

# BMJ Open Impact of the hospitalist system on inpatient mortality and length of hospital stay in a teaching hospital in Japan: a retrospective observational study

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## ABSTRACT

**Objective** To examine the differences in the quality of care among inpatients before and after the introduction of the hospitalist system.

**Design** A retrospective observational study.

**Setting** A community teaching hospital in Japan.

**Participants** The inpatients admitted between the preintervention (January–December 2018) and 1-year intervention (January–December 2019) periods. There were 8508 and 8788 inpatients in 2018 and 2019, respectively.

**Interventions** The study compared the lengths of hospital stay and mortality among inpatients between the pre- and post-intervention (2018 and 2019) periods concerning the introduction of a hospital medicine department.

**Outcome measures** The primary objective was to evaluate and compare the in-hospital mortality and the length of stay (LOS) between 2018 and 2019. The secondary objective was to identify the characteristics of hospitalists and non-hospitalists in the system.

**Results** The LOS was significantly reduced after the introduction of the hospital medicine department (adjusted difference,  $-0.659$  days; 95% CI  $-1.118$  to  $-0.136$ ,  $p=0.01$ ). There were no differences in the adjusted mortalities between the two periods.

**Conclusions** To the best of our knowledge, our study is the first involving a teaching hospital in Japan to reveal that the hospitalist system had a positive effect on the efficiency of inpatient care by shortening the LOS. Further studies are needed to clarify other benefits related to the introduction of the hospital medicine department in Japan.

## INTRODUCTION

Ensuring patient safety and maintaining high-quality medical care are essential components of hospitals. However, this is becoming increasingly difficult due to the increased complexity of hospital care. At present, 13 countries worldwide have been classified as ‘super-aged societies.’<sup>1</sup> In these countries, more than 21% of the population is over 65 years old, and there are large numbers of multimorbidity patients.<sup>2</sup> With increasing

## Strengths and limitations of this study

- This was a retrospective observational study in Japan to compare the lengths of hospital stay and mortality among inpatients of a community teaching hospital between the preintervention and postintervention (2018 and 2019) periods to demonstrate that the introduction of a hospitalist system could reduce patients’ lengths of hospital stay.
- The hospitalist system reduced length of hospital stay without change of inpatient mortality in the current study. However, being a retrospective observational study, further investigation using a randomised controlled design is required.
- Although we adjusted for multiple factors in our comparison, unrecognised bias may have still influenced the results.
- The physicians, including the residents and trainees, were not identical between the two compared groups; therefore, the effect of the changes in physicians was negligible.
- We did not consider the impact of readmissions because their accurate assessment proved difficult; thus, we could not eliminate the possibility that the patients received treatment at other medical institutions after discharge.

numbers of patients with several comorbidities, their clinical management becomes more complicated, leading to an exponential growth in healthcare expenditure. Therefore, quality of care and cost efficiency must be improved.

Japan has been classified as a super-aged society since 2013.<sup>1</sup> This has forced medical care to deal with significant numbers of patients with complicated clinical problems and multiple morbidities. In Japan, the increase of medical expenditures is a growing problem, with super-aged societies and multimorbidity of elderly citizens as driving factors.<sup>2</sup> However, hospital inpatient care has



been divided by subspecialists derived from subspecialty-based medical education in Japanese medical schools.<sup>3</sup> However, the Japanese hospital system is still mainly organised according to specialist doctors,<sup>4</sup> and medical concerns regarding whether each organ-specific specialist could comprehensively manage hospitalised elderly patients have emerged.<sup>3</sup>

In the USA, hospitalists were proposed as a solution for the rapidly ageing society.<sup>5</sup> Since the advent of hospitalists at the end of the 20th century, hospitalist systems (HS) have spread rapidly across the country because they demonstrated abilities to achieve significant improvements in the quality of medical care.<sup>6</sup> The number of hospitalists in the USA increased to more than 50 000 in 2016, and 75% of all university hospitals have established these systems.<sup>7</sup> Currently, HS have spread to other countries from the USA and have reached East Asian countries, including Singapore, Korea and Taiwan, which have demonstrated notable improvements in the quality of care.<sup>8–10</sup> For example, Korea introduced a HS into general medicine and surgery in 2016 to solve their problems such as patient safety, healthcare quality and residents' well-being.<sup>11 12</sup> The HS improved many clinically significant indicators about not only medical quality and safety but also patient satisfaction.<sup>13–15</sup> Similarly, Taiwan introduced a HS in 2002, and it could improve medical quality and cost.<sup>8 16</sup> Regarding the length of hospital stay, Singapore, Korea and Taiwan have succeeded in reducing it by the HS.<sup>10</sup>

