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**Original**

# Analysis of the Characteristics of Patients Presenting with Exacerbation of Asthma to Emergency Care Units

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**SUMMARY**

**Background** : Fatal asthma remains a serious problem, and patient self-management of asthma is important to prevent exacerbation. To reduce the asthma mortality rate, we analyzed the characteristics of patients who visited an emergency care unit with exacerbation of asthma.

**Methods** : Subjects were 317 patients (135 men, 182 women ; mean age, 47.0 years) who visited the emergency room at Dokkyo Medical University Hospital or Dokkyo Medical University Koshigaya Hospital for exacerbation of asthma between April 2010 and March 2011. When categorized by severity, 41.3% of patients were step 1, 8.2% were step 2, 18.9% were step 3, 30.9% were step 4, and 0.6% were unknown. When categorized by primary care physician, 60.3% of patients had a primary care physician at Dokkyo Medical University, 13.6% had one at another hospital, and 26.2% had no primary care physician. When categorized by recovery from exacerbation, control was achieved within 1 day in 63.1% of cases, after more than 1 day in 30.6% of cases, and required admission in 6.3% of cases.

**Results** : The rate of admissions was highest for cases with step 1 severity (step 1, 55.0% ; step 2, 20.0% ; step 3, 0.0% ; and step 4, 25.0%). The rate of admissions did not differ significantly by age (age 15-39 years, 40.0% ; 40-65 years, 25.0% ; >65 years, 35.0%). Initial value of oxyhemoglobin saturation ($SpO_2$) measured by pulse oximetry was significantly lower in the admission group ($SpO_2$ 92.4%) than in the non-admission group ($SpO_2$ 95.2%, $p<0.01$).

**Conclusion** : Patients with step 1 severity who visit an emergency unit with exacerbation of asthma may need regular treatment for asthma. When initial $SpO_2$ is less than 92%, we should consider hospitalization for treatment of asthma.

**Key Words** : asthma, emergency room, fatal asthma, pulse oximetry, exacerbation of asthma

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## INTRODUCTION

The asthma mortality rate is decreasing year on year in Japan. Around 6,000 patients died per year from asthma in the 1990's in Japan, compared to 1,726 fatal cases recorded in 2013[1]. This reduction in the number fatal asthma cases is thought to be due to improvements in inhaled corticosteroids (ICSs) and leukotriene receptor antagonists (LTRAs) that are widely used to treat asthma[2]. However, although the asthma mortality rate is decreasing, severe exacerbation or poor management of asthma continues to reduce the quality of life (QOL) of some patients and is a known risk factor for death[3~5]. In addition, exacerbation of asthma is associated with considerable healthcare costs and negatively effects on the quality of life of family members[6,7]. The prevalence of asthma has been reported to be 8.4% in Japan[8,9] and exacerbation of asthma remains a serious problem.

To reduce mortality from asthma, it is very important to investigate the characteristics of patients who experience exacerbation of asthma. At the two university hospitals within Dokkyo Medical University (Dokkyo Medical University Hospital and Dokkyo Medical University Koshigaya Hospital), we have emergency care units and provide 24-hour emergency care to all patients with exacerbation of asthma. In this study, we analyzed the demographic characteristics of patients who presented at our university hospitals with exacerbation of asthma.

## MATERIAL and METHODS

*Study design*

In a retrospective review of the medical records of patients who visited the emergency care unit of Dokkyo Medical University Hospital or Dokkyo Medical University Koshigaya Hospital for exacerbation of asthma, we noted patient age, sex, initial value of oxyhemoglobin saturation ($SpO_2$) measured by pulse oximetry, medication for exacerbation of asthma, and their primary care physician. Physicians at our hospitals had recorded the severity of asthma based on treatment of asthma before exacerbation, according to the Asthma prevention and Management Guideline 2009, Japan (JGL2009) : step 1, intermittent ; step 2, mild persistent ; step 3, moderate persistent ; and step 4, severe persistent[10]. This retrospective study conformed to the guidelines of the Ethics Committee of Dokkyo Medical University.

