Effect of Treatment by Female Cardiologists on Short-Term Readmission Rates of Patients Hospitalized With Cardiovascular Diseases

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Background: The effect of the sex ratio of the team of the attending doctors on clinical outcomes remains unknown.

Methods and Results: This retrospective cohort study included 9,544 patients admitted between 2012 and 2018 for cardiovascular diseases. They were treated by teams of 3 attending doctors comprising a trainee doctor, middle-grade cardiologist who played the main role in the clinical management, and upper-grade cardiologist who was responsible for the management. We explored whether the sex of the attending doctors influenced the risk of emergency readmission within 30 days after discharge. The primary hospitalization periods were similar for male and female middle-grade cardiologists. The risk of emergency readmission of patients hospitalized with cardiovascular diseases was significantly higher for patients treated by male middle-grade cardiologists than in those treated by female middle-grade cardiologists (odds ratio: 2.09, P<0.01). This beneficial effect of treatment by female cardiologists was observed in younger (<65 years) patients, male patients, patients with New York Heart Association stages II–IV, and those with emergency primary hospitalization, and in medical teams led by a male upper-grade cardiologist.

Conclusions: The risk of emergency readmission after discharge in patients hospitalized with cardiovascular diseases was ameliorated when treatment was performed by female middle-grade cardiologists. The combination of male and female cardiologists in the attending doctors’ team could result in better prognoses for cardiovascular patients.

Key Words: Cardiology; Female doctors; Gender; Quality of life
less. In Japan, such a gender gap may affect the power balance in the physicians’ community and the relationship between physician’s sex and patient’s death, a situation that is totally different from that in Western countries.

The purpose of this study was to elucidate the influence of female cardiologists on the short-term readmission rates and deaths of patients hospitalized with cardiovascular disease (CVD) when compared with male cardiologists in Japan.

**Methods**

We declare that all supporting data are available within the article. This study was approved by the corresponding institutional ethics committee. This study proceeded after explanation about participation in this study, including an opt-out option, was provided electronically to the patients. The data were obtained from all patients according to the protocol approved by the ethics committee.

In the study hospital, patients hospitalized with CVD are treated by a team comprising a trainee doctor, a middle-grade cardiologist who has the primary role in the clinical management and treatment, and an upper-grade cardiologist who is fully responsible for supervising the middle-grade cardiologist. Within this team structure, we explored the effects of the sex of the cardiologist on clinical outcomes in hospitalized patients with CVD.

**Study Population**

All patients (n=10,252) admitted for CVD between January 2012 and September 2018 were enrolled in this study. The patients whose cardiologist in-charge changed because the hospital stay was longer than 30 days were excluded (n=708) from the analysis. After this exclusion, 9,544 hospitalized patients were divided into 2 subgroups based on whether they had been treated by a female (n=1,994) or male middle-grade cardiologist (n=7,550) at discharge. In these subgroups, 935 of 1,994 (47%) and 3,296 of 7,550 (44%) patients had repeat hospitalization during the enrollment period (from January 2012 to September 2018).

**Background Data and Outcomes**

The patients’ background data at the time of hospitalization, including age, sex, ejection fraction (EF), New York Heart Association (NYHA) classification, cardiac diagnoses, and emergency hospitalization, were obtained from the data stored in the “Patient’s Card” in the department of cardiology. The background data of the doctors were also obtained from the “Patient’s Card”. The data were entered using FileMaker Pro 11 (File Maker Inc., Santa Clara, CA, USA) by a specialist in the medical office and double-checked by the attending doctors. The endpoints were all-cause death and unplanned emergency readmission within 30 days after discharge.

**The Medical System**

The current medical system of a clinical training program for new physicians in Japan was established in 2003. The Japanese residency matching started as part of comprehensive reforms of the medical residency programs. Approximately 8,000 doctors and 1,500 residency programs participate in the matching process each year.

**The Trainee**

The trainee doctor who experiences the first 2 years as a clinician needs to complete rotations in all specialties after graduating from a medical school. The details of the medical residency programs are available on the websites of the government ministry and matching organizer. Concerning risk management, the trainee is not permitted to decide any medical treatment alone and the professional role is extremely limited. For example, a trainee cannot decide on admissions, discharges, or prescriptions of medications or perform medical procedures except securing vascular access. A trainee examines the patients daily supervised by middle-grade specialists or upper-grade experts in the disease. The training in the cardiovascular ward is assigned for 1–2 months. After the medical residency program, most trainees work in community hospitals for 2–3 years to accrue experience in clinical medicine.