The HS may be appropriate for the Japanese setting; however, whether it could function in Japan is still unclear. One report found that hospitalists and general physicians improved the quality of the treatment of two crucial common diseases (pneumonia and cerebral infarction) in a community hospital.<sup>17</sup> In contrast, another report demonstrated that the lengths of hospitalisation of patients with aspiration pneumonia treated by hospitalists were longer than those of patients treated by non-hospitalists in a community hospital were.<sup>18</sup> However, there have been no reports on the effects of the HS on the overall improvement of care for hospitalised patients in Japan. Thus, in this study, we compared the length of hospital stay and mortality of inpatients before and after the implementation of the HS to clarify the effect of its introduction.

## METHOD

### Study design and participants

This was a retrospective observational study investigating the clinical characteristics and outcomes of adult patients before and after the introduction of the HS at Urasoe General Hospital (UGH) in Okinawa, Japan. UGH is a 334-bed community teaching hospital that has played a central role in providing a range of services, from primary to tertiary care, in the Urasoe area, with approximately 100 000 people.<sup>19</sup> In 2018, at UGH, 6 out of 19 specialties (respiratory medicine, cardiology, gastroenterology,

nephrology, neurology and endocrinology) were responsible for the management of common diseases, such as aspiration pneumonia and urinary tract infections. UGH introduced the HS in January 2019 as part of its hospital management plan. To assist the specialties above and sufficiently use their collective professional abilities, the hospitalist team covered all common diseases that were presented. Due to the limited human resources, in 2019, the hospitalists treated as many patients with common diseases as possible, and the specialists treated some of the inpatients. There are four hospitalist teams, and each team comprises one hospitalist, one to three senior residents and two to four junior residents. Notably, our definition of a hospitalist was based on the definition provided by a previous report,<sup>20</sup> which is 'physicians whose primary professional focus was the general medical care of hospitalised patients, and whose activities included patient care, teaching, research and leadership related to hospital medicine.'

We compared the clinical characteristics and outcomes of the inpatients admitted between the preintervention (January–December 2018) and 1-year intervention (January–December 2019) periods. In total, 17 296 patients were admitted to UGH between 1 January 2018 and 31 December 2019 (8508 patients in 2018 and 8788 patients in 2019). Based on previous reports, the patients' primary data, including age, sex, Charlson Comorbidity Index (CCI),<sup>21</sup> Barthel index (BI),<sup>22</sup> emergency admission rate, ambulance use, length of stay (LOS) and mortality, were obtained from the electronic health records provided by the data manager (TO).<sup>8</sup> The CCI attaches weights to clinical conditions such as myocardial infarction and dementia and then calculates the weightage of those conditions present in an individual.<sup>21</sup> The BI was used to rate the patients' activities of daily living.<sup>22</sup> The diseases that caused hospitalisation were analysed using the International Classification of Diseases, 10th revision (ICD-10).

### Outcome measures

The primary objective of this study was to evaluate and compare the in-hospital mortality and LOS between 2018 and 2019, while the secondary objective was to identify the characteristics of hospitalists and non-hospitalists in the system. Moreover, we evaluated the differences in the LOS in identical ICD-10 subgroups between 2018 and 2019.

### Statistical analysis

Data were collected from the hospital database by an independent data manager (TO) and analysed by two investigators (MK and YT). We compared the data from 2018 to 2019 and that between the group treated under the HS (here forth HS) and the non-HS (here forth National Health Service (NHS)) in 2019. Each variable was summarised as the median and IQR or as the mean. Intergroup differences in statistical data were assessed using the Wilcoxon rank-sum and  $\chi^2$  tests for continuous,

ordinal and categorical variables, respectively. A linear regression model was used to compare the LOS and mortality after adjusting for the independent variables, including treatment under the HS, age, sex, emergency admission rate, ambulance use, CCI and BI. Subgroup analysis according to the disease category based on the ICD-10 codes was performed based on the patient's final diagnosis. Statistical software STATA V.11 (Stata) was used to perform the analyses, and statistical significance was defined as  $p < 0.05$ .