*Subjects*

Study subjects were all patients who had presented with exacerbation of asthma at either of the Dokkyo Medical University (DMU) emergency care units between April 2010 and March 2011. In total, 317 cases (135 men, 182 women ; mean age, 47.0 years), who were excluded other lung disease such as COPD, were identified for analysis. The detailed characteristics of patients are shown in Table 1. When categorized by severity, 41.3% of patients were step 1, 8.2% were step 2, 18.9% were step 3, 30.9% were step 4, and 0.6 % were unknown. When categorized by primary care physician, 60.3% of patients had a primary care physician at Dokkyo Medical University, 13.6% had one at another hospital, and 26.2% had no primary care physician. When categorized by age, 39.7% of patients were 15-39 years old (young group), 41.0% were 40-65 years old (middle-aged group), and 19.2% were> 65 years old (advanced aged group). Recovery from exacerbation of asthma was within 1 day in 63.1% of patients,>1 day in 30.6%, and required admission in 6.3%.

In regard to the treatment required for recovery from exacerbation of asthma, we divided patients into three groups according to corticosteroid dose : <60 mg of methylprednisolone (low-dose group), ≥60 to 125 mg of methylprednisolone (mid-dose group), and> 125 mg of methylprednisolone (high-dose group). When patients took a corticosteroid other than methylprednisolone, we calculated the equivalent dose for methylprednisolone. Two cases in which corticosteroid dose is unknown are not shown as relative risk could not be calculated.

*Statistical analysis*

All statistical analysis was performed using Microsoft Excel® and JMP® statistical software. Differences between two independent samples were examined by calculating relative risk along with the 95% confidence intervals by the chi-square test or Wilcoxon's signed rank test. Differences at $p<0.05$ were considered significant.

**Table 1** Background of patients

| | No. of patients (%) |
|---|---|
| Total | 317 (100.0) |
| Sex | |
| Male | 135 (42.6) |
| Female | 182 (57.4) |
| Age bracket (years) | 47.0±18.0 |
| Young (15-39 years) | 126 (39.7) |
| Middle-aged (40-65 years) | 130 (41.0) |
| Advanced age (>65years) | 61 (19.2) |
| Severity | |
| Step 1 | 131 (41.3) |
| Step 2 | 26 (8.2) |
| Step 3 | 60 (18.9) |
| Step 4 | 98 (30.9) |
| Unknown | 2 (0.6) |
| Primary care physician | |
| DMU | 191 (60.3) |
| Other hospitals | 43 (13.6) |
| No primary care physician | 83 (26.2) |
| Recovery from exacerbation | |
| Within 1 day | 200 (63.1) |
| >1 day | 97 (30.6) |
| Required admission | 20 (6.3) |

DMU : Dokkyo Medical University

## RESULTS

*Analysis based on severity*

Most patients with exacerbation of asthma who visited the emergency care units had step 1 severity (Table 1). The results of analysis based on the severity of asthma are shown in Table 2. Two cases in which severity of asthma is unknown are not shown as relative risk could not be calculated. In regard to severity and the primary care physician, the rate of step 4 patients was highest for those with a primary care physician at DMU (step 1 in 15.7%, step 2 in 8.9%, step 3 in 27.2%, and step 4 in 48.2%), while the rate of step 1 patients was highest without a primary care physician (100.0 %, 0.0%, 0.0%, and 0.0%, respectively) and then at another hospital (43.9%, 22.0%, 19.5%, and 14.6%, respectively). Significant differences were observed between the three groups ($p<0.001$) as well as within them ($p<0.001$).

Looking at severity with respect to patient age, the rate of step 1 patients was highest in the young age group (step 1 in 68.0% of patients, step 2 in 8.0%, step 3 in 17.6%, and step 4 in 6.4%), whereas the rate of step 4 patients was highest in the advanced aged group (23.0%, 8.2%, 16.4%, and 52.5%, respectively), followed closely by the middle-aged group (24.8%, 8.5 %, 21.7%, and 45.0%, respectively). Significant differences were observed between the young age and the middle-aged groups, and between the young and advanced age groups ($p<0.001$). A significant difference was observed within the three age groups ($p<0.001$).