**The Middle-Grade Cardiologist**

To become a cardiovascular specialist, professional training for more than 2 years is required. After that, some cardiologists become students at the graduate school of a university. These students work in the university hospitals at the first level of graduate school as middle-grade cardiologists managing patients with CVD for 1 year. These middle-grade cardiologists correspond to 5–6th grade medical doctors. They make most of the medical decisions, obtain informed consent from the patients and their families, and perform procedures including catheter insertions. Their incomes are standardized and their social economy status can be obtained from the Ministry of Health, Labour and Welfare’s “Basic Survey on Wage Structure”. After finishing the first year of graduate school, these doctors usually start clinical or basic research.

**The Upper-Grade Cardiologist**

Some of the postdoctoral cardiologists who are experts in coronary artery disease (CAD), heart failure (HF), arrhythmias, valvular heart disease, pulmonary hypertension, congenital heart disease, cardiac echocardiography, cardiac imaging, and cardiac rehabilitation become clinical attending doctors as upper-grade cardiologists at a university hospital. They lead the treatment plans and review the decisions made by the middle-grade cardiologists.

In this way, the medical team for each hospitalized patient with CVD comprises a trainee, middle-grade cardiologist, and upper-grade cardiologist.

**The Medical Team**

Upon admission, a patient is assigned to an attending doctor’s team. The combination of team members is randomly assigned every month and will be changed after 1 month. Therefore, patients hospitalized for >30 days were excluded from this study. The doctors and patients cannot choose each other. The period of working as a middle-grade cardiologist is only 1 year, and the combinations of attending doctors in a team change every month; therefore, the same combination does not last for more than 2 months. To rectify any inequality in the work load, the number of patients per doctor is generally kept equal up to a limit of 10.

**Management of the Medical Teams**

The nurse first calls for the trainee, and then the trainee consults with the middle-grade cardiologist. The trainee and middle-grade cardiologist have a meeting with the upper-grade cardiologist twice a day, in the morning and evening. The middle-grade cardiologist presents all of the cases at a cardiovascular meeting once a week; upper-grade cardiologists, including a professor of the department of cardiology, attend this meeting to provide expert advice. Informed consent from patients or patients’ families is obtained by the middle- or upper-grade cardiologist. During holidays, the trainee gets leave of absence, and most of the middle-grade cardiologists check the patients’ status in the morning, and the upper-grade cardiologists work if needed. Additionally, in-hospital cardiac
Results

The baseline characteristics of the cardiologists and hospitalized patients were compared between female and male middle-grade cardiologists (Table 1). The background data of the male and female middle-grade cardiologists were similar. Although EF was not different between the 2 groups, the NYHA stage was more severe in those treated by female middle-grade cardiologists when compared with those treated by male middle-grade cardiologists. Female middle-grade cardiologists were more frequently combined with male upper-grade cardiologists than male middle-grade cardiologists (females vs. males: 78% vs. 74%; P<0.01).

The in-hospital death rates within 30 days after admission were equivalent for patients treated by female middle-grade cardiologists and those treated by male middle-grade cardiologists (Table 2). Although the rates of patients who were transferred to another hospital after discharge or enrolled in outpatient cardiac rehabilitation were similar between the groups, the emergency readmission rate (<30 days) after discharge was significantly lower in patients treated by female middle-grade cardiologists as compared with those treated by male middle-grade cardiologists (females vs. males: 0.9% vs. 1.9%; P<0.01). Conversely, the

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Table 1. Background Characteristics

<table>
<thead>
<tr>
<th>Middle-grade cardiologists</th>
<th>Female middle-grade cardiologists</th>
<th>Male middle-grade cardiologists</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of cardiologists, n</td>
<td>20</td>
<td>68</td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>30.4±3.4</td>
<td>30.1±2.8</td>
<td>0.79</td>
</tr>
<tr>
<td>Years of experience since becoming a medical doctor (years)</td>
<td>5.6±1.3</td>
<td>5.8±2.2</td>
<td>0.11</td>
</tr>
<tr>
<td>Patients per physician (/day), n</td>
<td>9.0±3.0</td>
<td>8.2±1.6</td>
<td>0.12</td>
</tr>
<tr>
<td>Annual household income (×10⁴ Yen)</td>
<td>402±196</td>
<td>386±195</td>
<td>0.78</td>
</tr>
<tr>
<td>Graduated from a national university, n (%)</td>
<td>19 (95)</td>
<td>65 (96)</td>
<td>0.92</td>
</tr>
</tbody>
</table>

