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Sociodemographic and work-related factors influencing long working hours among cardiovascular surgeons in Japan: a cross-sectional study

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A short running title: CARDIOVASCULAR SURGEONS’ LONG WORKING HOURS IN JAPAN
Abstract

The maximum limit on overtime working hours for physicians will be applied from 2024. To explore sociodemographic and work-related factors influencing overtime work among cardiovascular surgeons (CS) in Japan. This cross-sectional study included 607 CS who responded to an online survey. Working hours were categorized into ≤60 hours, 60–79 hours, and ≥80 hours per week according to Japan Ministry of Health, Labour and Welfare. Adjusted odds ratios (aOR) were calculated using a multinomial analysis with stepwise reduction after adjustment for potential confounders. Compared to ≤60 hours, significant factors related to 60–79 hours and ≥80 hours per week were age groups of 30s to 50s versus 60s (aOR: 7.48–3.22 and 23.64–4.87), management with cardiovascular drugs (aOR: 1.87 and 5.80), and postoperative wound management (aOR: 0.47 and 0.16), respectively. Significantly related informed consent for surgery (aOR: 3.29) was seen in 60–79 hours. Contrarily, CS who worked for ≥80 hours took on-duty 5 times or more per month (aOR: 3.89), performed night or holiday calls 20 times or more per month (aOR: 2.26), and attended the intensive care unit (aOR: 3.12).
These findings suggest that younger, and some non-surgical work-related factors could influence long working hours among CS.

Key words: Cardiovascular surgeon, Working hours, Cardiovascular surgery,

Postoperative management, Task shifting, Occupational health
INTRODUCTION

The Ministry of Health, Labor and Welfare (MHLW) is defining specific systems and other issues that require measures in medical legislation and medical policy regarding the upper limit of working hours for physicians in preparation for the reform of the working style of physicians in Japan from 2024\(^1\). In 2019, the MHLW highlighted that physicians had the longest working hours among all occupations\(^2\). It was reported that 40.5% of hospital physicians worked 60 hours or more per week and that 10.5% of hospital physicians worked 80 hours per week. In comparison, physicians across the United States of America reported working an average of 52.2 hours per week\(^3\), and in Germany, the United Kingdom, and France, the Parliament of the European Union has limited the maximum working hours to 48 hours per week\(^4\). Although, medical care in Japan is supported by the self-sacrificing long working hours of physicians, 3.6% of Japanese physicians report suicidal tendency, 6.5% or more are moderately depressed, and reports of medical accidents are increasing annually\(^2\).

Among surgeons, the Japan Surgical Society has reported that 61.7% of 6221 surgeons work for more than 60 hours per week and 13.9% of surgeons work more than 90 hours
Based on these data, the percentage of surgeons working 60 hours or more per week, stratified by surgical specialty, indicated that cardiovascular surgeons (CS) comprised 71%, and hepatobiliary surgeons and trauma physicians, 65%\(^4\). In addition, the Japanese Society for Cardiovascular Surgery (JSCVS) reported that 75.5% of 634 CS worked more than 60 hours per week, while 28.0% worked more than 80 hours per week\(^6\). These studies revealed that Japanese CS experience harsher working conditions than other surgeons. Although the shortage of surgeons (72.8%), excessive emergency surgeries (69.4%), and a high risk of lawsuits (67.7%) were the reasons reported for these long working hours\(^7\), there are no reports on the sociodemographic and work-related factors related to working hours among CS. This study aimed to explore the relationship between long working hours and sociodemographic factors and working environment of CS in Japan.

**SUBJECTS AND METHODS**

*Design and participants*

A cross-sectional study employing an online survey was conducted among 3071 CS who were registered with the JSCVS across Japan and abroad for one month starting...
December 1, 2018, entitled “Working environment of CS in Japan”. The JSCVS provided informed consent forms via the web-based interface, and informed consent was obtained when the participants answered the questionnaire. Since the participants were not incentivized to complete the survey, it was registered anonymously and the section regarding their place of work was removed, and 634 respondents (response rate, 17%) finally agreed to complete the questionnaire.

Questionnaire content

The questionnaire included 1) sociodemographic variables, such as age, sex, family, income, position, affiliation and specialty conditions; 2) outpatient services, ward operations, postoperative management, and involvement in medical affairs by CS; and 3) working hours, including working hours at hospitals, overtime work, and duty calls. The JSCVS developed questions specifically for this survey. On-call hours were limited to hours worked when actually called to the hospital.

Definition of long working hours

The Labor Standards Act stipulates that, as a general rule, the working hours per week should not exceed 40 hours. For physicians, the MHLW stipulates that the standard
overtime working hours should be no more than 960 hours per year, including holidays, or 60 hours per week. Working hours were categorized into three groups, 60 hours or less, 60–79 hours, and 80 hours or more, based on the MHLW’s recommendations.

**Statistical analysis**

Of the 634 respondents, we analyzed 607 valid responses; 27 were excluded for the following reasons: 1) respondents did not complete 3 questions regarding average working hours per week, sex, and age in the main workplace; 2) respondents were not CS; and 3) respondents were general practitioners.

Differences between individual sociodemographic and work-related factors of participants among working hours groups were analyzed using the chi-squared test or the Fisher's exact test. Using a multinomial logistic regression analysis to explore factors related to long working hours, we first examined possible independent factors at p-values <0.2 from the previous analysis. Then, all possible independent variables at p-values <0.2 from the previous analysis were further analyzed using a manual backward stepwise method, the remaining factors were reanalyzed after adjusting for potential confounding factors.
All statistical analyses were conducted using SPSS Statistics 26 for Windows (IBM SPSS, Inc., Tokyo, Japan), using an assumed type I error rate of 0.05.