In regard to the treatment required for recovery of the exacerbation of asthma, the rate of step 1 patients were highest in the ultrasonic nebulizer only group (step 1 in 74.5% of patients, step 2 in 7.8%, step 3 in 3.9%, and step 4 in 13.7%), followed by mid-dose corticosteroids group (56.0%, 9.0%, 22.0%, and 13.0%, respectively) and the low-dose corticosteroids group (46.0%, 10.8%, 10.8%, and 32.4%, respectively). On the other hand, with the rate of step 4 patients being highest in the high-dose corticosteroids group (14.4%, 7.2%, 25.6%, and 52.8%, respectively). Significant differences were observed between the four treatment groups ($p<0.05$) as well as within them ($<0.001$). As for recovery from exacerbation of asthma, the rate of step 1 patients was highest in the required admission group (step 1 in 55.0% of patients, step 2 in 20.0%, step 3 in 0.0%, and step 4 in 25.0%, respectively), followed by the recovery within 1 day group (52.5%, 8.6 %, 18.2%, and 20.7%). In contrast, the rate of step 4 patients was highest in the recovery>1 day group (16.5%, 5.2%, 24.7%, and 53.6%, respectively). Significant differences were observed between the within 1 day and>1 day groups and between the>1 day and required admission groups ($p<0.001$). Also, a significant difference was observed within the three recovery groups ($p<0.001$).

*Analysis based on a primary care physician*

In regard to patient age, the rate of patients who had no primary care physician was highest in the young age group (DMU in 38.9%, other hospital in 15.9%, no primary care physician in 45.2%), while the rate of patients who had a primary care physician at DMU was highest in the advanced aged group (82.0%, 13.1%, 4.9 %, respectively), followed by the middle-aged group (70.8%, 11.5%, 17.7%, respectively).

A significant difference was seen between the young

**Table 2** Analysis of patient characteristics

| | Step 1 | | Step 2 | |
|---|---|---|---|---|
| | Prevalence % (n) | RR (95%CI) | Prevalence % (n) | RR (95%CI) |
| Primary care physician | | | | |
| 1. DMU | 15.7 (30/191) | | 8.9 (17/191) | |
| 2. Other hospital | 43.9 (18/41) | 0.36 (0.22-0.58) | 22.0 (9/41) | 0.41 (0.19-0.84) |
| 3. No primary care physician | 100.0 (83/83) | 0.16 (0.11-0.22) | 0.0 (0/83) | N/A |
| Age bracket (years) | | | | |
| 4. Young (15-39) | 68.0 (85/125) | | 8.0 (10/125) | |
| 5. Middle-aged (40-65) | 24.8 (32/129) | 2.74 (1.98-3.79) | 8.5 (11/129) | 0.94 (0.41-2.13) |
| 6. Advanced age (>65) | 23.0 (14/61) | 2.96 (1.84-4.77) | 8.2 (5/61) | 0.98 (0.35-2.73) |
| Treatment for exacerbation | | | | |
| 7. Ultrasonic nebulizer only | 74.5 (38/51) | | 7.8 (4/51) | |
| 8. Low-dose of corticosteroids | 46.0 (17/37) | 1.62 (1.10-2.38) | 10.8 (4/37) | 0.73 (0.19-2.71) |
| 9. Mid-dose of corticosteroids | 56.0 (56/100) | 1.33 (1.05-1.69) | 9.0 (9/100) | 0.87 (0.28-2.69) |
| 10. High-dose of corticosteroids | 14.4 (18/125) | 5.17 (3.28-8.17) | 7.2 (9/125) | 1.09 (0.35-3.38) |
| Recovery from exacerbation | | | | |
| 11. Within 1 day | 52.5 (104/198) | | 8.6 (17/198) | |
| 12. >1 day | 16.5 (16/97) | 3.18 (2.00-5.08) | 5.2 (5/97) | 1.67 (0.63-4.38) |
| 13. Required admission | 55.0 (11/20) | 0.96 (0.63-1.45) | 20.0 (4/20) | 0.43 (0.16-1.15) |

RR : relative risk, CI : confidence interval, DMU : Dokkyo Medical University
Two cases in which severity of asthma is unknown are not shown as RRs could not be calculated. Two cases in which corticosteroid dose is unknown are not shown as RRs could not be calculated.

and middle-aged groups and between the young and advanced groups ($p<0.001$), A significant difference was also observed within the three age groups ($p<0.001$). The table is not shown.

