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Performance Changes Following the Revision of Organ Allocation System of Lung Transplant: Analysis of Korean Network for Organ Sharing Data

Hye Ju Yeo [1,2] **Do Hyung Kim** [3] **Yun Seong Kim** [1] **Doosoo Jeon** [1] and **Woo Hyun Cho** [1,2]

[1]Division of Pulmonary, Allergy, and Critical Care Medicine, Department of Internal Medicine, Pusan National University Yangsan Hospital, Yangsan, Korea
[2]Research Institute for Convergence of Biomedical Science and Technology, Pusan National University Yangsan Hospital, Yangsan, Korea
[3]Department of Thoracic and Cardiovascular Surgery, Pusan National University Yangsan Hospital, Yangsan, Korea

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Address for Correspondence:
Woo Hyun Cho, MD
Division of Pulmonary, Allergy, and Critical Care Medicine, Department of Internal Medicine and Research Institute for Convergence of Biomedical Science and Technology, Pusan National University Yangsan Hospital, 20 Geumo-ro, Mulgeum-eup, Yangsan 50612, Republic of Korea.
E-mail: chowh@pusan.ac.kr

ORCID iDs
Hye Ju Yeo
https://orcid.org/0000-0002-8403-5790
Do Hyung Kim
https://orcid.org/0000-0002-8774-3397
Yun Seong Kim
https://orcid.org/0000-0003-4328-0818
Doosoo Jeon
https://orcid.org/0000-0002-8206-9487
Woo Hyun Cho
https://orcid.org/0000-0002-8299-8008

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ABSTRACT

Background: There is currently a lack of data on the impact of the recent revision of the domestic lung allocation system on transplant performance.
Methods: We conducted a retrospective analysis of transplant candidates and transplant patients registered in Korean Network for Organ Sharing between July 2015 and July 2019. Study periods were classified according to the introduction of the revised lung allocation system as follows: period 1 from July 2015 to June 2017 and period 2 from August 2017 to July 2019.
Results: During the study period, a total of 627 patients were on the waiting list, of which 398 lung transplantations were performed. Total waiting list size increased by 98.6%, from 210 in period 1 to 417 in period 2. The number of transplant patients also increased by 32.7%, from 171 in period 1 to 227 in period 2. The number of donors decreased from 1,042 to 878, whereas the usage rate, i.e., the number of lung donors used for transplantation among the total number of reported lung donors, increased from 16.4% to 25.9%. The proportion of patients with high urgent status at transplantation increased from 45% to 60.4%, whereas those with urgent status decreased from 46.8% to 35.7% ($P = 0.006$). The use of marginal donor lungs increased from 29.8% to 53.7% ($P < 0.001$). To adjust urgency status and marginal donor usage between two groups, we conducted a propensity score matching analysis. No significant differences were detected in 1-year survival rates between the two periods after propensity score matching. As well, no significant difference was observed in mortality on the waiting list between the two periods.
Conclusion: The recent revision of the lung allocation system in Korea did not change the performance of lung transplant in terms of waiting list mortality and 1-year survival. The rapid increase in the volume of waiting list between the two periods increased the waiting time, transplantation of high-urgency patients, and use of marginal lung donors.

Keywords: Lung Transplantation; Lung Allocation System; Korea; Mortality

Disclosure
The authors have no potential conflicts of interest to disclose.

Author Contributions
Conceptualization: Cho WH. Methodology: Kim DH. Formal analysis: Yeo HJ. Data curation: Jeon D. Validation: Kim YS. Writing - original draft: Yeo HJ. Writing - review & editing: Cho WH. Approval of final manuscript: all authors.