Ethical considerations

The study protocol was approved by the Board of the Dokkyo Medical University Hospital Ethics Committee in Japan (No R-38-8J).

RESULTS

Participant characteristics

Males accounted for the highest percentage of respondents (n=570, 93.9%). The largest age strata were 40–49 years and 50–59 years (n=188, 31.0%; n=177, 29.2%). Overall, 40.4% (n=245) of respondents were affiliated with a university hospital. The most common category by specialty was “adult cardiovascular surgery” (n=466, 76.8%), and the highest position was “manager” (n=285, 47.0%). Of the study participants, 24.5% (n=149) of physicians worked for 60 hours or less (standard working hours, reference), 47.5% (n=288) worked for 60–79 hours, and 28.0% (n=170) worked for 80 hours or more.

Sociodemographic and work-related factors by working hours per week

Basic attributes were compared for each category of working hours. Variables that were
significant relationships ($p<0.05$) included age, marital status, having children, position, ratio of income from major workplaces, percentage of main place of work attributed to the total wage, cardiovascular specialist status, and chief status. In the work-related comparison, significant relationships were found in on-duty, on-call duty, and night or holiday on-call duty (Table 1-1).

No clinical duties in the outpatient clinic showed relationships between the groups. Regarding ward-related work, variables that were significant relationships ($p<0.05$) included medical examination and records, examination orders, venous line insertion, insertion and removal of nasogastric tubes, postoperative wound management, removal of thoracic tubes, management of cardiovascular drugs, and management of hospital discharge. For desk work, variables that were significant relationships ($p<0.05$) included obtaining informed consent for surgery, registration for the Japan Adult Cardiovascular Surgery Database (JACVSD), registration for Diagnosis Procedure Combination (DPC), and correspondence for medical receipts. Postoperative management in the intensive care unit (ICU) was mostly conducted by CS (Table 1-2).

*Relationships between average working hours and individual factors*
Comparison with the 60 working hours or less group is shown in Table 2-1, which summarizes significant characteristic factors, such as age, marital status, having children, position, annual income, chief of training, on duty, and on-call in workday, in both the 60–79 hours group and the 80 hours or more group, respectively. There was a significant relationship between specialization category, cardiovascular specialist, education, and on duty in other hospital and the 80 hours or more group compared to 60 working hours or less group.

Compared with the 60 working hours or less group, Table 2-2 shows each significant work-related factor, such as clinical work in the ward including in the medical examination and records, examination order, venous line insertion, urethral catheter insertion, insertion and removal of nasogastric tube, postoperative wound management, removal of thoracic tube, management of cardiovascular drugs and hospital discharge; postoperative management including in CS at ICU; desk work in the ward including in informed consent for surgery, and registration for JCVSD and DPC in both the 60–79 hours group and the 80 hours or more group, respectively. There was a significant relationship between medical certificate and registration for NCD and the 60–79 hours
group; between blood sampling, ICU physician at ICU, and correspondence for medical receipt and the 80 hours or more group compared to 60 working hours or less group.

Work hours-related independent factors in the multivariable analysis

Table 3 shows the independent factors identified by the multinomial logistic regression analysis with stepwise reduction and reanalysis of these factors following the adjustment for sociodemographic confounding factors including sex, marital status, children, affiliation, number of full-time doctors, annual income, and percentage of main place of work attributed to the total wage. Compared with the 60 working hours or less group, there was a significant relationship with adjusted odds ratio [aOR]: 6.20, 95% confidence intervals [CI] 1.06–36.41 and aOR: 23.64, 95% CI 3.34–167.16 in less than 30 years group, aOR: 7.48, 95% CI 3.01–18.64 and aOR: 19.10, 95% CI 5.05–72.22 in 30–39 years group, aOR: 5.51, 95% CI 2.52–12.04 and aOR: 12.17, 95% CI 3.54–41.84 in 40–49 years group in 50–59 years group, and aOR: 3.22, 95% CI 1.58–6.56 and aOR: 4.87, 95% CI 1.49–15.97 in 50–59 years group for the 60–79 hours group and the 80 hours or more group, respectively.

Compared with the 60 working hours or less group, postoperative wound management
(aOR: 0.47, 95% CI 0.23–0.95 and 0.16, 95% CI 0.07–0.41) and management of cardiovascular drugs (aOR: 1.87, 95% CI 1.00–3.47 and 5.80, 95% CI 2.45–13.67) were significantly related both the 60–79 hours group and the 80 hours or more group, respectively. There was significantly related informed consent for surgery (aOR, 3.29; 95% CI, 1.67–7.05) for the 60–79 hours group, and on-duty 5 times or more per month (aOR: 3.89, 95% CI 1.58–9.55), night or holiday calls 20 times or more per month (aOR: 2.26, 95% CI 1.26–4.08), and CS at ICU (aOR: 3.12, 95% CI 1.49–6.51) for the 80 hours or more group, respectively.

**DISCUSSION**

The results of this study showed that the factors that significantly influenced the working hours of 61–79 hours per week compared those influencing working less than 60 hours per week among CS were age, postoperative wound management, management of cardiovascular drugs, and informed consent for surgery. And age, being on duty five times or more per month, on-call at night or on holiday 20 times or more per month, management of cardiovascular drugs, and postoperative management by CS in the ICU were significant factors for CS working 80 hours or more per week. To our knowledge,
this is the first study to clarify the relationship of working hours of CS with sociodemographic and work-related factors.