*Analysis based on treatment for exacerbation of asthma*

As for the periods to visit the DMU emergency care unit from exacerbation of asthma,<24hr was 27.6%, 24hr-72hr was 38.7%, and>72hr was 33.7%. We divided the above three groups, because it is difficult for patients to know the correct onset of exacerbation as the time.

Table 3 shows the results of analysis according to treatment type. As for treatment and the primary care physician, most patients who were treated with high-dose corticosteroids had a primary care physician at DMU (ultrasonic nebulizer only in 6.8% of patients, low-dose corticosteroids in 12.0%, mid-dose corticosteroids in 25.7%, and high-dose corticosteroid in 55.5%), while most patients treated with mid-dose corticosteroids had a primary care physician at another hospital group (21.4%, 9.5%, 47.6%, and 21.4%, respectively), followed by those with no primary care physician (35.4%, 12.2%, 39.0%, and 13.4%, respectively). Significant differences were observed between the DMU and other hospital groups and between the DMU and no primary care physician groups ($p<0.001$). A significant difference was also seen within these three groups (p

according to severity of asthma

| Step 3 | | Step 4 | | Chi-square test | |
|---|---|---|---|---|---|
| Prevalence % (n) | RR (95%CI) | Prevalence % (n) | RR (95%CI) | $\chi^2$ (p-value) | Subject |
| 27.2 (52/191) | | 48.2 (92/191) | | | |
| 19.5 (8/41) | 1.40 (0.72-2.71) | 14.6 (6/41) | 3.29 (1.55-6.99) | 27.86 (<0.001) | vs "1" |
| 0.0 (0/83) | N/A | 0.0 (0/83) | N/A | 169.65 (<0.001) | vs "1" |
| | | | | 57.16 (<0.001) | "2" vs "3" |
| | | | | 184.96 (<0.001) | "1"～"3" |
| 17.6 (22/125) | | 6.4 (8/125) | | | |
| 21.7 (28/129) | 0.81 (0.49-1.34) | 45.0 (58/129) | 0.14 (0.07-0.29) | 62.61 (<0.001) | vs "4" |
| 16.4 (10/61) | 1.07 (0.54-2.12) | 52.5 (32/61) | 0.12 (0.06-0.25) | 56.11 (<0.001) | vs "4" |
| | | | | 1.14 (0.767) | "5" vs "6" |
| | | | | 77.09 (<0.001) | "4"～"6" |
| 3.9 (2/51) | | 13.7 (7/51) | | | |
| 10.8 (4/37) | 0.36 (0.07-1.88) | 32.4 (12/37) | 0.42 (0.18-0.97) | 7.98 (0.047) | vs "7" |
| 22.0 (22/100) | 0.18 (0.04-0.73) | 13.0 (13/100) | 1.06 (0.45-2.48) | 8.87 (0.031) | vs "7" |
| 25.6 (32/125) | 0.15 (0.04-0.62) | 52.8 (66/125) | 0.26 (0.13-0.53) | 63.30 (<0.001) | vs "7" |
| | | | | 7.98 (0.047) | "8" vs "9" |
| | | | | 18.88 (<0.001) | "8" vs "10" |
| | | | | 54.82 (<0.001) | "9" vs "10" |
| | | | | 86.41 (<0.001) | "7"～"10" |
| 18.2 (36/198) | | 20.7 (41/198) | | | |
| 24.7 (24/97) | 0.73 (0.47-1.16) | 53.6 (52/97) | 0.39 (0.28-0.54) | 45.54 (<0.001) | vs "11" |
| 0.0 (0/20) | N/A | 25.0 (5/20) | 0.83 (0.37-1.86) | 6.27 (0.099) | vs "11" |
| | | | | 23.14 (<0.001) | "12" vs "13" |
| | | | | 54.19 (<0.001) | "11"～"13" |

<0.001).