### Patient and public involvement

No patient was involved.

## RESULTS

### Participant characteristics

All of the admitted patients were included in this study. The baseline characteristics of the patients in both periods are presented in [table 1](#). The patients' median age in 2019 was significantly higher than in 2018 (68.0 years vs 67.1 years,  $p = 0.003$ ). There were 4688 (55.1%) and 4764 (54.0%) men admitted in 2018 and 2019, respectively. The average CCI in 2019 was also significantly higher than in 2018 (1.41 vs 1.34,  $p = 0.005$ ). In contrast, there was no significant difference noted when the average BI in 2019 was compared with that in 2018 (2018; 52.6 vs 52.1,  $p = 0.25$ ).

**Table 1** The baseline characteristics of patients before and after the implementation of the hospitalist system

	Prehospitalist system	Posthospitalist system		
		Total	Hospitalist	Non-hospitalist
<b>Patient characteristics</b>				
Sex, male (%)	4687 (55.1)	4.749 (54.0)	885 (51.5)	3860 (54.6)
Age, years (IQR)	67.1 (57–81)	68.0 (59–81)	74.1 (66–86)	66.5 (57–80)
Charlson Comorbidity Index (IQR)	1.3 (0–2)	1.4 (0–2)	1.4 (0–2)	1.4 (0–2)
Barthel Index (IQR)	52.6 (10–90)	52.1 (10–90)	40.2 (5–75)	55.0 (15–90)
<b>Description of the disease</b>				
Infection (%)	233 (2.7)	427 (4.9)	263 (15.3)	164 (2.3)
Neoplasm (N, %)	988 (11.6)	1048 (11.9)	105 (6.1)	943 (13.3)
Haematology (%)	188 (2.2)	187 (2.1)	36 (2.1)	151 (2.1)
Endocrine (%)	207 (2.4)	252 (2.9)	102 (5.9)	150 (2.1)
Mental (%)	14 (0.2)	12 (0.1)	6 (0.4)	6 (0.1)
Nervous system (%)	330 (3.9)	411 (4.7)	66 (3.8)	345 (4.9)
Eye and adnexa (%)	67 (0.8)	87 (1.0)	14 (0.8)	73 (1.0)
Circulatory system (%)	1918 (22.5)	1923 (21.9)	76 (4.6)	1844 (26.1)
Respiratory system (%)	957 (11.3)	1031 (11.7)	651 (37.9)	380 (5.4)
Digestive system (%)	1473 (17.3)	1357 (15.4)	56 (3.3)	1301 (18.4)
Skin tissue (%)	125 (1.5)	151 (1.7)	62 (3.6)	89 (1.3)
Musculoskeletal system and connective tissue (%)	618 (7.3)	608 (6.9)	72 (4.2)	536 (7.6)
Genitourinary system (%)	277 (3.3)	273 (3.1)	165 (9.6)	108 (1.5)
Congenital abnormalities (%)	11 (0.1)	18 (0.2)	2 (0.1)	16 (0.2)
Injury and poisoning (%)	26 (0.3)	12 (0.1)	2 (0.1)	10 (0.1)
Other (%)	1076 (12.7)	991 (11.3)	38 (2.2)	953 (13.5)
<b>Clinical course</b>				
Emergency admission (%)	5159 (60.6)	5463 (62.2)	1606 (93.4)	3860 (54.6)
Ambulance use (%)	2100 (24.7)	2373 (27.0)	516 (30.0)	2373 (26.3)
Length of stay, days (IQR)	13.6 (4–16)	13.2 (4–15)	13.3 (5–15)	13.2 (4–15)
In-hospital mortality (%)	262 (3.1)	281 (3.2)	77 (4.5)	205 (2.9)

In 2019, after the implementation of the hospitalist system, the hospitalists managed 19.6% of the hospitalised patients. There were no differences in the mortality rates before and after the introduction of the system. The percentages of the diseases according to the International Classification of Diseases, 10th revision codes before and after the introduction of the hospitalist system are shown.

