COPD, surgical site, excised lung tissue, lymphatic invasion in case of lung cancer, lymph node metastasis; Table 1) between Period A and B. The study was approved by the Nagasaki University institutional review board with an informed consent waiver (No. 19,021,815).

Statistics

Data are presented as mean ± SD for continuous variables and number of participants (%) for categorical variables. Comparisons by univariate analysis were performed between Period A and B patients. A Wilcoxon rank-sum test was used to compare continuous variables; chi square test or Fisher exact test was used in comparisons of categorical factors. The patients with respiratory problem in Period A and Period B were referred to as AP group and BP group, respectively, and the patients without respiratory problem in Period A and Period B were referred to as AH group and BH group. Multivariate analysis was performed to clarify the relation of the factors to hospital days and variance rate. In the clinical pathway, a variance is defined as when any scheduled perioperative process does not proceed as it should. All analyses were performed based on an overall significant level of 0.05, using JMP ver.17 (SAS Institute Inc., NC, USA).

Table 1 Subjects characteristics of Period A and Period B

	Period A (257)	Period B (260)	p-value
Age, years	67.44 (12.26)	68.02 (11.34)	0.845
Male/ Female, n	162/95	153/107	0.329
Smoker or ex-smoker/ non smoker, n	82/144	78/155	0.528
Smoking index, pack·year	13.5 (26.5)	14.6 (27.2)	0.989
COPD, no/yes, n	225/32	234/26	0.377
Resection lobe, RU/ RM/RL/LU/LL, n	66/20/43/45/37	66/16/59/46/35	0.602
Pathology, no malignancy/adeno Ca.*/ squamous Ca./ small cell Ca. / large cell Ca., n	29/120/27/1/6	39/129/39/2/0	0.078
Ly+**/N0/N1/N2, n	42/86/11/5	37/87/10/3	0.880

*: Ca. indicates carcinoma. **: Ly + means positive lymphovascular invation

No significant differences were found in background factors (age, gender ratio, smoking rate, incidence of COPD, surgical site, excised lung tissue, lymphatic invasion in case of lung cancer, lymph node metastasis between Period A and B

Results

Surgery cancelled cases after hospitalization in period A and period B

Four patients' operations were cancelled after hospitalization due to insufficient preoperative examination in Period A (3 patients with respiratory dysfunction and 1 patient with multiple malignant metastasis), while 0 patients in Period B (chi square = 4.03, p = 0.045; Fig. 1). The number of discontinuations that could not be predicted was 3 for Period A (2 due to improvement on imaging at admission, and 1 due to sudden convulsive seizure due to brain metastasis after hospitalization) and 4 for Period B (1 due to hypoxia, 1 due to pneumonia on admission, 1 due to heavy alcohol drinking, 1 due to iodine anaphylaxis at the beginning of the anesthesia).

Preoperative pulmonologist intervention

In Period B, 80 patients (30.8%) were referred as having obstructive pulmonary dysfunction and/or a history of obstructive disorder (Fig. 1). Various interventions such as drug treatment (such as anticholinergic drugs, beta-stimulants, inhaled steroids etc.), respiratory rehabilitation, smoking cessation guidance, were performed. All of the patients received the VATS.

Post-operative evaluation

Both operation time and anesthesia time were shortened by about 40 min in Period B compared with Period A significantly ($p < 0.0001$, respectively). In addition, the hospital stay was reduced by 4.6 days from 15.8 to 11.2 days significantly ($p < 0.0001$). Postoperative oxygenation time was significantly reduced by 12 h from 70 to 58 h significantly ($p = 0.04$). The rates of airway secretion, airway stenosis, and airway reflex at extubation were not different between Period A and Period B (Table 2).

Table 2 Operative data

	Period A, n = 257	Period B, n = 260	p-value
Operation time, minutes	234 (104)	193 (74)	< 0.0001
Anesthesia time, minutes	324 (112)	278 (77)	< 0.0001
Hospital stay, days	15.8 (9.1)	11.2 (4.5)	< 0.0001
Postoperative oxygenation time, hours	70.5 (166.4)	58.2 (74.6)	0.04
Airway secretion at extubation, y/n	37/114	45/185	0.49
Airway stenosis at extubation, y/n	0/149	1/229	0.60
Airway reflex at extubation, y/n	140/8	218/11	0.94

Both operation time and anesthesia time were shortened by about 40 min in Period B compared with Period A. In addition, the hospital stay was reduced by 4.6 days from 15.8 to 11.2 days. Postoperative oxygenation time was significantly reduced by 12 h from 70 to 58 h

The comparison of the hospital days among the four groups

The hospital days of the four groups were compared **(**Fig. 2**)**. The mean hospital days of AP group (17.2 ± 12.5 days) was longest. BP group had significantly shorter hospital days (12.7 ± 5.7 days) than AP group, which was similar to BH group (10.8 ± 4.1 days).