As for treatment and patient age, the rate of patients treated with mid-dose corticosteroids was highest in the young age group (ultrasonic nebulizer only in 27.4 %, low-dose corticosteroids in 9.7%, mid-dose corticosteroids in 38.7%, and high-dose corticosteroids in 24.2 %). On the other hand, the rate of patients treated with high-dose corticosteroids was highest in the advanced aged group (6.6%, 6.6%, 29.5%, and 57.4%, respectively), followed by the middle-aged group (10.0 %, 16.2%, 26.9%, and 46.9%, respectively). Significant differences were observed between the young and middle-aged groups and between the young and advanced aged groups ($p<0.001$). A significant difference was also observed within the three age groups ($p<0.001$).

*Analysis based on recovery from exacerbation of asthma*

Table 4 shows the results of the analysis based on recovery from exacerbation of asthma. Overall, 6.3% of patients who visited DMU emergency care unit required admission (Table 1).

In regard to patient age, the risk of admission was higher in the advanced aged group (recovery within 1 day in 57.4% of patients, >1 day in 31.2%, and required admission in 11.5%) than in the young age group (73.0%, 20.6%, and 6.4%, respectively) and the middle-aged group (56.2%, 40.0%, and 3.9%, respec-

**Table 3** Analysis of patient characteristics according

| | Ultrasonic nebulizer only | | Low-dose of corticosteroids | |
|---|---|---|---|---|
| | Prevalence % (n) | RR (95%CI) | Prevalence % (n) | RR (95%CI) |
| Primary care physician | | | | |
| 1. DMU | 6.8 (13/191) | | 12.0 (23/191) | |
| 2. Other hospital | 21.4 (9/42) | 0.32 (0.15-0.69) | 9.5 (4/42) | 1.26 (0.46-3.46) |
| 3. No primary care physician | 35.4 (29/82) | 0.19 (0.11-0.35) | 12.2 (10/82) | 0.99 (0.49-1.98) |
| Age bracket (years) | | | | |
| 4. Young (15-39) | 27.4 (34/124) | | 9.7 (12/124) | |
| 5. Middle-aged (40-65) | 10.0 (13/130) | 2.74 (1.52-4.95) | 16.2 (21/130) | 0.60 (0.31-1.17) |
| 6. Advanced age (>65) | 6.6 (4/61) | 4.18 (1.55-11.2) | 6.6 (4/61) | 1.48 (0.50-4.39) |

RR : relative risk, CI : confidence interval, DMU : Dokkyo Medical University
Two cases in which corticosteroid dose is unknown are not shown as RRs could not be calculated.

**Table 4** Analysis of patient characteristics according to recovery from exacerbation of asthma

| | Recovery within 1 day | | Recovery>1 day | |
|---|---|---|---|---|
| | Prevalence % | RR (95%CI) | Prevalence % | RR (95%CI) |
| Primary care physician | | | | |
| 1. DMU | 52.4 (100/191) | | 45.0 (86/191) | |
| 2. Other hospital | 74.4 (32/43) | 0.70 (0.56-0.88) | 4.7 (2/43) | 9.68 (2.48-37.8) |
| 3. No primary care physician | 81.9 (68/83) | 0.64 (0.54-0.76) | 10.8 (9/83) | 4.15 (2.20-7.85) |
| Age bracket (years) | | | | |
| 4. Young (15-39) | 73.0 (92/126) | | 20.6 (26/126) | |
| 5. Middle-aged (40-65) | 56.2 (73/130) | 1.30 (1.08-1.57) | 40.0 (52/130) | 0.52 (0.35-0.77) |
| 6. Advanced age (>65) | 57.4 (35/61) | 1.27 (1.00-1.62) | 31.2 (19/61) | 0.66 (0.40-1.10) |

RR : relative risk, CI : confidence interval, DMU : Dokkyo Medical University

tively). A significant difference was seen between the young and middle-aged groups ($p<0.01$) but not between the other pairs. A significant difference was observed within the three age groups ($p<0.01$).