Patients

<table>
<thead>
<tr>
<th>n</th>
<th>1,994</th>
<th>7,550</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>64.8±16.3</td>
<td>64.5±16.7</td>
<td>0.60</td>
</tr>
<tr>
<td>Male, n (%)</td>
<td>1,348 (68)</td>
<td>5,184 (69)</td>
<td>0.19</td>
</tr>
<tr>
<td>Emergency hospitalization, n (%)</td>
<td>365 (18)</td>
<td>1,655 (22)</td>
<td>&lt;0.01</td>
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<tr>
<td>Coronary artery disease, n (%)</td>
<td>844 (42)</td>
<td>3,386 (45)</td>
<td>0.02</td>
</tr>
<tr>
<td>Heart failure, n (%)</td>
<td>376 (19)</td>
<td>1,371 (18)</td>
<td>0.26</td>
</tr>
<tr>
<td>Infection, n (%)</td>
<td>53 (3)</td>
<td>213 (3)</td>
<td>0.38</td>
</tr>
<tr>
<td>Arrhythmia, n (%)</td>
<td>407 (20)</td>
<td>1,423 (19)</td>
<td>0.07</td>
</tr>
<tr>
<td>Congenital heart disease, n (%)</td>
<td>52 (3)</td>
<td>166 (2)</td>
<td>0.16</td>
</tr>
<tr>
<td>Pulmonary hypertension, n (%)</td>
<td>135 (7)</td>
<td>454 (6)</td>
<td>0.12</td>
</tr>
<tr>
<td>Valvular disease, n (%)</td>
<td>59 (3)</td>
<td>227 (3)</td>
<td>0.49</td>
</tr>
<tr>
<td>Aortic disease, n (%)</td>
<td>14 (1)</td>
<td>67 (1)</td>
<td>0.26</td>
</tr>
<tr>
<td>Other, n (%)</td>
<td>54 (3)</td>
<td>243 (3)</td>
<td>0.24</td>
</tr>
<tr>
<td>EF, ejection fraction</td>
<td>59.3±15.9</td>
<td>59.3±15.6</td>
<td>0.90</td>
</tr>
<tr>
<td>NYHA I, n (%)</td>
<td>1,371 (69)</td>
<td>5,401 (72)</td>
<td>0.01</td>
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<tr>
<td>NYHA II, n (%)</td>
<td>450 (23)</td>
<td>1,403 (19)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>NYHA III, n (%)</td>
<td>122 (6)</td>
<td>524 (7)</td>
<td>0.11</td>
</tr>
<tr>
<td>NYHA IV, n (%)</td>
<td>51 (3)</td>
<td>222 (3)</td>
<td>0.20</td>
</tr>
<tr>
<td>Male upper-grade cardiologist, n (%)</td>
<td>1,554 (78)</td>
<td>5,579 (74)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Male trainee doctor, n (%)</td>
<td>1,252 (63)</td>
<td>4,675 (62)</td>
<td>0.25</td>
</tr>
<tr>
<td>Male outpatient cardiologist after discharge, n (%)</td>
<td>1,643 (83)</td>
<td>6,211 (83)</td>
<td>0.50</td>
</tr>
<tr>
<td>Years of experience since becoming an outpatient cardiologist after discharge</td>
<td>11.2±5.7</td>
<td>11.1±5.8</td>
<td>0.69</td>
</tr>
</tbody>
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EF, ejection fraction; NYHA, New York Heart Association.
rate of mortality within 30 days of discharge was similar between the groups (females vs. males: 0.6% vs. 0.4%; P=0.15). In this study, there were no deaths within 30 days of primary discharge in the patients with emergency readmission within 30 days of discharge.

Subsequently, we evaluated the odds ratio (OR) according to the sex of the middle-grade cardiologist for emergency readmission within 30 days of discharge (Figure 1). Overall, emergency readmission within 30 days of discharge was significantly more frequent in those treated by male middle-grade cardiologists as compared with those treated by female middle-grade cardiologists (OR 2.09; 95% confidence interval [CI]: 1.28–3.43; P<0.01). This beneficial effect of treatment by female cardiologists was observed in the following patients: patients aged <65 years, male patients, patients with NYHA grades II–IV, patients with initial emergency hospitalization, patients with CAD or HF, and patients treated by attending doctors’ teams that included a male upper-grade cardiologist or female trainee doctor. After adjusting for these covariates, the tendency of beneficial effect did not change. In addition, logistic regression analysis suggested the preference of female cardiologists did not change even after adjustment for sex or years of experience of the outpatient cardiologists (OR 2.10, P<0.01 and OR 2.01, P<0.01, respectively).