INTRODUCTION

Lung transplantation is the only lifesaving option for patients with end-stage lung diseases. Studies have reported that approximately 5,000 lung transplantations were performed annually at the global level, and 90 transplantations were performed in Korea.[1,2] The number of patients on the lung transplant waiting list in Korea increased steadily up to 197 and exceeded the number of transplantation procedures performed every year.[2] Unfortunately, a shortage of donor lungs inevitably results in considerable numbers of patient deaths on the waiting list. An efficient donor organ allocation system remains crucial in optimizing donor use and to balance waiting list mortality and improve transplant outcomes.[3]

Current donor lung allocation systems in Korea are based on urgency, without survival benefit being the accepted primary goal.[4] Allocation systems are based on various factors, including geographical (regional) accumulated waiting time, audit-derived urgency criteria, and individual clinical profile. Our national policy constitutes several of these criteria used in combination. However, weighing of these factors differs between different countries such as USA and Europe.[5-7] In July 2017, Korea revised the lung allocation system from the one based on urgency and waiting time to a system based on urgency, blood type, and region. However, till date, there is a lack of information assessing the impact of the current lung allocation system on transplant performance in Korea. Therefore, this study was conducted to evaluate the performance of the recent revision of the lung allocation system in Korea.

METHODS

We retrospectively reviewed and analyzed the Korean Network for Organ Sharing (KONOS) database. Collected data included donor, candidate, and recipient information such as age, sex, region of registration, date of registration, diagnosis, ABO blood type, urgent status at registration, death on the waiting list, date of transplantation, urgent status at transplantation, and date of death after transplantation. Study periods were classified according to the lung allocation system as follows: period 1 from July 2015 to June 2017 and period 2 from August 2017 to July 2019. We compared the transplant outcomes and waiting list mortality between the two periods. We included only newly registered lung transplant candidates during the study period for the analysis of candidates. Survival status and date of death were collected till July 2020 for all patients included in this study.

Classification of diagnosis

KONOS collects the underlying disease in the following 12 categories: idiopathic pulmonary fibrosis (IPF), sarcoidosis, bronchiectasis, bronchiolitis obliterans after transplant, emphysema, lymphangioleiomyomatosis, asbestosis, primary pulmonary hypertension, cystic fibrosis, Eisenmenger syndrome, other, and unknown. We classified the underlying disease into the following 5 categories: chronic obstructive pulmonary disease (COPD; emphysema), interstitial lung disease (ILD, idiopathic pulmonary fibrosis, sarcoidosis, lymphangioleiomyomatosis, asbestosis), primary pulmonary hypertension, bronchiectasis (cystic fibrosis), and other (Eisenmenger syndrome, bronchiolitis obliterans after transplant, other and unknown).

Lung allocation policy changes

Before the implementation of the system in July 2017, all donor lungs were allocated according to an urgency tier system. Patients were classified as status 0, 1, 2, 3 and 7 (**Supplementary Table 1**). Patients with status 0 were defined as those who require mechanical ventilation or extracorporeal membrane oxygenation (high urgent status). Those with status 1 (urgent status) were defined as having one or more of the following conditions: 1) New York Heart Association (NYHA) IV and PaO_2 < 55 mmHg on arterial blood gas test measured without oxygen administration, 2) NYHA IV and mean pulmonary arterial pressure > 65 mmHg or mean right atrial pressure > 15 mmHg, and 3) cardiac index < 2 L/min/m^2. Status 2 were defined as having one or more of the following conditions: 1) In the pulmonary function test, forced expiratory volume at 1 second (FEV1) < 25%, 2) PaO_2 < 60 mmHg in arterial blood gas test measured without oxygen, 3) When the average right atrial blood pressure is 10–15 mmHg, 4) When the average pulmonary arterial pressure is 55–65 mmHg, 5) Cardiac index < 2–2.5 L/min/m^2. Status 3 were defined as having one or more of the following conditions: 1) When a single lung transplant is required, 2) Emphysema, pulmonary hypertension, diffuse interstitial lung disease, 3) Forced expiratory volume < 30% in pulmonary function test, 4) If hospitalized more than 3 times for respiratory failure. Status 7 was defined as whose status does not meet 0–3. Status from 2 to 7 was considered an elective status. Patients with status 0 (high urgent status) were prioritized over those with status 1 to 7. Moreover, within the same urgency tier, patients with the longest waiting period received the lung donation first. In July 2017, the Korea organ commission of the Korea medical council decided to change the system. The changed system was primarily based on urgency, blood type, and distance between donor and recipient. Urgency was the most prioritized variable, followed by same region, same blood type, waiting times, past history or family history of organ donation and age in order. Furthermore, the following criteria were added to status 1: 1) arterial blood gas analysis with $PCO_2 \geq 80$ mmHg and 2) patients with high-flow nasal cannula 30 L and $FiO_2 \geq 0.6$ for more than 2 weeks. The region was divided into regions 1–3, where region 1 included Seoul, Incheon, Gyeonggi, Gangwon, and Jeju. Region 2 included Gwangu, Daejeon, Jeonbuk, Jeonnam, Chungbuk, and Ghungnam, and region 3 included Busan, Daegu, Ulsan, Geyongbuk, and Gyeongnam.