**Table 2** The result of regression analysis for lengths of hospital stay between 2018 and 2019

Variables	Length of hospital stay				
	$\beta$	SE	T	P value	95% CI
Hospitalist system	-0.02	0.27	-2.47	0.013	-1.181 to -0.136
Age	0.08	0.01	10.51	<0.001	0.067 to 0.097
Sex	0.01	0.27	1.48	0.139	-0.130 to -0.932
Emergency admission	0.11	0.29	13.77	<0.001	3.459 to 4.601
Ambulance use	0.04	0.32	4.65	<0.001	0.853 to 2.094
Charlson Comorbidity Index	0.14	0.06	18.28	<0.001	1.051 to 1.303
Barthel Index	-0.11	0.00	-13.78	<0.001	-0.062 to -0.047

Of all the patients admitted in 2019, 19.6% (n=1719) were categorised into the hospitalist management group. Patients in this group were significantly older (HS: 74.1 years old vs NHS: 66.5 years old,  $p<0.001$ ). When the HS and NHS groups were compared in 2019, the hospitalists had seen patients with higher CCIs and lower BIs than the non-hospitalists (HS: 1.43 and 40.2 vs NHS: 1.42 and 55.0,  $p=0.010$  and  $p<0.001$ , respectively).

### Clinical courses of participants

Overall, the inpatients in 2019 were more likely to be transported to UGH by ambulance than in 2018 (27.0% vs

24.7%,  $p<0.001$ ). Furthermore, in 2019, a greater number of patients were admitted through the emergency department than in 2018 (62.2% vs 60.6%,  $p=0.04$ ). Cardiovascular and gastrointestinal diseases were common in both periods (2018: 1918 and 1473 (22.5% and 17.3%) vs 2019: 1923 and 1357 ([21.9% and 15.4%), respectively; table 1).

The LOS in 2019 was shorter than in 2018 (13.2 days (IQR: 4–15 days) vs 13.6 days (IQR: 4–6 days),  $p=0.001$ ). Furthermore, when adjusting for the independent variables, the LOS was significantly shorter after the

**Table 3** Lengths of stay for each disease categorised by ICD-10 codes

Description of the disease	Length of stay			
	Prehospitalist system	Posthospitalist system		
		Total	Hospitalist	Non-hospitalist
Average length of stay (days, IQR)	13.6 (4–16)	13.2 (4–15)	13.3 (5–15)	13.2 (4–15)
Infection (days, IQR)	17.4 (7–19)	16.0 (7–17)	13.3 (7–15)	20.4 (8–22)
Neoplasms (days, IQR)	14.2 (4–16)	12.1 (2–14)	10.2 (2–12)	12.4 (5–15)
Haematology (days, IQR)	12.5 (4–13.5)	9.1 (3–10)	9.9 (3.5–11)	8.9 (3–10)
Endocrine (days, IQR)	11.1 (4–14)	10.8 (4–12)	10.1 (4–12)	11.2 (4–12)
Mental (days, IQR)	10.7 (6–15)	9.6 (3.5–16.5)	15.0 (5–23)	4.2 (2–5)
Nervous system (days, IQR)	12.9 (4–15)	12.6 (3–13)	8.4 (3–8)	13.4 (3–14)
Eye and adnexa (days, IQR)	4.9 (2–6)	4.3 (2–6)	4.2 (2–4)	4.3 (2–6)
Circulatory system (days, IQR)	14.3 (3–18)	14.1 (3–18)	18.7 (6–30)	13.9 (3–17)
Respiratory system (days, IQR)	13.2 (6–14)	12.2 (5–13)	12.6 (6–13)	11.5 (4–13)
Digestive system (days, IQR)	9.9 (5–11)	9.3 (4–10)	11.7 (5–12.5)	9.2 (4–10)
Skin tissue (days, IQR)	18.9 (7–22)	19.3 (7–21)	13.8 (8–18)	23.1 (7–30)
Musculoskeletal system and connective tissue (days, IQR)	17.9 (9–20)	17.9 (7–20)	20.0 (5.5–23.5)	17.6 (8–20)
Genitourinary system (days, IQR)	13.5 (7–15)	13.2 (6–16)	13.8 (7–16)	12.3 (5–17)
Congenital abnormalities (days, IQR)	8.9 (3–11)	6.2 (3–5)	4.0 (3–5)	6.5 (2.5–5)
Injury and poisoning (days, IQR)	3.8 (2–5)	3.7 (2–5)	4.0 (2–6)	3.6 (2–5)
Other (days, IQR)	14.9 (3–20.5)	16.9 (3–23)	30.6 (3–40)	16.4 (3–23)