A comparison between the sexes of middle-grade cardiologists for death within 30 days after discharge is shown in Figure 2. Overall, there was no difference in deaths within 30 days after discharge between the patients treated by male middle-grade cardiologists and those treated by female middle-grade cardiologists (OR 0.71, 95% CI: 0.33–1.53, P=0.38).

Finally, we analyzed the effect of a combination of both the sex of the cardiologist and the sex of the patient on emergency readmission within 30 days of discharge. The results are shown in Figure 3. The combination of female cardiologists and female patients had the lowest rate of emergency readmission (OR 0.66; 95% CI: 0.42–1.02, P=0.06), whereas the combination of male cardiologists and male patients had the highest rate of emergency readmission (OR 2.10; 95% CI: 1.36–3.23, P<0.01).
Effect of Female Cardiologist on Prognosis

Discussion

From this study, patients hospitalized with CVD and treated by female cardiologists had a lower emergency readmission rate than those treated by male cardiologists. This beneficial effect previously reported in US studies was also observed in our study, which was performed in a representative teaching-

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**Figure 2.** Effect of the sex of the cardiologists on deaths within 30 days after discharge. Odds ratio (95% confidence interval [CI]) for deaths within 30 days after discharge. After excluding patients who died during the primary hospitalization (n=53), logistic regression analysis was performed to compare the rates of death within 30 days after discharge.

**Figure 3.** Effect of the combination of sexes of attending doctors in a team on emergency readmission rates within 30 days after discharge. The emergency readmission rates within 30 days after discharge, according to the combinations of sexes in teams of attending doctors, were compared using one-way analysis of variance (ANOVA) and post-hoc analysis.

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sexes in the team on emergency readmission rates within 30 days after discharge (Figure 3). The rate tended to be lower in patients who were treated by teams that included a female physician when compared with those with 3 male physicians. The combination of female middle-grade cardiologist and female trainee had a lower readmission rate than the combination of male middle-grade cardiologist and male trainee.
hospital in Japan and included patients with all CVD.

According to previous studies, female physicians might be more likely to adhere to clinical guidelines, provide patient-centered care, provide preventive care, have less problems with treating female patients, and could have more robust physician-patient communication. Lou et al reported that female medical students completed basic surgical skills training more efficiently and passed the theoretical examination with significantly higher scores than male medical students. Judging from these results, the female cardiologists in our study likely worked well as part of the attending doctors’ team. Our findings suggested that the beneficial effect of being treated by a female doctor on the readmission rate was not influenced by the severity of the cardiac disease, but was influenced by the combination of sexes in the attending doctors’ team. According to official communication reports, female managers prefer to communicate with subordinate staff than do the male managers. For example, a Japanese study of 900 workers (300 female and 200 male managers, and 200 male and female subordinate workers each) reported that female managers communicated more with subordinate workers than did the male managers. In that study, a male manager found it difficult to communicate with female subordinate workers when compared with a female manager (44.5% vs. 13%, P<0.0001). A meta-analysis showed women cooperate more than men in mixed-sex interactions. Male middle-grade cardiologists might find it difficult to work with a female trainee. Although we did not investigate directly the communication approaches of doctors, the communication skills of the doctor appear to be the key word for discussion of this study. It was previously reported that male doctors could hone their communication skills by practicing with more female colleagues. In this study, the medical team essentially works together for 1–2 months, which may not provide with male doctors enough opportunities to demonstrate their communication skills that are particularly important.

Patients with CAD and HF who were managed by female cardiologists had better prognoses. HF or arrhythmia sometimes requires a more intricate approach to treatment, discussion, and communication with other experts than does AMI. We first hypothesized that the readmission and mortality rates are ameliorated in patients with HF or arrhythmia as compared with those in CAD patients; however, the benefit of being treated by female cardiologists was larger in patients with CAD than in those with HF (OR 2.82 for CAD vs. OR 2.16 for HF, P-value for interaction=0.02), and there was no difference in the readmission rates in patients with arrhythmia between those treated by female and male cardiologists (Figure 1). We could not detect a gender difference in patients with infection, congenital heart disease, pulmonary hypertension, valvular disease, and aortic disease, which may be caused by the low rates of readmission.

In previous studies, the severity of heart dysfunction, which is a major risk factor for poor outcomes was not taken into consideration. In this study, even after adjustment for low EF or NYHA class, the beneficial effect of being treated by female middle-grade cardiologist remained.