Definition of marginal donor

A marginal donor was defined as when any of the following parameters was fulfilled: age ≥ 55 years, PF ratio ≤ 300, smoking history ≥ 20 pack-years, consolidation or collapse in the chest radiograph, organisms in sputum cultures, and purulent secretion or inflammation on bronchoscopy.[8]

Statistical analysis

Donor, recipient, and transplant factors are expressed as either total number and percentage or mean and standard deviation. Categorical variables were analyzed using a χ^2 test, and continuous variables were assessed using the Mann-Whitney U test. To adjust urgent status and marginal donor usage, we performed a propensity score matching analysis (1:1). Univariate analysis was performed to determine the donor and recipient factors affecting 1-year mortality. Multivariate analysis was conducted on all factors with $P < 0.05$ using a logistic regression model. All statistical analyses were accomplished using SPSS version 21 (IBM corporation, Armonk, NY, USA). $P < 0.05$ was considered to be statistically significant for all analyses.

Ethics statement

The present study protocol was reviewed and approved by the Institutional Review Board of Pusan National University Yangsan Hospital (approval No. 05-2020-004). Informed consent was waived because of the retrospective nature of the study.

RESULTS

Among the total 627 patients identified on the waiting list during the study period, 398 lung transplantations were performed. During the same periods, there were 2,012 donated lung organs and 1,614 donor lungs that were not used. We analyzed a total of 1,523 donor lungs, except those with missing data (n = 91).

Waiting list

Table 1 summarizes the characteristics of all lung transplant candidates registered during the 4 years before (n = 210) and after (n = 417) the introduction of the revised system. The primary diagnosis was ILD (47.4%). No differences were noted related to the primary diagnosis and the blood type among the candidates listed for transplant between the two periods. In addition, there were no significant differences in age, gender, and urgency between the two periods. The total waiting list size increased by 98.6%, from 210 in period 1 to 417 in period 2 (**Fig. 1**). Regarding the urgency status, there were no differences among the candidates listed for transplantation between the two periods (**Fig. 1**). A total of 35.4% of candidates were in the high urgent status requiring mechanical ventilation and/or extracorporeal membrane oxygenation support (37.1% vs. 34.5%, $P = 0.519$).