The fact that younger surgeons work longer hours is widely known. Hanasaki et al.\textsuperscript{7)} reported average weekly work hours for surgeons aged 70 years and older was 42.2 hours, whereas the average weekly work hours for those aged 39 years and younger was 92.2 hours, which confirms that younger surgeons worked longer hours. This previous study supported our findings. Long working hours of young physicians are not only associated with a high near-miss incidents and accidents\textsuperscript{8)}, but they also are prone to more mental disorders such as depression and self-reported burnout\textsuperscript{9–11)}. Other studies reported that the burnout is independently associated with the length of working hours\textsuperscript{12–14)}. Meanwhile, was reported the shorter the working hours, the less occurrence of burnout in a longitudinal study for restriction\textsuperscript{15,16)}.

For reducing the work hours, residency programs have been required to limit the working hours such as no more than 24 consecutive hours of work, no more than 80 hours of work per week, a minimum of 10 hours of rest between shifts, and one day off per week in the USA\textsuperscript{17)}. A survey demonstrating the residents reduced working hours, and showed
positive results, with a decrease in the average length of stay, the rate of readmission within 30 days, and the rate of transfer to the ICU\textsuperscript{21}. However, a “reduced quality of care” could occur owing to the increased handoffs, decreased availability for teaching conferences, and reduced intern presence during daytime work hours\textsuperscript{18}. Moreover, the number of consecutive hours (16 hours) worked by surgical residents resulted in a shift of their primary work to senior physicians\textsuperscript{19, 20}. These reports showed that balance between surgeons’ careers and working hours is a complicated problem in the younger surgeons. Although MHLW recommends overtime work will be limited to 1,860 hours or less per year in the reform of the Japanese work style\textsuperscript{22}, it might be necessary to set detailed CS working hours according to age through further research.

Regarding the number of shifts, the MHLW recommends one day off and one night-call duty each week\textsuperscript{1}. Previous studies reported that the average number of night duties per month for surgeons was 2–4 days\textsuperscript{5, 7}. In our results, an average of five or more-night duties per month was an associated factor in the group of 80 hours or more per week, which is more than the number of night duties recommended by the MHLW. Shortage of surgeons is considered to be one cause. According to the MHLW’s Summary of Statistics
on Doctors, Dentists, and Pharmacists for 2008\textsuperscript{23}, the aging of surgeons is acknowledged along with the decrease in the number of surgeons trained per year, 51.2\% of the facilities had five or fewer full-time physicians, and the average number of full-time physicians in this group was 3.3. In other words, fewer full-time physicians meant more on-call and night duties due to emergency surgeries and sudden changes.

As a CS, surgery and acute postoperative management are tasks that cannot be overlooked. The time required for cardiovascular surgery depends on surgical factors such as cardiopulmonary bypass (CPB), hypothermia, and cardiac arrest. The 2017 data provided by JACVSD investigated at operative times and found that the overall average operative time for coronary artery bypass grafting (CABG), valve surgery, and major vascular surgery was 300 minutes, with operative times of 344, 292, and 380 minutes, respectively. According to our survey results, CS spent an average of 34.4\% (median 30\%) of their entire working time for surgery\textsuperscript{6}). Moreover, a characteristic of acute postoperative management in the field of cardiovascular surgery is that most patients are intubated and managed in the ICU. As soon as we enter the ICU, we perform monitoring and initial investigations, Circulation management (cardiovascular drugs and arrhythmia
management), sedation and analgesia management, respiratory management, hypothermia to hyperthermia, electrolyte management, glycemic control, hemostasis and blood transfusion. Based on the JACVSD data, the overall median intubation time was 12 hours. Regarding the type of surgery, the median operative time for CABG, valvular surgery, and major vascular surgery (open surgery) was 14, 12 and 18 hours, respectively, suggesting extremely long working hours for postoperative management. Longer operation time means more cardiac decompensation, hypoxemia, hypothermia, and bleeding, and volume over causes prolonged respiratory and cardiovascular drugs and postoperative wound management. The results of this study also showed that the factors that contributed to long working hours were the tasks of postoperative management: management of cardiovascular drugs, and postoperative management by CS. If we focus on the working hours of surgeons aged 30–49 years, the percentage of those working 60 hours or more per week is high at 85.5% and is considered specific to the field of cardiovascular surgery, which requires skilled postoperative management. In contrast, some reports have described improved treatment results when ICU management is conducted by an ICU specialist\textsuperscript{24,25}. If the acute postoperative management could be task
shifting to ICU physicians, it will have the advantage of reducing working hours and allowing us to concentrate on surgery.

Regarding task shifting, it is important to train and utilize specific certified nurses who have completed specific action training as well as medical office workers. The MHLW recommends that task shifting of physicians’ outpatient and ward duties could reduce working hours by 25% and utilizing 10,000 certified nurses could reduce physicians’ working hours by 7 hours per week. However, based on the results of the previous survey6), 25% of the respondents answered that specific certified nurses had been introduced, and only 43% answered that the introduction of task shifting had been effective. Factors affecting long working hours in this study include the preparation of informed consent for surgery, and it must be pointed out that task shifting in the field are insufficient at this stage.

First, duties related to ward operations and medical affairs should be clearly defined, and each hospital's cardiovascular surgery team should be staffed with two or more specific certified nurses according to the number of surgical procedures performed. However, in other countries, nurse practitioners, who are equivalent to specialized nurses,
focuses more on “care” in addition to conducting medical tasks (“cure”) to meet a patient’s needs. The physician assistant system has been introduced overseas and has been extremely effective in reducing the number of working hours of physicians as physician assistants. By introducing this system in Japan as well, it would be effective in reducing overtime work such as duty and ward work. Second, working hours can be reduced by consolidating facilities, increasing the number of full-time physicians to 15 or more, and shifting the work system.