A multivariate analysis showed that “Period B” refer to Period A (equal to “with MSC system”), shorter “Operation time”, and shorter “Postoperation oxygenation time” were independent effective factors for the shorter hospital days (Table 3).

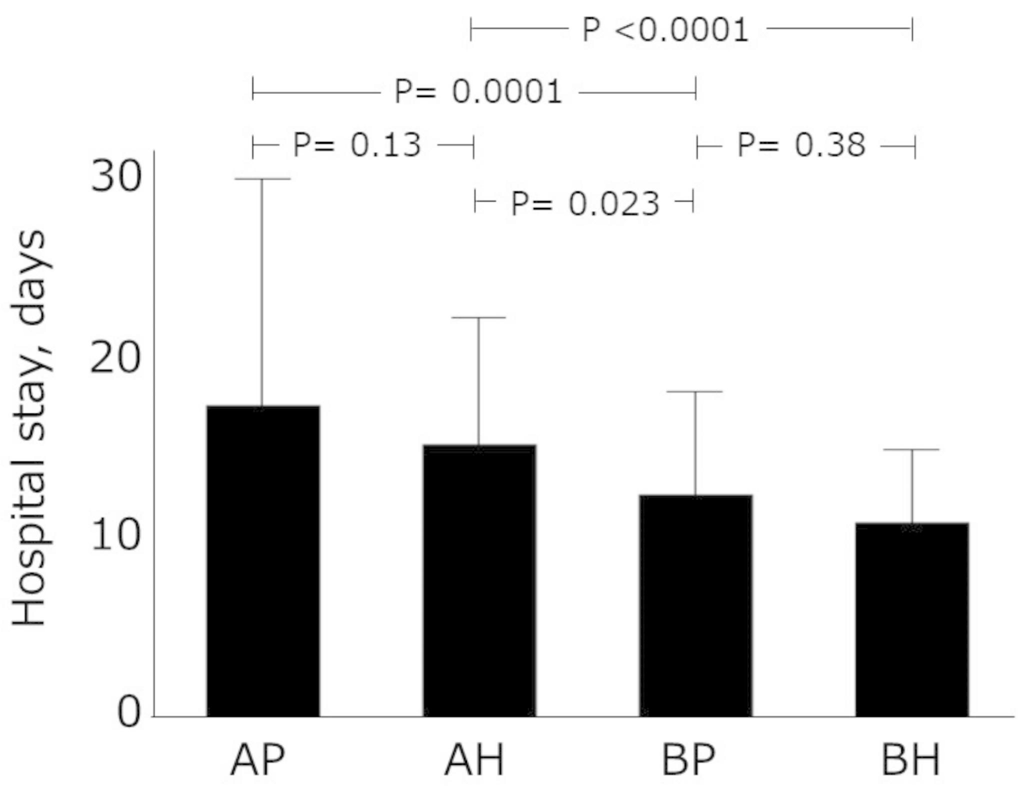

Fig. 2 The hospital days comparison among the four groups. The patients with respiratory problem in Period A and Period B were referred to as AP group and BP group, respectively, and the patients without respiratory problem in Period A and Period B were referred to as AH group and BH group. The mean hospital days of AP group (17.2 ± 12.5 days) was longest. BP group had significantly shorter hospital days (12.7 ± 5.7 days) than AP group, which was similar to BH group (10.8 ± 4.1 days)

Table 3 The factors associated to the hospital days

	Multiple regression analysis	
Factors	t-values	P values
Age	0.30	0.77
Period B [to Period A]	-5.27	< 0.0001
With asthma [to without asthma]	0.38	0.53
With low FEV1 [to normal FEV1]	0.99	0.32
FEV1, %predicted	0.05	0.91
Operation time	2.76	0.0063
Postoperation oxygenation time	16.89	< 0.0001
Smoking index	0.17	0.86
Tumor size	0.52	0.60

A multivariate analysis showed that "Period B" refer to Period A (equal to "with MSC system"), shorter "Operation time", and shorter "Postoperation oxygenation time" were independent effective factors for the shorter hospital days

The comparison of the variance rates among the four groups

The variance rates of the four groups were compared (Fig. 3). The variance rate of AP group (28.9%) was highest. BP group had significantly lower variance rate (11.3%) than AP group, which was not different from BH group (17.7%).