ICD-10, International Classification of Diseases, 10th revision.

introduction of the HS (adjusted difference,  $-0.659$  days; 95% CI  $-1.118$  to  $-0.136$ ,  $p=0.01$ ; table 2). Table 3 shows the LOSs for each disease categorised according to their ICD-10 codes. Patients in 2019 who had respiratory, gastrointestinal or musculoskeletal and connective tissue diseases (2018: 13.2, 9.9 and 17.9 days, 2019: 12.2, 9.3 and 17.9 days;  $p<0.001$ ,  $p<0.001$  and  $p=0.020$ , respectively) had significantly shorter LOSs than patients admitted in 2018. Patients in 2019 who had skin tissue diseases (2018: 18.9 days, 2019: 19.3 days;  $p=0.032$ , respectively) and other category diseases (2018: 14.9 days, 2019: 16.9 days;  $p=0.003$ , respectively) had significantly longer LOSs than patients admitted in 2018. However, the patients' in-hospital mortality did not differ between 2018 and 2019 (262 (3.1%) vs 281 (3.2%),  $p=0.66$ ). Additionally, after adjusting for the independent variables, the in-hospital mortality did not differ between the pre-HSs and post-HSs (95% CI  $-0.006$  to  $0.004$ ;  $p=0.654$ ).

Table 2 shows the result of regression analysis for lengths of stay between 2018 and 2019. After adjusting for the independent variables, including treatment under the HS, age, sex, emergency admission rate, ambulance use, CCI and BI, the LOS was significantly shorter after the introduction of the HS.

Table 3 shows the duration of the lengths of stay between the pre-HS and post-HS and hospitalist and non-hospitalist groups according to the ICD-10 codes. After the introduction of the HS, there were significant differences noted for the malignant, haematological, respiratory, digestive and musculoskeletal disease groups throughout the hospital.

When we compared the characteristics of the patients who were cared for by the hospitalists to those cared for by the non-hospitalists in 2019, the former were more likely to use ambulances and be admitted to UGH through the emergency department (HS: 30.0% and 93.4% vs NHS: 26.3% and 54.6%,  $p=0.002$  and  $p<0.001$ , respectively). The LOS among the patients who were cared for by the hospitalists was significantly longer than for those who were not (HS: 13.3 days (IQR:  $-5$ – $15$  days) vs NHS: 13.2 days (IQR:  $4$ – $15$  days),  $p<0.001$ ). Notably, patients with infectious, neoplastic, or neurological diseases who were treated by hospitalists had significantly shorter LOSs than those who were not (HS: 13.3, 10.2 and 8.4 days vs NHS: 20.4, 12.4 and 13.4 days;  $p=0.004$ ,  $p<0.001$  and  $p<0.001$ , respectively). In contrast, patients with cardiovascular, respiratory, and digestive diseases who were treated by hospitalists had significantly longer LOSs than those who were not (HS: 18.7, 12.6 and 11.7 days vs NHS: 13.9, 11.5, 9.2 days;  $p<0.001$ ,  $p<0.001$  and  $p=0.02$ , respectively).