Initial emergency hospitalization was less with female cardiologists as compared with male cardiologists in this study, which is unlikely to inevitably occur for any reason. Although it is possible that patients with initial emergency hospitalization are subject to emergency readmission <30 days after discharge, after adjustment for covariates including initial emergency hospitalization, our results were unchanged. However, all-cause death <30 days after discharge was not significantly different between patients treated by female cardiologists and those treated by male cardiologists after adjustment by covariates including initial emergency hospitalization (P=0.32) (Figure 2). The small number of deaths <30 days after discharge in this study had little statistical power. Both emergency readmission and death are component factors of poor prognosis after discharge, and the probability of which component will tend to occur might depend on the clinical situation, including the type and/or severity of disease. The disequilibrium of readmission and mortality rates was reported in a previous study. Taken together, comprehensive analysis of total outcomes might be informative rather than analyzing the emergency readmission and deaths separately. In this study, the rate of total outcomes composed of emergency readmission and death <30 days after discharge proved to be lower in patients treated by female cardiologists than in those treated by male cardiologists (P<0.03) (Table 2).

This study clearly revealed that the management of cardiac diseases by female doctors resulted in a better prognosis than that by male doctors, not only in Western cultures, but also in an East Asian culture. Women’s status in Japan is said to be lower than in other countries. A female cardiologist is still uncommon in Japan. The rate of woman doctors is the lowest among the Organization for Economic Co-operation and Development (OECD) countries. According to a periodic statistical report of the Ministry of Health, Labour and Welfare in 2017, female cardiologists constituted 9.5% of all cardiologists (females=1,161, males=11,009), while female doctors constituted 21.1% of all doctors (females=67,493, males=251,987) in Japan.

This imbalance may be related to the demands of a doctor’s job and the culture in Japan. A striking feature of the work style of Japanese doctors is that they are extremely overworked compared with doctors in most other countries. A physician in Japan works for an average of 70.6h/week, while those in Western countries work <50h/week. The number of hospitals and hospital beds in Japan are the largest in the world; the total number of hospital beds per 1,000 population is the largest in the OECD countries, and hospitalization is approximately 3-fold longer than in Western countries. Indeed, sudden death of doctors for overwork, called “karoshi”, is becoming a serious problem in Japan. The National Police Agency in Japan reported that suicide by doctors is frequent, as in other countries, with 32.4 per 100,000 doctors committing suicide annually. Such a heavy work load of doctors in hospitals might render women doctors unable to work comfortably after they get married or concentrate on their families at different stages in their lives. Under such conditions, no gender difference in annual household income and medical education was seen in this study. Therefore, we believe that female middle-grade cardiologists in this study were not ‘highly selected’ professionals as compared with male middle-grade cardiologists.

Regardless of the severity of CVD or the culture that doctors belong to, the readmission rate managed by female cardiologists was lower than male cardiologists. The good communication or cooperation in a medical team provided by female cardiologists may improve the management of patients with CVD.

**Study Limitations**

This was a retrospective cohort study in a single high-volume
university hospital. Conducting a prospective blinded clinical trial or allocation study to evaluate the effects of the sex of the doctor on the outcomes is practically difficult in the real world. Therefore, a meta-analysis of such retrospective cohort studies is required to confirm our findings. In Japan, the unplanned readmission rate within 30 days after discharge was 1.9% vs. 12% in the USA. Although we believe the sample size was large enough to draw definite conclusions, the effects of the combination of both sexes in the team on emergency readmission rates within 30 days after discharge did not reach statistical significance in some comparisons, in part because emergency readmission rate is low in Japan and female doctors are fewer than male doctors (Figure 3).

The influence of the cardiac-team concept is important when making clinical decisions. The concept varies depending on the clinical setting or institution. The effects of male or female sex of attending physician on patients and the integrity of the data and the accuracy of the data analysis. T.F. and female cardiologists in the attending doctors’ team could result in better prognoses for patients hospitalized with CVD.

Acknowledgments
We acknowledge Ms. Akiko Shimanuki for collecting the data. A.N. had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. T.F. managed the system of collecting data. A.N., H.M., and I.K. contributed to the study concept and design. All authors performed the acquisition, analysis, or interpretation of data. A.N. drafted the manuscript.

Sources of Funding / Disclosures / Conflict of Interest
None.

References
25. Iwasaki T, Takahashi M, Nakata A. Health problems due to long working hours in Japan: Working hours, workers’ compensation (Karoshi), and preventive measures. Ind Health 2006; 44: 537 – 540.