Figure 1 shows the results according to treatment before exacerbation. Chi-square tests revealed that the number of patients differed significantly between three groups who used a combination of inhaled corticosteroids and long acting beta agonists (ICSs/LABAs, $p<0.001$), leukotriene receptor antagonists (LTRAs, $p<0.001$), theophylline ($p<0.01$), anti-IgE antibody ($p<0.001$), oral steroid ($p<0.01$), and short acting beta agonists (SABAs, $p<0.001$). The chi-square test analysis results between two groups are shown in Fig. 1.

Figure 2 shows the results of the analysis of initial $SpO_2$ values, using the Wilcoxon signed rank test. Initial $SpO_2$ values were significantly lower in patients who required admission ($92.4 \pm 4.2\%$) than those with recovery from exacerbation within 1 day ($95.1 \pm 2.6\%$, $p<0.01$) and those with recovery from exacerbation of >1 day ($95.4 \pm 3.0\%$, $p<0.001$). As another analysis, it is important to compare with usual $SpO_2$ values with-

to treatment for exacerbation of asthma

| Mid-dose of corticosteroids | | High-dose of corticosteroids | | Chi-square test | |
|---|---|---|---|---|---|
| Prevalence % (n) | RR (95%CI) | Prevalence % (n) | RR (95%CI) | $\chi^2$ (p-value) | Subject |
| 25.7 (49/191) | | 55.5 (106/191) | | | |
| 47.6 (20/42) | 0.54 (0.36-0.80) | 21.4 (9/42) | 2.59 (1.43-4.69) | 21.69 (<0.001) | vs "1" |
| 39.0 (32/82) | 0.66 (0.46-0.94) | 13.4 (11/82) | 4.14 (2.35-7.27) | 57.58 (<0.001) | vs "1" |
| | | | | 3.53 (0.317) | "2" vs "3" |
| | | | | 66.36 (<0.001) | "1"～"3" |
| 38.7 (48/124) | | 24.2 (30/124) | | | |
| 26.9 (35/130) | 1.44 (1.00-2.06) | 46.9 (61/130) | 0.52 (0.36-0.74) | 24.31 (<0.001) | vs "4" |
| 29.5 (18/61) | 1.31 (0.84-2.05) | 57.4 (35/61) | 0.42 (0.29-0.62) | 22.91 (<0.001) | vs "4" |
| | | | | 4.48 (0.214) | "5" vs "6" |
| | | | | 37.04 (<0.001) | "4"～"6" |

| Required admission | | Chi-square test | |
|---|---|---|---|
| Prevalence % | RR (95%CI) | $\chi^2$ (p-value) | Subject |
| 2.6 (5/191) | | | |
| 20.9 (9/43) | 0.13 (0.04-0.35) | 37.92 (<0.001) | vs "1" |
| 7.2 (6/83) | 0.36 (0.11-1.15) | 30.82 (<0.001) | vs "1" |
| | | 5.91 (0.052) | "2" vs "3" |
| | | 60.88 (<0.001) | "1"～"3" |
| 6.4 (8/126) | | | |
| 3.9 (5/130) | 1.65 (0.55-4.91) | 11.49 (0.003) | vs "4" |
| 11.5 (7/61) | 0.55 (0.21-1.46) | 4.71 (0.095) | vs "4" |
| | | 4.73 (0.094) | "5" vs "6" |
| | | 14.95 (0.005) | "4"～"6" |

out exacerbation of asthma. But, we could not analyze, because we could not know those in the other hospital group or the no primary care physician group.

## DISCUSSION

The findings of this study suggest the following risk factors for visits to emergency care units with exacerbation of asthma were being young with no primary care physician and being middle or advanced age and having more severe asthma although they were receiving full treatment for their asthma at DMU hospital. Although patients who were older and had more severe asthma needed high-dose corticosteroids and took a longer time to recover from the exacerbation, their risk of admission was lower. The risk of admission was high for patients of advanced aged who were treated for step 1 asthma at another hospital. Moreover, the risk of admission was higher when the initial $SpO_2$ value was<92%. We suggest that when a patient shows <92% initial $SpO_2$ at presentation to the emergency care unit, admission for treatment of exacerbation of asthma is required.