## DISCUSSION

### Study summary

To the best of our knowledge, this was the first interventional study in Japan to show that the introduction of the HS significantly reduced LOS in a teaching hospital without increasing hospital mortality. This finding is

the cornerstone for the usefulness of the HS in Japan. Nonetheless, while the Society of Hospital Medicine defines a hospitalist as a physician who focuses on the medical care of hospitalised patients,<sup>20</sup> the implementation of a HS must be adapted to each country's health-care system to ensure appropriateness. For example, in Japan, several hospitalist societies and organisations—including the Japanese Society of Hospital General Medicine,<sup>23</sup> the country's national hospitalist society—have varying working methods and systems. This should be considered when implementing the HS.<sup>24</sup> Additionally, there is an increasing need for high-quality, safe care. This is primarily and significantly because the number of patients with multiple morbidities and complicated social backgrounds is increasing with the ageing society.<sup>2</sup> In particular, statistics have shown that LOSs in Japan were longer than those in other developed countries<sup>25</sup>; thus, we propose that LOS reduction is one of the biggest challenges in Japan. However, there have only been a few reports on the effectiveness of HS in tackling this challenge in Japan.

### Impact on LOS

In this interventional study, the overall LOS was significantly shortened after the introduction of the HS. Various studies have reported on the positive impact of the HS since the introduction of hospitalists in 1996,<sup>26</sup> and LOS is one of the most investigated indicators in this regard.<sup>27</sup> A meta-analysis that compared hospitalist and non-hospitalist services also reported that the average LOS was significantly shorter in the hospitalist group compared with the non-hospitalist group.<sup>6,28</sup> Hospitalists also contributed to a shorter mean hospital stay when compared with family physicians and general internists.<sup>29</sup> However, most of these studies were conducted in US hospitals, and studies from other countries were reported in isolation and on a small scale.<sup>8,14,30</sup> In other Asian countries, including Korea, Taiwan and Singapore, the effects of the HS on LOS were reported. In Korea, they reviewed 19 450 medical admissions through the emergency department in a tertiary care hospital and revealed that the hospitalists unit could reduce 9.1 days of LOS.<sup>13</sup> The efficacy of the HS was also reported in Taiwan. They reported the positive effect of HS on LOS (non-hospitalist vs hospitalist; 15.4 vs 8.8 days,  $p<0.001$ ) and the no weekend effect on hospital mortality rates in the Hospitalist unit (hospitalist; weekday vs weekend; 8.1% vs 8.5%,  $p=0.818$ ).<sup>8,16</sup> Singapore adopted a HS based on family medicine. They revealed patients cared for by family medicine hospitalists had a shorter adjusted LOS of about 0.9 days compared with patients cared for by specialists.<sup>30</sup> These Asian countries and Japan have the same issues regarding medical quality and patient safety.<sup>10</sup> In this study, we revealed the exact effects of the reduction of LOS.

We identified three explanations for how the HS reduced LOS. First, the hospitalists primarily focused on onward care, which created a closer working relationship with the patients and medical staff. Previous studies<sup>31</sup> also



noted that hospitalists have the skills to work with ancillary staff, such as social workers or discharge planners. This serves to reduce the LOS associated with complex discharge planning. The results from this study also established that hospitalists were often in charge of patients admitted through the emergency room, suggesting that they could have better focus in the ward than their counterparts and, therefore, shorten the LOS.

Second, non-hospitalist physicians were able to utilise their expertise. In this study, when examining the LOS according to the ICD-10 category, after adjusting for the independent variables, there was a significant decrease in the LOS for malignant tumours and haematological and gastrointestinal diseases. Previous studies also indicated that a HS could reduce LOS for patients with pneumonia, sepsis or urinary tract infections<sup>14 31</sup> and could allow for the standardisation of the treatment.<sup>32</sup> This study supports these results. Moreover, the reduction in the average LOS for the disease groups that hospitalists were less likely to treat suggested that the HS enabled non-hospitalist physicians not to provide appropriate care in their areas of expertise. In contrast, a HS could increase LOS for patients with skin and soft tissue disease and other category diseases such as symptoms of unknown cause in this study. The number of patients with skin and soft tissue disease may be insignificant; skin and soft tissue disease comprised only 1.5% and 1.7% of total inpatients in 2018 and 2019. In addition, diagnosing skin and soft tissue diseases requires experienced physicians care,<sup>33</sup> and HS physicians are younger than NHS physicians (HS teams average postgraduate year: 12.8 and NHS teams average post-graduate year: 18.9). The number of inpatients with other category diseases reduced in 2019 than in 2018, although the total number of inpatients in 2019 was greater than in 2018. The HS hospitalists could initially diagnose unknown diseases and reclassify them into other ICD-10 categories. Further study in Japan is needed to reveal the effects on the LOS of each disease condition with HS.