This study has certain limitations since the survey only achieved a 17% response rate from among the large proportion of CS in their 40s and 50s; therefore, the population analyzed may not be representative of the entire population of CS. Nevertheless, this is the first report of basic data for physician working style reform recommended by the MHLW that included responses from over 600 JSCVS CS. Secondly, the survey could not have avoided information bias since it was a self-reported questionnaire. Thirdly, we could not obtain the average numbers of working hours and night duties for doctors at university hospitals due to the focus on working hours at the main workplace. Lastly, CS do not have a fixed work allocation because their daily work is determined by patient
priority, and for this study, we used overall working hours for the analysis. As for the current working conditions for surgeons in the field of cardiovascular surgery, careful interpretation of the survey results is warranted.

**Conclusions**

The survey results revealed the working hours of CS. We identified factors related to high-adjusted odds ratios by clarifying factors associated with average weekly work of over 60 h to 80 h. We propose recommendations for future policies so that the findings of the present study can support and promote the improvement of the working environment for CS.

**Conflict of interest**

None declared.

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### Table 1-1. Comparisons of characteristics and work-related factors of cardiovascular surgeons among three working hours groups (N=607)

| Variables                      | Category               | <60 | ≥60 to 79 | ≥80 | p value<sup>a</sup> |
|-------------------------------|------------------------|-----|-----------|-----|---------------------|
| Sex                           | Male                   | 570 | 143       | 96.0| 268                 | 93.1 | 159                 | 93.5 | 0.468               |
| Age, years                    | <30                    | 26  | 2         | 1.3 | 9                   | 3.1  | 15                  | 8.8  | <0.001              |
|                               | 30–39                  | 142 | 15        | 10.1| 71                  | 24.7 | 56                  | 32.9 | -                   |
|                               | 40–49                  | 188 | 33        | 22.1| 96                  | 33.3 | 59                  | 34.7 | -                   |
|                               | 50–59                  | 177 | 48        | 32.2| 93                  | 32.3 | 36                  | 21.2 | -                   |
|                               | ≥60                    | 74  | 51        | 34.2| 19                  | 6.6  | 4                   | 2.4  | -                   |
| Marital status                | Yes                    | 539 | 143       | 96.6| 254                 | 88.8 | 142                 | 84.5 | 0.002               |
| Having children               | No                     | 118 | 18        | 12.2| 60                  | 20.9 | 40                  | 23.7 | 0.024               |
|                               | One or two             | 317 | 76        | 51.4| 155                 | 54.0 | 86                  | 50.9 | -                   |
|                               | ≥Three                 | 169 | 54        | 36.5| 72                  | 25.1 | 43                  | 25.4 | -                   |
| Affiliation                   | University hospital    | 245 | 58        | 38.9| 111                 | 38.8 | 76                  | 44.7 | 0.550               |
|                               | Public hospital        | 205 | 49        | 32.9| 105                 | 36.7 | 51                  | 30.0 | -                   |
|                               | Private hospital       | 155 | 42        | 28.2| 70                  | 24.5 | 43                  | 25.3 | -                   |
| Number of full-time doctors   | ≤5                     | 311 | 76        | 51.0| 151                 | 52.6 | 84                  | 49.4 | 0.904               |
|                               | 6–10                   | 191 | 49        | 32.9| 89                  | 31.0 | 53                  | 31.2 | -                   |
|                               | >10                    | 104 | 24        | 16.1| 47                  | 16.4 | 33                  | 19.4 | -                   |
| Position<sup>c</sup>          | Manager                | 285 | 100       | 67.1| 132                 | 45.8 | 53                  | 31.2 | <0.001              |
|                               | Middle manager         | 134 | 20        | 13.4| 73                  | 25.3 | 41                  | 24.1 | -                   |
|                               | General staff          | 188 | 29        | 19.5| 83                  | 28.8 | 76                  | 44.7 | -                   |
| Annual income, Japanese Yen per year | ≤10 million | 80  | 12        | 8.1 | 28                  | 9.8  | 40                  | 23.5 | <0.001              |
|                               | >10, ≤20 million       | 431 | 103       | 69.6| 217                 | 75.9 | 111                 | 63.3 | -                   |
|                               | >20 million            | 93  | 33        | 22.3| 41                  | 14.3 | 19                  | 11.2 | -                   |
| Percentage of main place of work attributed to the total wage, % | <50                    | 105 | 23        | 15.6| 51                  | 17.7 | 31                  | 18.3 | 0.022               |
|                               | 51–70                  | 114 | 33        | 22.4| 48                  | 16.7 | 33                  | 19.5 | -                   |
|                               | 71–99                  | 170 | 46        | 31.3| 93                  | 32.3 | 31                  | 18.3 | -                   |
|                               | 100                    | 215 | 45        | 30.6| 96                  | 33.3 | 74                  | 43.8 | -                   |
| Specialty of cardiovascular surgery | Adult          | 466 | 106       | 71.1| 227                 | 78.8 | 133                 | 78.2 | 0.134               |
|                               | Pediatric              | 71  | 18        | 12.1| 30                  | 10.4 | 23                  | 13.5 | -                   |
|                               | Vascular surgery       | 70  | 25        | 16.8| 31                  | 10.8 | 14                  | 8.2  | -                   |
| Cardiovascular specialist     | Yes                    | 492 | 132       | 88.6| 243                 | 84.7 | 117                 | 68.8 | <0.001              |
| Chief of training             | Yes                    | 319 | 106       | 71.1| 151                 | 52.6 | 62                  | 36.5 | <0.001              |
| Education time, %             | >10                    | 114 | 34        | 23.0| 56                  | 19.5 | 24                  | 14.2 | 0.128               |
|                                    | ≤100 | 101–300 | 301–600 | >600 |          |          |
|------------------------------------|------|---------|---------|------|----------|----------|
| Open heart surgery, cases per year | 164  | 164     | 164     | 164  | 164      | 164      |