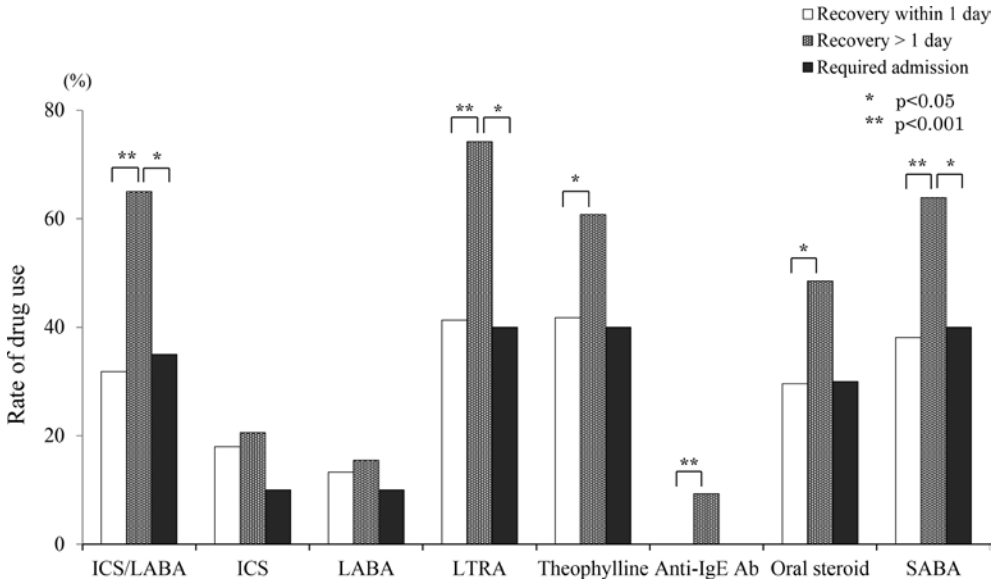


**Fig. 1** Treatment before exacerbation of asthma
Open bars denote patients with recovery of exacerbation within 1 day, gray bars denote patients with recovery of >1 day, and closed bars denote required admission. *p<0.05, **p<0.001.

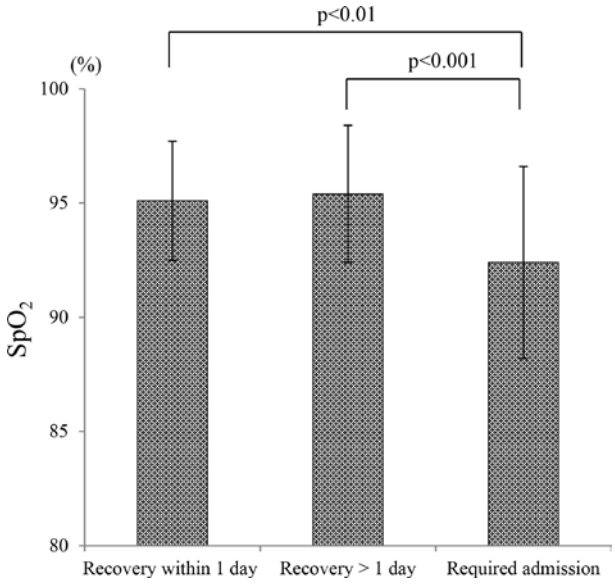


**Fig. 2** Initial $SpO_2$ values on visiting the emergency care unit according to recovery from exacerbation
Significant differences were observed between the required admission and non-admission groups ($p<0.01$). Data are expressed as means ± SD.