A multivariate analysis showed that "Period B" refer to Period A and shorter "Operation time" were independent effective factors for the less variance rate (Table 4).

Discussion

In this study, we found that MSC system eliminated the surgery cancellations after hospitalization, and shorten hospital days and decreased valiance rate. The lengths of hospital days, operation time, anesthesia time, and postoperative

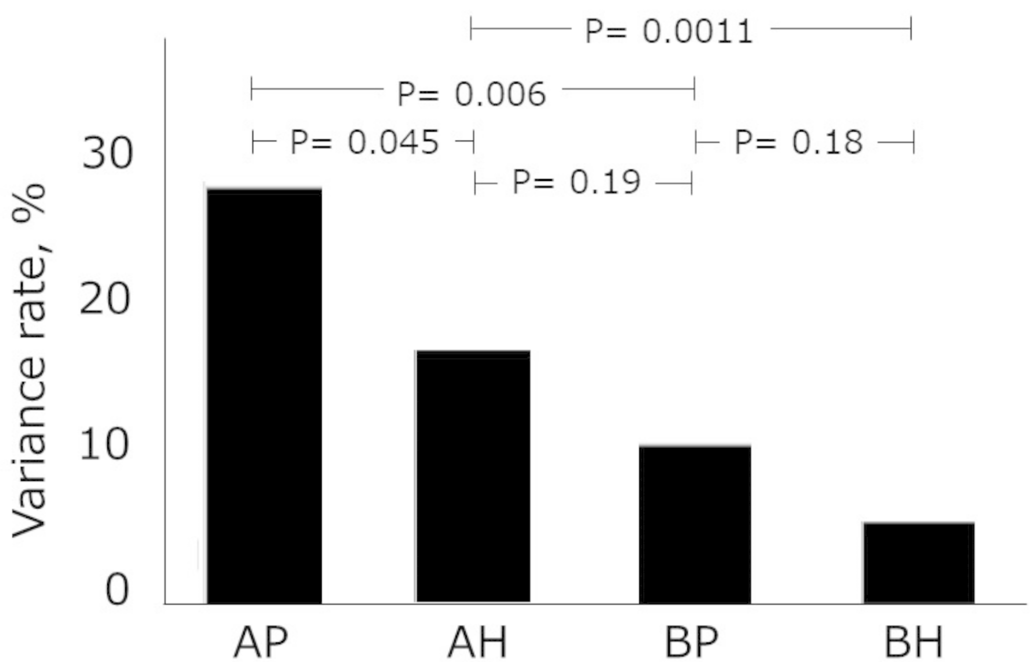

Fig. 3 The variance rates comparison among the four groups. The patients with respiratory problem in Period A and Period B were referred to as AP group and BP group, respectively, and the patients without respiratory problem in Period A and Period B were referred to as AH group and BH group. The variance rate of AP group (28.9%) was highest. BP group had significantly lower variance rate (11.3%) than AP group, which was not different from BH group (17.7%)

Table 4 Factors associated to the variance rate

	Multiple regression analysis	
Factors	chi square	P values
Age	1.31	0.25
Period B [to Period A]	4.10	0.043
With asthma [to without asthma]	0.38	0.53
With low FEV1 [to normal FEV1]	0.01	0.93
FEV1, %predicted	0.44	0.51
Operation time	4.44	0.035
Postoperation oxygenation time	0.04	0.83
Smoking index	0.18	0.67
Tumor size	0.39	0.53

A multivariate analysis showed that "Period B" refer to Period A and shorter "Operation time" were independent effective factors for the less variance rate. A variance is defined as when any scheduled perioperative process does not proceed as it should

oxygenation time were all shorten significantly after MSC system introduction (in Period B). "Period B" (equal to "with MSC system"), short "operation time", and short "postoperation oxygenation time" were independent factors for shorter hospital days, and the former 2 were independent factors for less "variance rate" also.

The purpose of this study was to clarify whether the introduction of MSC reduced the cancellation of surgery after hospitalization. The surgery delay or cancellation causes waste of considerable medical resources [16]. The preoperative clinic could reduce the delays and cancellations, resulted in lower costs [17]. In this study as well, the cancellation was eliminated from 4 patients to 0 patient. ($p = 0.045$), which may reconfirm the importance of preoperative consultation. Edwards et al. said that the preoperative clinic consultation was unnecessary for most patients, but for certain patients, it would be useful for (1) decreased surgical delays and cancellations caused by non-medical issues, (2) decreased perioperative morbidity and mortality, (3) increased patient and surgeon satisfaction, (4) increased regulatory compliance and operating room efficiency, (5) improving information transfers (e.g., consents, history and physical examinations) etc. [9].