|                                    | 47   | 47      | 47      | 47   | 47       | 47       |
|                                    | 31.5 | 31.5    | 31.5    | 31.5 | 31.5     | 31.5     |
|                                    | 83   | 83      | 83      | 83   | 83       | 83       |
|                                    | 29.0 | 29.0    | 29.0    | 29.0 | 29.0     | 29.0     |
|                                    | 34   | 34      | 34      | 34   | 34       | 34       |
|                                    | 20.0 | 20.0    | 20.0    | 20.0 | 20.0     | 20.0     |
| Vascular surgery, cases per year   | 282  | 282     | 282     | 282  | 282      | 282      |
|                                    | 72   | 72      | 72      | 72   | 72       | 72       |
|                                    | 48.3 | 48.3    | 48.3    | 48.3 | 48.3     | 48.3     |
|                                    | 135  | 135     | 135     | 135  | 135      | 135      |
|                                    | 47.4 | 47.4    | 47.4    | 47.4 | 47.4     | 47.4     |
|                                    | 75   | 75      | 75      | 75   | 75       | 75       |
|                                    | 44.1 | 44.1    | 44.1    | 44.1 | 44.1     | 44.1     |
|                                    | 0.311| 0.311   | 0.311   | 0.311| 0.311    | 0.311    |
| On duty, times per month           | ≤5   | ≥6      | ≥6      | ≥6   | ≥6       | ≥6       |
|                                    | 506  | 506     | 506     | 506  | 506      | 506      |
|                                    | 141  | 141     | 141     | 141  | 141      | 141      |
|                                    | 95.3 | 95.3    | 95.3    | 95.3 | 95.3     | 95.3     |
|                                    | 245  | 245     | 245     | 245  | 245      | 245      |
|                                    | 87.3 | 87.3    | 87.3    | 87.3 | 87.3     | 87.3     |
|                                    | 118  | 118     | 118     | 118  | 118      | 118      |
|                                    | 84.2 | 84.2    | 84.2    | 84.2 | 84.2     | 84.2     |
|                                    | 0.001| 0.001   | 0.001   | 0.001| 0.001    | 0.001    |
| On-call in workday, times per month| ≤10  | ≥11     | ≥11     | ≥11  | ≥11      | ≥11      |
|                                    | 354  | 354     | 354     | 354  | 354      | 354      |
|                                    | 110  | 110     | 110     | 110  | 110      | 110      |
|                                    | 73.8 | 73.8    | 73.8    | 73.8 | 73.8     | 73.8     |
|                                    | 171  | 171     | 171     | 171  | 171      | 171      |
|                                    | 59.4 | 59.4    | 59.4    | 59.4 | 59.4     | 59.4     |
|                                    | 73   | 73      | 73      | 73   | 73       | 73       |
|                                    | 43.2 | 43.2    | 43.2    | 43.2 | 43.2     | 43.2     |
|                                    | <0.001|<0.001  |<0.001   |<0.001|<0.001    |<0.001    |
| On-call at night or on holiday, times per month| ≤10  | ≥11     | ≥11     | ≥11  | ≥11      | ≥11      |
|                                    | 234  | 234     | 234     | 234  | 234      | 234      |
|                                    | 90   | 90      | 90      | 90   | 90       | 90       |
|                                    | 60.4 | 60.4    | 60.4    | 60.4 | 60.4     | 60.4     |
|                                    | 104  | 104     | 104     | 104  | 104      | 104      |
|                                    | 36.2 | 36.2    | 36.2    | 36.2 | 36.2     | 36.2     |
|                                    | 40   | 40      | 40      | 40   | 40       | 40       |
|                                    | 23.5 | 23.5    | 23.5    | 23.5 | 23.5     | 23.5     |
|                                    | <0.001|<0.001  |<0.001   |<0.001|<0.001    |<0.001    |
| On-call in workday, times per month| 11–20| ≥21     | ≥21     | ≥21  | ≥21      | ≥21      |
|                                    | 48   | 48      | 48      | 48   | 48       | 48       |
|                                    | 14   | 14      | 14      | 14   | 14       | 14       |
|                                    | 9.4  | 9.4     | 9.4     | 9.4  | 9.4      | 9.4      |
|                                    | 23   | 23      | 23      | 23   | 23       | 23       |
|                                    | 8.0  | 8.0     | 8.0     | 8.0  | 8.0      | 8.0      |
|                                    | 11   | 11      | 11      | 11   | 11       | 11       |
|                                    | 6.5  | 6.5     | 6.5     | 6.5  | 6.5      | 6.5      |
| On-call at night or on holiday, times per month| >20  |          |          |          |          |          |
|                                    | 324  |          |          |          |          |          |
|                                    | 45   |          |          |          |          |          |
|                                    | 30.2 |          |          |          |          |          |
|                                    | 160  |          |          |          |          |          |
|                                    | 22.7 |          |          |          |          |          |
|                                    | 119  |          |          |          |          |          |
|                                    | 70.0 |          |          |          |          |          |
| Working hours in other hospital, per week| ≥10  |          |          |          |          |          |
|                                    | 181  |          |          |          |          |          |
|                                    | 41   |          |          |          |          |          |
|                                    | 28.3 |          |          |          |          |          |
|                                    | 82   |          |          |          |          |          |
|                                    | 29.3 |          |          |          |          |          |
|                                    | 58   |          |          |          |          |          |
|                                    | 35.4 |          |          |          |          |          |
|                                    | 0.310|          |          |          |          |          |
| On duty in other hospital, times per month| ≥6   |          |          |          |          |          |
|                                    | 23   |          |          |          |          |          |
|                                    | 2    |          |          |          |          |          |
|                                    | 1.4  |          |          |          |          |          |
|                                    | 10   |          |          |          |          |          |
|                                    | 3.5  |          |          |          |          |          |
|                                    | 11   |          |          |          |          |          |
|                                    | 6.6  |          |          |          |          |          |
|                                    | 0.050|          |          |          |          |          |