Table 1. Lung transplant candidates registered in Korea according to the period

Variables	Total (n = 627)	Period 1 (n = 210)	Period 2 (n = 417)	*P* value
Diagnosis				0.989
ILD	297 (47.4)	99 (47.1)	198 (47.5)	
PPH	33 (5.3)	10 (4.8)	23 (5.5)	
Bronchiectasis	34 (5.4)	11 (5.2)	23 (5.5)	
COPD	13 (2.1)	4 (1.9)	9 (2.2)	
Other	250 (39.9)	86 (41.0)	164 (39.3)	
Location				0.845
Region 1	538 (85.8)	181 (86.2)	357 (85.6)	
Region 3	89 (14.2)	29 (13.8)	60 (14.4)	
Age, yr	51.5 ± 16.0	51.8 ± 13.5	51.4 ± 17.1	0.722
Male	395 (63.0)	125 (59.5)	270 (64.7)	0.201
BMI, kg/m^2	21.2 ± 4.3	21.2 ± 3.9	21.2 ± 4.4	0.924
ABO blood group				0.605
ABO-A	226 (36.0)	83 (39.5)	143 (34.3)	
ABO-B	161 (25.7)	50 (23.8)	111 (26.6)	
ABO-O	163 (26.0)	51 (24.3)	112 (26.9)	
ABO-AB	77 (12.3)	26 (12.4)	51 (12.2)	
Urgency at the time of registration				0.361
High urgent	222 (35.4)	78 (37.1)	144 (34.5)	
Urgent	252 (40.2)	88 (41.9)	164 (39.3)	
Elective	153 (24.4)	44 (21.0)	109 (26.1)	

All data are presented as numbers (%) or mean ± standard deviation.
ILD = interstitial lung disease, PPH = primary pulmonary artery hypertension, COPD = chronic obstructive pulmonary disease, BMI = body mass index.

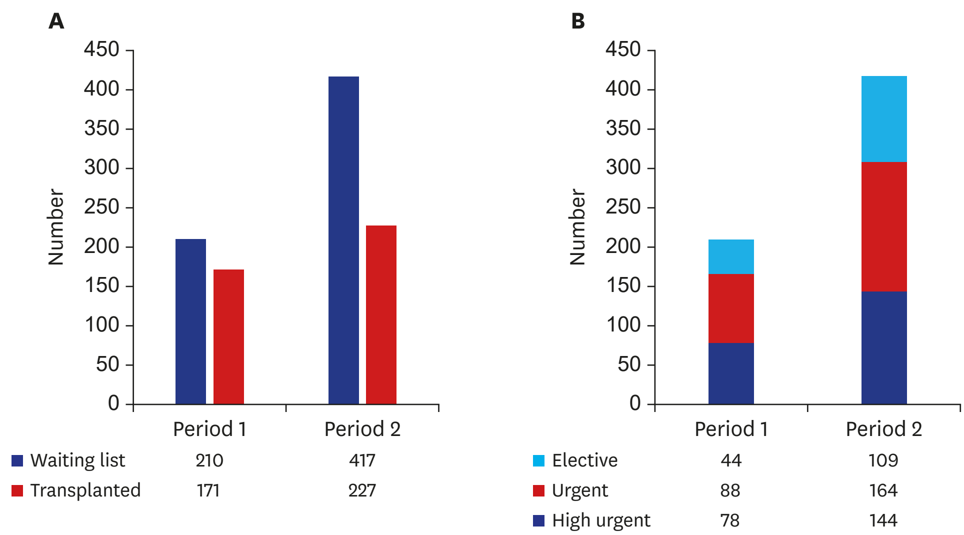

Fig. 1. Number of patients on the lung transplant waiting list in Korea according to period, by urgency status. (**A**) Total waiting list size increased by 98.6%, from 210 in period 1 to 417 in period 2. (**B**) There were no differences related to urgency status among candidates listed for transplant between the two periods. A total of 35.4% of candidates had high urgent status requiring mechanical ventilation and/or extracorporeal membrane oxygenation support (37.1% vs. 34.5%, $P = 0.519$).