The most important reason for the reduced mortality from asthma is the more widespread use of ICSs. Rates of ICSs prescription for asthmatic patients in Japan were 12% in 2000, 18% in 2005, and 34% in 2011[11~13], indicating a negative correlation between asthma mortality and prescribed ICSs. Although the rate of ICSs prescribed in Japan has increased, it is still lower than that in Western countries. 85.9% of patients treated at our DMU hospitals were prescribed ICSs, including ICSs/LABAs, a higher rate than the 12–34% reported by the Japanese studies being investigated in Japan[11~13]. Therefore, patients who receive full treatment at our DMU hospitals typically have well-controlled asthma, although some with severe asthma may not have full control over their condition. The patients we should focus on most to reduce mortality from asthma are those who do not have a primary care physician and those who are not receiving full treatment by a non-specialist physicians. To narrow the focus, we tried to analyze treatment of asthma before exacerbation for the other hospital group and the no primary care physician group. But, we could not know the correct kind or dose of asthmatic drugs for those patients. Also, it was very difficult to analyze statistically, because combinations of drugs were too many. In the present study, three patients required to inhale oxygen over 10 L/min at initial treatment. One of cases was a 40 year old woman who was aspirin induced asthma without regular use of ICS. The other cases were a 37 year old woman and a 65 year old man who used ICS regularly. Whether they received full treatment was

unknown because they have been treated at other hospitals. No cases of them required intubation and had asthma-related death.

In the present study, 41.3% of patients who visited our emergency care units with exacerbation of asthma were categorized with step 1 severity and 55.0% of the patients admitted by us were also categorized as step 1. Because we did not always know the severity of the asthma patient before the episode of exacerbation, we had to categorize the severity based on regular treatment of asthma only in the present study[10]. However, step 1 may not denote mild asthma in all instances. Additional treatment might be needed for total control of asthma for those patients who are categorized as step 1 but subsequently require admission to a hospital with exacerbation of asthma. Most of our patients who were categorized as step 1 were young and could not visit the hospital regularly due to daily life commitments. Therefore, they did not have a primary care physician assigned to them. However, because they do not actually have mild asthma, they sometimes experience exacerbation of asthma. Despite the importance of total control of their asthma, it is very difficult for these patients to receive the full treatment for their asthma—a problem we pointed out in our previous study[14].

Many asthma-related deaths have been reported in young people who were frequently using only SABAs, without regular anti-inflammatory treatment[15,16]. Because mild exacerbation can be controlled by SABAs, patients do not think it is necessary to consult their physicians regularly. Patients are also unaware of the risk of asthma-related death because they lack sufficient information about asthma. Consequently, it is very important for patients without primary care physicians to receive advice from the emergency physician, because most do not have the opportunity to consult an allergist or pulmonologist. The educational interventions undertaken in emergency departments reduce subsequent asthma-related admissions to hospital[17]. Thus, to reduce asthma mortality further, ideally emergency physicians should evaluate the need for regular treatment and advise patients of their need accordingly. To facilitate proper care, we intend to establish guidelines for the diagnosis and treatment of asthma by emergency physicians.

Another of our findings was that patients who were older and had more severe asthma were categorized as step 4 visited our emergency care units frequently, despite having well-designed treatment, which included ICSs. Persistence of severe asthma and the poor response to treatment in this group of patients may be because airway remodeling occurred before the use of ICSs became widespread. Older patients who die from asthma are included in this group. Airway remodeling is a risk factor for fatal asthma, and prevention of asthma-related deaths is extremely difficult in older patients with airway remodeling[18]. The risk for multiple exacerbations and fatal asthma in such patients was noted in another Japanese study[19]. Although such patients in the present study needed high-dose corticosteroids and took a long time to recover from exacerbation of asthma, their risk of admission was lower. This could be because they have experienced exacerbations many times and so visit the emergency care unit in the early stage of exacerbation. It has been reported, however, that patients with a history of near-fatal asthma show reduced sensitivity to dyspnea[20~26]. In other words, these patients incorrectly perceive their symptoms to be mild rather than to be a more serious case of airway obstruction, and so can experience a severe attack without premonitory symptoms. It is important, therefore, to determine which patients are at risk before they experience a severe attack.

The present study highlighted a number of issues in the treatment of asthma. The most serious problem we should address concerns young patients without a primary care physician. In addition, some patients with mild (step 1) asthma needed to visit our emergency care unit with exacerbation and they may be needed regular treatment for asthma. When initial $SpO_2$ is less than 92%, we should consider hospitalization for treatment of asthma.

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