**a:** Chi-squared test or Fisher’s exact test

**b:** Missing values were excluded (partner=5, children=3, annual income=3, attributed to the total wage=3, affiliation=2, number of full-time doctors=1, cardiovascular specialist=1, chief of training=1, education time=3, open heart surgery=2, vascular surgery=3, on duty=6, on-call in workday=1, on-call at night or on holiday=1, working hours in other hospital=18, on duty in other hospital=9).

**c:** Manager included in professor, director, and division chief. Middle manager included in lecturer and chief physician. General staff include in staff physician and specialist in specialty.
| Variables                                           | <60  |  ≥60 to 79 | ≥80  | \( p \) value^a |
|-----------------------------------------------------|------|------------|------|-----------------|
| Clinical work in outpatient clinic, yes             |      |            |      |                 |
| Initial examination at first visit                   | 210  | 104        | 60   | 0.537           |
| Examination orders at first visit                    | 420  | 204        | 119  | 0.452           |
| Medical examination and record                       | 558  | 269        | 154  | 0.410           |
| Reservation for next visit                          | 455  | 219        | 123  | 0.652           |
| Blood sampling                                      | 15   | 6          | 7    | 0.128           |
| Intravenous injection                               | 6    | 2          | 3    | 0.483           |
| Venous line insertion                               | 25   | 11         | 11   | 0.565           |
| Explanation for examination and hospitalization     | 205  | 100        | 60   |                 |
| Clinical work in the ward, yes                      |      |            |      |                 |
| Medical examination and records                      | 539  | 259        | 162  | <0.001          |
| Examination order                                   | 448  | 220        | 142  | <0.001          |
| Blood sampling                                      | 50   | 22         | 20   | 0.102           |
| Intravenous injection                               | 40   | 20         | 14   | 0.302           |
| Venous line insertion                               | 91   | 49         | 31   | 0.011           |
| Urethral catheter insertion                         | 96   | 47         | 34   | 0.050           |
| Insertion and removal of nasogastric tube           | 199  | 92         | 74   | <0.001          |
| Postoperative wound management                       | 438  | 217        | 134  | <0.001          |
| Removal of thoracic tube                            | 417  | 207        | 134  | <0.001          |
| Management of cardiovascular drugs                  | 408  | 199        | 142  | <0.001          |
| Preoperative shaving                                 | 48   | 23         | 13   | 0.899           |
| Patient transport                                   | 135  | 64         | 43   | 0.379           |
| Management of hospital discharge                    | 401  | 200        | 124  | <0.001          |
| Desk work in the ward, yes                          |      |            |      |                 |
| Informed consent for surgery                        | 530  | 268        | 151  | <0.001          |
| Medical certificate                                 | 417  | 207        | 118  | 0.093           |
| Documents for patient insurance                     | 295  | 142        | 88   | 0.330           |
| Registration for NCD                                 | 300  | 148        | 88   | 0.191           |
| Registration for JCVSD                               | 275  | 144        | 79   | 0.010           |
| Registration for DPC                                 | 225  | 104        | 76   | 0.025           |
| Correspondence for medical receipt                  | 408  | 195        | 126  | 0.011           |
| Postoperative management, yes                        |      |            |      |                 |
| Procedure Combination | Total | %  | %  | %  | %  | %  | p-value |
|------------------------|-------|----|----|----|----|----|---------|
| Cardiovascular Surgeon at ICU | 489   | 102| 68.5| 232| 80.6| 155| 91.2| <0.001 |
| ICU doctor at ICU | 151   | 45 | 30.2| 80 | 27.8| 26 | 15.3| 0.003  |
| Cardiovascular Surgeon at High Care Unit | 86    | 21 | 14.1| 51 | 17.7| 14 | 8.2 | 0.019  |

ICU: Intensive Care Unit; NCD: National Clinical Database; JCVSD: Japan Adult Cardiovascular Surgery Database; DPC: Diagnosis Procedure Combination