Transplantation

The number of transplant patients also increased by 32.7%, from 171 in period 1 to 227 in period 2 (**Fig. 1A**). The number of donors decreased from 1,042 to 878, whereas the usage rate, i.e., the number of donor lungs used for transplantation among the total number of reported donor lungs, increased from 16.4% to 25.9%. **Table 2** shows the baseline characteristics of the lung transplantations performed during the study period. The primary disease for which lung transplantation was performed was ILD. No significant difference was detected in the diagnosis profile between the two periods. There was also no significant difference in the blood type, except a very slight trend toward significance indicating that the proportion of patients with blood type A decreased from 40.9% to 30.8%, otherwise that of type O increased from 19.9% to 24.7%, between the two periods. The proportion of patients with high urgent status at transplantation increased from 45% to 60.4%, whereas those with urgent status decreased from 46.8% to 35.7% ($P = 0.006$, **Fig. 2**). No significant difference was observed in the waiting time from registration to transplantation, although it showed an increasing tendency among those with urgent status. The use of marginal donor lungs was strikingly increased from 29.8% to 53.7% ($P < 0.001$). To adjust urgency status and marginal donor usage between two groups, we conducted a propensity score matching analysis (**Supplementary Table 2**). No significant differences were detected in 1-, 6-month and 1-year survival rates between the two periods after propensity score matching (1-month survival 96.5% vs. 95.3%, $P = 0.585$, 6-month survival 81.2% vs. 82.4%, $P = 0.779$, 1-year survival 70.6% vs. 71.2%, $P = 0.905$). In the subgroup analysis for high urgent patients, 1-year survival tended to decrease from 72.7% to 61.3% ($P = 0.127$). Conversely, 1-year survival tended to increase from 70.9% to 80.2% ($P = 0.168$) in the urgent patients (**Fig. 3**).

Factors associated with 1-year mortality

The univariate analysis revealed that recipient age (≥ 65 years) (odds ratio [OR], 2.44; 95% confidence interval [CI], 1.40–4.25; $P = 0.002$) and donor age (≥ 55 years) (OR, 1.81; 95% CI, 1.01–3.25; $P = 0.045$) were significantly associated with 1-year mortality (**Supplementary**

Table 3). However, in the multivariate analysis, only recipient age (≥ 65 years) was found to be significantly associated with 1-year mortality (OR, 2.44; 95% CI, 1.40–4.25; $P = 0.002$).

Table 2. Baseline characteristics of patients with lung transplantation performed in Korea

Factors	Total (n = 398)	Period 1 (n = 171)	Period 2 (n = 227)	*P* value
Diagnosis				0.857
ILD	196 (49.2)	88 (51.5)	108 (47.6)	
PPH	12 (3.0)	5 (2.9)	7 (3.1)	
Bronchiectasis	21 (5.3)	7 (4.1)	14 (6.2)	
COPD	6 (1.5)	3 (1.8)	3 (1.3)	
Others	163 (41.0)	68 (39.8)	95 (41.9)	
Age, yr	52.3 ± 15.1	52.9 ± 13.1	52.0 ± 16.5	0.542
Male	256 (64.3)	104 (60.8)	152 (67.0)	0.205
BMI, kg/m^2	21.3 ± 4.1	21.3 ± 3.9	21.2 ± 4.3	0.874
ABO blood group				0.199
ABO-A	140 (35.2)	70 (40.9)	70 (30.8)	
ABO-B	107 (26.9)	44 (25.7)	63 (27.8)	
ABO-O	90 (22.6)	34 (19.9)	56 (24.7)	
ABO-AB	61 (15.3)	23 (13.5)	38 (16.7)	
Location				0.257
Region 1	330 (82.9)	146 (85.4)	184 (81.1)	
Region 3	68 (17.1)	25 (14.6)	43 (18.9)	
Urgency at the time of transplant				0.006
High urgent	214 (53.8)	77 (45.0)	137 (60.4)	
Urgent	161 (40.5)	80 (46.8)	81 (35.7)	
Elective	23 (5.8)	14 (8.2)	9 (4.0)	
Time to lung transplant, day				
Total	143.2 ± 265.9	116.6 ± 185.1	163.1 ± 312.2	0.065
High urgent	97.1 ± 218.9	74.2 ± 126.6	110.0 ± 256.2	0.252
Urgent	207.7 ± 318.0	158.8 ± 230.1	256.0 ± 381.1	0.052
Utilization rate of marginal donor				
Total	173 (43.6)	51 (29.8)	122 (53.7)	< 0.001
High urgent	104 (48.6)	27 (35.1)	77 (56.2)	0.003
Urgent	59 (36.6)	21 (26.3)	38 (46.9)	0.007

All data are presented as mean ± standard deviation or numbers (%).
ILD = interstitial lung disease, PPH = primary pulmonary artery hypertension, COPD = chronic obstructive pulmonary disease, BMI = body mass index.