Finally, hospitalists managed patients with complex diseases well. They were more likely to take care of patients with high CCIs and low BIs. Previous studies have also demonstrated the effects of LOS reduction, especially in older patients, such as those with high CCIs and low BIs. In terms of cause and effect, these studies considered hospitalists to be more efficient due to their degree of experience, as they could repeatedly manage patients with similar diseases.<sup>14</sup> In the future, the number of older adults in developed countries will increase. Many older adults are affected by cognitive impairment or dementia that is often accompanied by delirium. This interferes with communication, leading to behaviours that require special attention and hinder accurate diagnosis and treatment. Elderly patients also tend to require multiple hospitalisations and have more extended hospital stays due to the complexities of their illnesses and multiple comorbidities.<sup>34</sup> Several previous studies also found that the more complex the patient, the more significant the

impact of the hospitalists.<sup>31</sup> From these results, in contrast with other professionals, this type of care is considered the specialty of hospitalists.

### Limitations

This study had several limitations. First, this was a retrospective observational study. Therefore, further investigation using a randomised controlled design is required. Although we adjusted for multiple factors in our comparison, there remained a possibility that unrecognised bias influenced the results. Second, the physicians, including the residents and trainees, were not identical between the two groups. However, all but one of the hospitalists in the HS were enrolled before the system started. Therefore, in this study, the effect of the changes in physicians was negligible. Additionally, we considered that the variation in the number of first-year residents was also negligible because they did not make medical decisions or practice medicine independently. Third, we did not consider the impact of readmissions in this study because their accurate assessment proved difficult. Although UGH is a regional, tertiary, emergency hospital, we could not eliminate the possibility that the patients may have received treatment at other medical institutions after discharge. Future studies should aim to improve the quality of care while considering the above issues. Finally, this study represented a single hospital's experience for 1 year. Long-term follow-up studies should be conducted at UGH to disseminate the hospitalist model applied at UGH, and further studies should be conducted at other hospitals.

Our study also had several strengths. Although the study dealt with hospital LOS, other positive effects of the introduction of hospitalists demonstrated here include cost reduction, patient satisfaction and increased educational effectiveness.<sup>35</sup>

The advantages of the HS include better availability of physicians during hospitalisations and the ability to provide high-quality inpatient care.<sup>34</sup> While Japan's population is expected to age further in the future, a shortage of physicians has been identified. This means that more efficient and higher quality medical care is required. In particular, the shortage of doctors is a severe problem in rural areas such as the Okinawa prefecture, where this study was conducted. In Korea, the need for inpatient care has also led to an increased number of hospitalists due to the lack of medical personnel in tertiary hospitals.<sup>36</sup> Demonstrating further hospital system improvements because of the introduction of hospitalists will increase the credibility of this field. We hope that, eventually, this system can be implemented across the region and throughout the country.

### Conclusion

The introduction of the HS improved patients' LOS at a Japanese teaching hospital. As data on the efficacy of the HS in Japan is scarce, quality improvement studies on HSs should be performed in other hospitals to popularise the system and make it more generalisable.

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**Contributors** MK conducted data cleaning, interpreted the data, drafted the manuscript and revised the manuscript for important intellectual content. KK drafted the manuscript and revised the manuscript for important intellectual content. YT conceived and designed this study, interpreted the data and revised the manuscript for important intellectual content. All authors have approved the final manuscript. MK is guarantor.

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**Patient consent for publication** Consent obtained from parent(s)/guardian(s)

**Ethics approval** This study was approved by the Institutional Review Board of the Muriubushi Okinawa Centre for Teaching Hospitals (no. 2020). Our institution's ethics committee does not require informed consent from patients for observational studies that use anonymous data previously collected for routine clinical care.

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**Data availability statement** No data are available. This is a retrospective observational study.

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