Mazo et al. noted that the ARISCAT score (age, preoperative SpO_2 in air, respiratory infection in the last month, preoperative anemia, upper abdominal or intrathoracic surgical incision, duration of surgery, and emergency procedure) is certainly useful for predicting of the perioperation risk, but its usefulness might vary by region and by facility as well [18]. This may relate to the intervention of the preoperative respiratory disease (COPD or asthma), that better treatment for the respiratory complications may decrease the perioperative respiratory troubles. In this study, we found that the "preoperative consultation" and "short duration of surgery" were independent factors for decrease of the postoperative variances or hospital days in our hospital system, but "presence of COPD", "high age" or "Brinkman index" were not involved in them.

It was important that appropriate preoperative specialist consultation was performed extremely smoothly. Actually in our study, in Period B, 80 cases (30.8%) pointed out respiratory problem were consulted, and not all of these patients were introduced to medical treatment. Silvanus MT et al. has mentioned that preoperative inhaled beta-2 adrenergic agonists (i.e., salbutamol) and anticholinergic agents (i.e., ipratropium) should be continued up to the day of surgery in all symptomatic asthmatics and in COPD patients and short-term treatment with systemic or inhaled corticosteroids has been shown to "tune up" the lung function and to decrease the incidence of wheezing following endotracheal intubation without increasing the risk of infection or wound dehiscence [19]. Currently, the main strategies of COPD are long-acting muscarinic antagonist, long-acting beta agonist, and/or corticosteroids, of which effect on perioperative care need to be investigated further.

Although smoking seems likely to increase the risk of postoperative complications because it increases airway endocrine secretions, there is no consensus on the adequate period of smoking cessation before surgery (at least with 8 weeks) [20]. Groth SS et al. said that most of the patients, with or without preoperative smoking cessation, do not have postoperative complications, therefore there is no need to delay surgery due to failure to quit smoking [21]. We have educated about the cessation of smoking and passive smoking as a preoperative intervention. In our study, smoking index was not a significant factor for the hospital days or variance rate. However, we believe to quit smoking as soon as possible is desirable.

There are some limitations in the study. First, there was the inherent bias of a retrospective approach. We believe this theme study is not suitable for prospective study. In addition to the background factors discussed here, there may be many factors to consider, such as pulmonary hypertension [3, 22], localization of intraoperative target lesions [23] etc. In the study, the histology and tumor size were not involved in the hospital days or variance rate [24]. The hook-wire is used for localization target lesions in our hospital, and this method was not changed through the investigated period. Next, our results are derived from single institution data, which may not fully reflect the clinical scenario elsewhere, which is a unique point of this study, because the preoperative procedures are depends on each institute. Propensity score matching was not used for analysis, because the patients' characteristics (mean age, subject numbers, duration months, etc.) were almost same between Period A and B. Lastly, we had not investigated about preoperative rehabilitation, there are some reports that training the respiratory muscles with physical therapy before surgery could reduce atelectasis and increase postoperative inspiratory pressure by 10% [25]. However, there is no sufficient consensus on the effect of preoperative rehabilitation intervention on reducing postoperative complications [26–28].

In conclusion, with the introduction of MSC system, patients whose surgery was cancelled due to inadequate preoperative examinations have disappeared. As a prerequisite for this, the system must be efficient, and a standardized protocol is important [9]. It seems that like improvements of surgical techniques, anesthesia techniques, and nursing care, the preoperative respiratory management may involve in reducing the operation time and hospital days.

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Declarations

Conflict of interest There are no conflicts of interests for any of the authors.

CRediT roles Eriho Yamaguchi: Writing- Original draft preparation. Yasushi Obase: Conceptualization, Methodology, Writing- Reviewing and Editing. Susumu Fukahori: Methodology. Jun Iriki: Validation. Tetsuya Kawano: Data curation. Noriho Sakamoto: Methodology. Ryoichiro Doi: Conceptualization, Data curation. Keitaro Matsumoto: Data curation. Tomoshi Tsuchiya: Data curation. Chizu Fukushima: Data curation, Formal analysis. Takehiro Matsumoto: Supervision. Takeshi Nagayasu: Supervision. Hiroshi Mukae: Supervision.

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