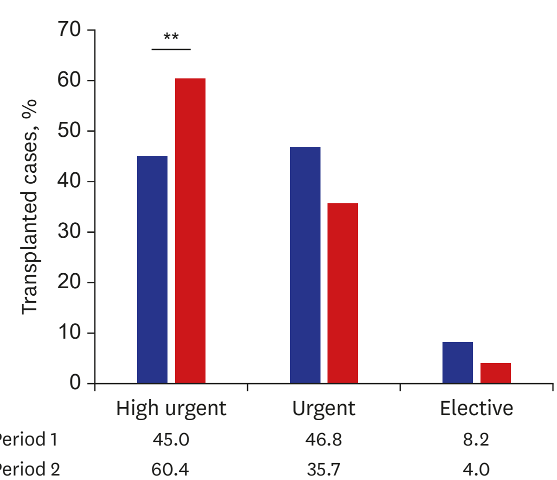

Fig. 2. Number of lung transplants performed in Korea according to urgency status and periods.
The proportion of patients with high urgent status at transplantation increased from 45% to 60.4% ($P = 0.006$).
**$P < 0.01$.

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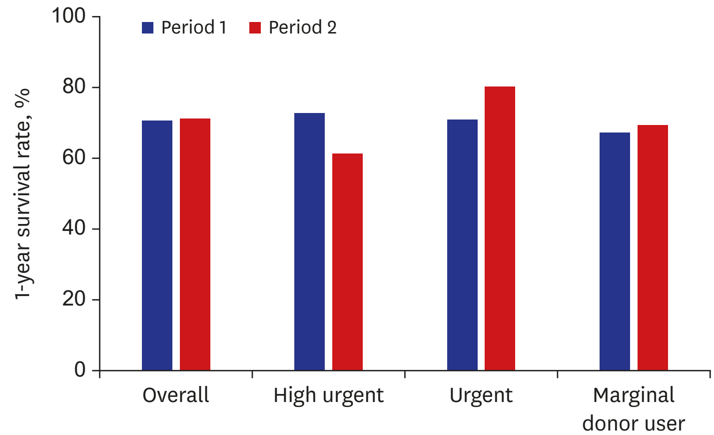

Fig. 3. 1-year survival rates of lung transplantations after propensity score matching analysis.
There were no significant differences in 1-year survival rates of each subgroup between the two periods after propensity score matching.

Characteristics of death on waiting list

Table 3 shows the baseline characteristics of the patients who died while waiting for lung transplantation. No significant differences were observed in the mortality rate on the waiting list between the two periods (17.1% vs. 19.4%, $P = 0.489$). The proportion of patients with ILD increased from period 1 to period 2 (30.6% vs. 54.3%, $P = 0.024$). The proportion of patients with blood type A increased from 33.3% to 46.9%, whereas that of type O decreased from 44.4% to 32.1%, with no statistical significance ($P = 0.531$). There was a significant difference in the urgency at the time of registration. The proportion of patients with urgent status significantly increased from 19.4% to 43.2% ($P = 0.039$). There was no significant difference in the cause of death on the waiting list between the two periods (**Supplementary Table 4**).