a: Chi-squared test
| Variables                        | Categories | Average working hours (per week) |          |          |          |          |
|---------------------------------|------------|----------------------------------|----------|----------|----------|----------|
|                                 |            |                                  | ≥60 to 79 vs <60 | ≥80 vs <60 |          |          |
|                                 |            | OR                               | 95%CI    | P value^a | OR       | 95%CI    | P value^a |
|                                 |            |                                  |          |          |          |          |
|                                 |            | 12.08                            | 2.39 - 61.05 | 0.003 | 95.63 | 15.93 - 574.09 | <0.001 |
| Age, years                      | <30        | 12.71                            | 5.90 - 27.35 | <0.001 | 47.60 | 14.83 - 152.81 | <0.001 |
|                                 | 30–39      | 7.81                             | 4.04 - 15.09 | <0.001 | 22.80 | 7.56 - 68.71 | <0.001 |
|                                 | 40–49      | 5.20                             | 2.77 - 9.78 | <0.001 | 9.56  | 3.17 - 28.89 | <0.001 |
|                                 | ≥60        | Ref.                             |          |          | Ref.     |          |          |
| Marital status                  | No vs yes  | 3.60                             | 1.37 - 9.45 | 0.009 | 5.24  | 1.96 - 14.01 | 0.001 |
|                                 | No         | 2.50                             | 1.33 - 4.71 | 0.005 | 2.79  | 1.41 - 5.54  | 0.003 |
|                                 | One or two | 1.53                             | 0.98 - 2.39 | 0.062 | 1.42  | 0.86 - 2.36  | 0.173 |
|                                 | ≥ three    | Ref.                             |          |          | Ref.     |          |          |
| Position                        | Manager    | 2.77                             | 1.58 - 4.84 | <0.001 | 3.87  | 2.06 - 7.26  | <0.001 |
|                                 | General staff | 2.22                          | 1.32 - 3.56 | 0.002 | 4.95  | 2.88 - 8.05  | <0.001 |
| Annual income, Japanese Yen per year | ≤10 million | 1.88                             | 0.83 - 4.25 | 0.131 | 5.79  | 2.46 - 13.64 | <0.001 |
|                                 | >10, ≤20 million | 1.69                          | 1.01 - 2.84 | 0.044 | 1.87  | 1.00 - 3.50  | 0.049 |
|                                 | >20 million | Ref.                             |          |          | Ref.     |          |          |
| Percentage of main place of work attributed to the total wage, % | <50 | Ref.                             |          |          | Ref.     |          |          |
|                                 | 51–70      | 0.66                             | 0.34 - 1.76 | 0.901 | 0.74  | 0.36 - 1.53  | 0.419 |
|                                 | 71–99      | 0.91                             | 0.50 - 1.67 | 0.765 | 0.50  | 0.25 - 1.01  | 0.054 |
|                                 | 100        | 0.96                             | 0.53 - 1.27 | 0.212 | 1.22  | 0.63 - 2.35  | 0.551 |
| Specialized Category            | Adult      | 1.73                             | 0.97 - 3.07 | 0.063 | 2.24  | 1.11 - 1.52  | 0.024 |
|                                 | Pediatric  | 1.34                             | 0.61 - 2.95 | 0.461 | 2.28  | 0.93 - 5.61  | 0.072 |
|                                 | Vascular surgery | Ref. |          |          | Ref.     |          |          |
| Cardiovascular specialist       | No vs yes  | 1.41                             | 0.77 - 2.56 | 0.265 | 3.52  | 1.93 - 6.41  | <0.001 |
|                                 | Chief of training | No vs yes | 2.22 | 1.45 - 3.39 | <0.001 | 4.29  | 2.68 - 6.89  | <0.001 |
|                                 | Education time, % | ≤10 vs >10 | 1.23 | 0.76 - 1.99 | 0.399 | 1.80  | 1.01 - 3.21  | 0.046 |
|                                 | On duty, times per month | >5 vs ≤5 | 2.94 | 1.27 - 6.77 | 0.012 | 8.88  | 3.89 - 20.28 | <0.001 |
|                                 | On-call in work day, times per month | ≤10 | Ref. |          | Ref.     |          |          |
|                                 |            | 11–20                            | 1.57  | 0.84 - 3.68 | 0.161 | 2.54  | 1.28 - 5.05  | 0.008 |
|                                 |            | >20                               | 2.18  | 1.29 - 2.94 | 0.003 | 4.52  | 2.59 - 7.89  | <0.001 |
|                                 |            | Ref.                             |          |          | Ref.     |          |          |
|               |   |   |   |   |   |   |   |
|---------------|---|---|---|---|---|---|---|
|               | 11-20 |   | 1.42 | 0.69 | 2.93 | 0.339 | 1.77 |
|               | >20  |   | 3.08 | 1.99 | 4.75 | <0.001 | 5.95 |
|               | ≥6   |   | 2.61 | 0.56 | 12.07 | 0.220 | 5.11 |

On duty in other hospital, times per month

OR: odds ratio; 95%CI: 95% confidence interval

a: Using a multinomial logistic regression, entered each variable with p value <0.2 from Table 1-1