Table 3. Clinical characteristics of death on the waiting list according to periods

Factors	Total (n = 117)	Period 1 (n = 36)	Period 2 (n = 81)	*P* value
Diagnosis				0.024
ILD	55 (47.0)	11 (30.6)	44 (54.3)	
PPH	12 (10.3)	4 (11.1)	8 (9.9)	
Bronchiectasis	5 (4.3)	4 (11.1)	1 (1.2)	
COPD	6 (5.1)	1 (2.8)	5 (6.2)	
Others	39 (33.3)	16 (44.4)	23 (28.4)	
Age, yr	52.1 ± 18.3	48.3 ± 14.0	53.8 ± 19.7	0.137
Male	73 (62.4)	20 (55.6)	53 (65.4)	0.309
BMI, kg/m^2	21.5 ± 4.5	21.0 ± 4.2	21.7 ± 4.6	0.442
ABO blood group				0.531
ABO-A	50 (42.7)	12 (33.3)	38 (46.9)	
ABO-B	18 (15.4)	6 (16.7)	12 (14.8)	
ABO-O	42 (35.9)	16 (44.4)	26 (32.1)	
ABO-AB	7 (6.0)	2 (5.6)	5 (6.2)	
Location				0.712
Region 1	102 (87.2)	32 (88.9)	70 (86.4)	
Region 3	15 (12.8)	4 (11.1)	11 (13.6)	
Urgency at the time of registration				0.039
High urgent	4 (3.4)	1 (2.8)	3 (3.7)	
Urgent	42 (35.9)	7 (19.4)	35 (43.2)	
Elective	71 (60.7)	28 (77.8)	43 (53.1)	

All data are presented as mean ± standard deviation or numbers (%).
ILD = interstitial lung disease, PPH = primary pulmonary artery hypertension, COPD = chronic obstructive pulmonary disease, BMI = body mass index.

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Table 4. Status of used donor lung

Factors	Total	Period 1	Period 2	*P* value
Age	40.1 ± 13.1	39.3 ± 12.6	40.7 ± 13.4	0.285
Age ≥ 55 yr	56 (14.1)	19 (11.1)	37 (16.3)	0.141
Smoking habit ≥ 20 pack-yr	143 (35.9)	61 (35.7)	82 (36.1)	0.926
PF ratio	445.8 ± 101.2	443.4 ± 102.8	447.6 ± 100.2	0.685
PF ratio < 300	40 (10.1)	19 (11.1)	21 (9.3)	0.541
Radiological abnormality[a]	103 (25.9)	24 (14.0)	79 (34.8)	< 0.001

All data are presented as mean ± standard deviation or numbers (%).
PF = PaO_2/FiO_2
[a]Radiological abnormality indicates a presence of consolidation or collapse in the chest radiograph.

Used donor lungs

The status of used donor lungs is presented in **Table 4**. The mean age of the patients was 40.1 ± 13.1 years, with no difference in donor age between the two periods. The proportion of patients aged ≥ 55 years tended to increase from 11.1% to 16.3%. Smoking habit and PF ratio showed no differences among the patients. However, the proportion of patients with consolidation or collapse in the chest radiograph significantly increased from 14.0% to 34.8% ($P < 0.001$).

Unused donor lungs

The causes of unused donor lungs are presented in **Supplementary Table 5**. The major cause was poor donor lung condition. The proportion of marginal donor lungs among the unused donor lungs was 81.7%, with no difference between the two periods (80.5% vs. 83.4%, $P = 0.146$). The mean age of donor patients whose lungs were unused was 49.1 ± 16.4 years, and the proportion of those aged ≥ 55 years was 41.8%, and 43.1% of patients had smoking habit. The mean PF ratio was 271.8 ± 128.7 mmHg, and chest X-ray abnormality was observed in 22.1% of patients. The difference in each factor between the two periods is presented in **Supplementary Table 6**. The mean age of donor patients whose lungs were unused increased from 48.2 ± 16.8 to 50.2 ± 15.8 years ($P = 0.015$), and no significant differences were detected in other factors between the two periods.

DISCUSSION

This study describes the performance changes of lung transplantation according to the revision of the lung allocation system in Korea. Overall, the transplant outcome in terms of waiting list mortality and 1-year survival rate after lung transplantation did not differ between the two organ allocation systems. However, there was an increase in the number of both transplant cases and waiting list patients between the two different time periods and allocation systems. Considering the shortage of donors, the number of recipients with high urgent status and the use rates of marginal donor lungs were increased. Despite the more efficient use of donor resources, there was an increase in the waiting list mortality among patients in specific subgroups such as those with ILD, blood type A, and the urgently registered group.

This study provides several important findings. First, as the volume of waiting list is doubling rapidly, there is worsening of donor shortage. Consequently, the waiting time for transplantation has increased, and the use of marginal donor lungs also increased with the increase in the number of patients with high urgent status. Furthermore, early registered population, including those with urgent status, loses the opportunity to obtain a donated lung. Second, the waiting list mortality among patients with ILD increased despite the increased use of marginal donor lungs. Considering that the majority of lung diseases for which lung transplantations are performed in Korea are ILDs, this remains a critical issue. Unlike other major diseases requiring lung transplantation, patients with ILD can experience acute exacerbations.[9] Although such patients can have a high priority in the current allocation system, the problem of donor shortage has increased the waiting list mortality among those with ILD. Third, with the increasing number of patients on the waiting list with high urgent status requiring mechanical ventilation and/or extracorporeal membrane oxygenation, the number of transplantations has increased under the high urgent condition. Obviously, these patients are not likely to be alive for 1 year without lung transplantation, and the current system provides them preferential access to transplantation. In this study, 1-year survival tended to decrease from 72.7% to 61.3% ($P = 0.127$) in the high urgent patients. Conversely, it tended to increase from 70.9% to 80.2% ($P = 0.168$) in the urgent patients. However, the transplantation of high urgent patients should not be restricted by simply considering the transplant outcomes. New allocation policy for transplantation of high urgent patients are required to balance waiting list mortality and post-transplant outcome.

The current system in Korea focuses primarily on medical urgency and does not consider the potential benefits of transplantation such as the 1-year outcome. In the principle of the lung allocation system, waiting list mortality and transplant outcomes are incompatible issues.[7] When priority is given to urgency, the waiting list mortality can be reduced, but the 1-year survival rate cannot be guaranteed. In 2005, the United States changed the urgency-based system to a balanced system that considers both urgency and transplantation outcomes.[10] The new system (lung allocation system; LAS) yields an estimate of the likelihood of survival within the following year on the waiting list and of the 1-year survival after transplantation; these estimates were derived from a set of patient-related variables. Patients with higher LAS scores are assigned a higher priority for lung transplantation because of their predicted higher likelihood of survival benefit after transplantation. Several studies have shown the positive effects of new systems (LAS) in the Unites States, and the German system was revised based on the US LAS in 2011.[11-13] This change has reduced the mortality on the waiting list and improved the transparency in the process of organ allocation in Germany.[14,15]

In this analysis, the revised system did not lead to worse overall post-transplant outcomes or waiting list mortality. Moreover, the transplantation result did not deteriorate despite the increased use of marginal donor lungs or increased number of recipients with severe condition. However, we cannot disclose whether these phenomena are due to the learning curve of the Korean lung transplant society or other undefined factors. A definite aspect is that currently there is no parameter that can be used to audit this new allocation system in the perspective of post-transplant outcomes. To develop and introduce a new allocation system tailored to Korean patients' characteristics like the LAS in US, it is essential to have a detailed record of each of the transplant centers about the additional recipient-related parameters before and after lung transplantation. The development of a new allocation model that predicts the transplant outcomes should be implemented based on such reliable data. This important issue of lung transplantation requires in-depth discussion and sophisticated planning in the Korea transplant society and government.

SUPPLEMENTARY MATERIALS

Supplementary Table 1

Comparison before and after the revision of the registration criteria for a lung transplant

Click here to view

Supplementary Table 2

PSM of patients with lung transplantation performed in Korea

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Supplementary Table 3

Univariate and multivariate regression analysis for 1-year mortality

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Supplementary Table 4

Cause of death on the waiting list

Click here to view

Supplementary Table 5

Causes of unused donor lungs

Click here to view

Supplementary Table 6

Unused donor lungs

Click here to view

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