b: Missing values were excluded (partner=5, children=3, annual income=3, percentage of main place of work attributed to the total wage=3, cardiovascular specialist=1, chief of training=1, education time=3, on duty=6, on-call in workday=1, on-call at night or on holiday=1, on duty in other hospital=9).
| Variables                                           | Average working hours (per week) |                                                                 |
|-----------------------------------------------------|---------------------------------|-----------------------------------------------------------------|
|                                                     | ≥60 to 79 vs <60                | ≥80 vs <60                                                       |
|                                                     | OR     | 95%CI | p value<sup>a</sup> | OR     | 95%CI | p value<sup>a</sup> |
| Clinical work in outpatient clinic, yes vs no       |        |       |                    |        |       |                    |
| Venous line insertion                               | 1.93   | 0.53  - 7.04 | 0.318 | 3.37   | 0.92  - 12.31 | 0.066 |
| Medical examination and records                     | 2.35   | 1.35  - 4.07 | 0.002 | 5.32   | 2.36  - 11.99 | <0.001 |
| Examination order                                   | 2.37   | 1.55  - 3.62 | <0.001 | 3.72   | 2.21  - 6.25  | <0.001 |
| Blood sampling                                      | 1.46   | 0.63  - 3.36 | 0.375 | 2.35   | 1.00  - 5.51  | 0.049 |
| Venous line insertion                               | 2.57   | 1.29  - 5.11 | 0.007 | 2.80   | 1.35  - 5.79  | 0.006 |
| Urethral catheter insertion                         | 1.74   | 0.94  - 3.23 | 0.079 | 2.23   | 1.16  - 4.29  | 0.016 |
| Insertion and removal of nasogastric tube           | 1.65   | 1.04  - 2.61 | 0.033 | 2.71   | 1.66  - 4.43  | <0.001 |
| Postoperative wound management                      | 2.18   | 1.43  - 3.32 | <0.001 | 2.65   | 1.62  - 4.34  | <0.001 |
| Removal of thoracic tube                            | 2.46   | 1.63  - 3.70 | <0.001 | 3.58   | 2.19  - 5.83  | <0.001 |
| Management of cardiovascular drugs                  | 2.74   | 1.82  - 4.12 | <0.001 | 6.21   | 3.70  - 10.42 | <0.001 |
| Management of hospital discharge                    | 2.37   | 1.57  - 3.56 | <0.001 | 3.17   | 1.98  - 5.10  | <0.001 |
| Postoperative management, yes vs no                 |        |       |                    |        |       |                    |
| Cardiovascular Surgeon at ICU                       | 1.91   | 1.210 - 3.00 | 0.01  | 4.76   | 2.53  - 8.96  | <0.001 |
| ICU doctor at ICU                                   | 0.89   | 0.580 - 1.37 | 0.595 | 0.42   | 0.24  - 0.72  | 0.002 |
| Cardiovascular Surgeon at High Care Unit            | 1.31   | 0.760 - 2.28 | 0.335 | 0.55   | 0.27  - 1.12  | 0.098 |
| Desk work in the ward, yes vs no                    |        |       |                    |        |       |                    |
| Informed consent for surgery                        | 4.59   | 2.56  - 8.23 | <0.001 | 2.72   | 1.49  - 4.97  | 0.001 |
| Medical certificate                                 | 1.58   | 1.04  - 2.41 | 0.031 | 1.41   | 0.88  - 2.24  | 0.150 |
| Registration for NCD                                | 1.40   | 0.94  - 2.09 | 0.095 | 1.43   | 0.92  - 2.22  | 0.116 |
| Registration for JCVSD                              | 1.87   | 1.24  - 2.81 | 0.003 | 1.62   | 1.03  - 2.55  | 0.037 |
| Registration for DPC                                | 1.31   | 0.86  - 2.00 | 0.217 | 1.87   | 1.18  - 2.97  | 0.008 |
| Correspondence for medical receipt                  | 1.49   | 0.99  - 2.25 | 0.054 | 2.04   | 1.27  - 3.28  | 0.003 |

OR: odds ratio; 95%CI: 95% confidence interval; ICU: Intensive Care Unit; NCD: National Clinical Database; JCVSD: Japan Adult Cardiovascular Surgery Database; DPC: Diagnosis Procedure Combination

<sup>a</sup> Using a multinomial logistic regression, entered each variable with p value <0.2 from Table 1-2.
Table 3. Relationship between average working hours and related factors of cardiovascular surgeons in the multivariable analysis with stepwise reduction method and adjustment after confounding factors (N=579)

| Variables                          | ≥60 to 79 vs <60 | ≥80 vs <60 |
|-----------------------------------|-----------------|-----------|
|                                   | AOR 95%CI | p value<sup>a</sup> | AOR 95%CI | p value<sup>a</sup> |
| Age, years                        |            |           |            |           |
| <30                               | 6.20 1.06 - 36.41 0.044 | 23.64 3.34 - 167.16 0.002 |
| 30–39                             | 7.48 3.01 - 18.64 <0.001 | 19.10 5.05 - 72.22 <0.001 |
| 40–49                             | 5.51 2.52 - 12.04 <0.001 | 12.17 3.54 - 41.84 <0.001 |
| 50–59                             | 3.22 1.58 - 6.56 0.001 | 4.87 1.49 - 15.97 0.009 |
| ≥60                               | Ref.       | Ref.      | Ref.       | Ref.      |
| On duty, >5 vs ≤5, times per month| 1.54 0.63 - 3.76 0.34 | 3.89 1.58 - 9.55 0.003 |
| On-call at night or on holiday, times per month| Ref. | Ref. |
| ≤10                               |            |           |            |           |
| 11–20                             | 0.93 0.41 - 2.59 0.87 | 1.10 0.40 - 3.01 0.855 |
| >20                               | 1.58 0.97 - 2.59 0.07 | 2.26 1.26 - 4.08 0.007 |
| Clinical work in the ward, yes vs no|            |           |            |           |
| Postoperative wound management    | 0.47 0.23 - 0.95 0.035 | 0.16 0.07 - 0.41 <0.001 |
| Management of cardiovascular drugs| 1.87 1.00 - 3.47 0.049 | 5.80 2.45 - 13.67 <0.001 |
| Postoperative management, yes vs no|            |           |            |           |
| Cardiovascular Surgeon at ICU     | 1.52 0.90 - 2.57 0.118 | 3.12 1.49 - 6.51 0.003 |
| Desk work in the ward, yes vs no  |            |           |            |           |
| Informed consent for surgery      | 3.29 1.67 - 7.05 <0.001 | 1.85 0.80 - 4.29 0.149 |

AOR: adjusted odds ratio; 95%CI: 95% confidence interval; ICU: Intensive Care Unit

<sup>a</sup>: Using a multinomial logistic regression with manual backward stepwise method, entered variables with p values <0.2 from Table 2 and adjusted after sex, partner, children, affiliation, number of full-time doctors, annual income, percentage of main place of work attributed to the total wage.