




## ORIGINAL ARTICLE

# Impact of board certification system and adherence to the clinical practice guidelines for liver cancer on post-hepatectomy risk-adjusted mortality rate in Japan: A questionnaire survey of departments registered with the National Clinical Database

Junichi Arita<sup>1,2,3</sup>  | Hiroyuki Yamamoto<sup>4,5,6</sup> | Takashi Kokudo<sup>1,2,3</sup> | Kiyoshi Hasegawa<sup>1,2,3</sup>  | Hiroaki Miyata<sup>4,5,6</sup> | Yasushi Toh<sup>2,7</sup> | Mitsukazu Gotoh<sup>2,8</sup>  | Norihiro Kokudo<sup>1,2,9</sup> | Yoshihiro Kakeji<sup>2,10</sup> | Yasuyuki Seto<sup>2,4,11</sup>

<sup>1</sup>Liver Cancer Study Group of Japan, Japan Society of Hepatology, Tokyo, Japan

<sup>2</sup>The Japanese Society of Gastroenterological Surgery, Tokyo, Japan

<sup>3</sup>Hepato-Biliary and Pancreatic Surgery Division, Department of Surgery, Graduate School of Medicine, The University of Tokyo, Tokyo, Japan

<sup>4</sup>National Clinical Database, Tokyo, Japan

<sup>5</sup>Department of Healthcare Quality Assessment, Graduate School of Medicine, The University of Tokyo, Tokyo, Japan

<sup>6</sup>Department of Health Policy and Management, School of Medicine, Keio University, Tokyo, Japan

<sup>7</sup>National Hospital Organization Kyushu Cancer Center, Fukuoka, Japan

<sup>8</sup>Osaka General Medical Center, Osaka, Japan

<sup>9</sup>National Center for Global health and Medicine, Tokyo, Japan

<sup>10</sup>Division of Gastrointestinal Surgery, Department of Surgery, Graduate School of Medicine, Kobe University, Kobe, Japan

<sup>11</sup>Gastrointestinal Surgery Division, Department of Surgery, Graduate School of Medicine, The University of Tokyo, Tokyo, Japan

## Correspondence

Mitsukazu Gotoh, The Japanese Society of Gastroenterological Surgery, Axiom Mita 6F, 3-1-17, Minato-ku, Tokyo 108-0073, Japan.  
Email: mgotoh@fmu.ac.jp

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## Abstract

**Background:** It is unclear to what extent a board certification system and implementation of clinical guidelines improves the quality of hepatectomy.

**Methods:** A web-based questionnaire survey was administered to departments registered with the National Clinical Database (NCD) in Japan between 1 October 2014 and 31 January 2015. Quality indicators (QIs), including affiliations with academic societies, numbers of board-certified doctors affiliated with each institute, and adherence to clinical practice guidelines for hepatocellular carcinoma, were evaluated by calculating risk-adjusted odds ratios (AORs) for 90-day postoperative mortality of patients who had undergone hepatectomy in 2013 and 2014.

**Results:** Of 1255 departments that had registered at least one hepatectomy in NCD, 592 departments, performing 8601 hepatectomies in total, responded to the questionnaire. AORs were significantly lower in departments that were certified as training

Junichi Arita and Hiroyuki Yamamoto contributed equally.

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hospitals by the Japanese Society of Gastroenterological Society, Japanese Society of Hepato-Biliary-Pancreatic Surgery (JSHBPS), and Japan Society of Hepatology than in non-certified departments. Affiliation of three or more JSHBPS-certified experts or instructors with an institution also contributed to low AORs. None of the QIs regarding implementation of guidelines significantly impacted on the AOR.

**Conclusions:** Quality indicator measurements may improve quality of post-hepatectomy outcomes in Japan.

#### KEYWORDS

board certification, clinical guidelines, hepatectomy, quality indicator, questionnaire survey

## 1 | INTRODUCTION

The safety and efficacy of hepatectomy have improved dramatically in recent years, enabling broadening of the indications for this procedure.<sup>1</sup> However, nationwide studies using the National Clinical Database (NCD) in Japan have demonstrated that post-hepatectomy mortality rates are relatively high compared with those of other gastrointestinal surgical procedures, such as gastrectomy and colorectal surgery.<sup>2,3-10,11</sup>

Donabedian et al have proposed a three-component model for measuring the quality of health care: structure, process, and outcome.<sup>12,13</sup> In this model, “structure” is defined as settings, qualifications of providers, and administrative systems through which care takes place; “process” as the components of care delivered; and “outcome” as recovery, restoration of function, and survival. In this model, certain quality indicators (QIs) for each of the three above-mentioned components are used to assess quality of care.

A three-stage board certification system for the education and training of highly skilled surgeons has been established in Japan. The Japan Surgical Society (JSS), Japanese Society of Gastroenterological Surgery (JSGS), and Japanese Society of Hepato-Biliary-Pancreatic Surgery (JSHBPS) are responsible for the first, second, and third levels of accreditation in the field of hepatectomy, respectively. Each of these academic societies accredits both training institutes and certified surgeons. Additionally, participation in provision of multidisciplinary treatment by hepatologists certified by the Japanese Society of Hepatology (JSH) and oncologists certified by the Japanese Board of Cancer Therapy (JBCT), classified as a “structure” factor, may improve the outcomes of hepatectomy for liver cancer. These board certification systems may be considered in constructing structure-related QIs.

Implementation of standards of care may play a role in improving quality of health care. The Clinical Practice Guidelines for hepatocellular carcinoma, first published in 2005 and most recently published in 2017 from the JSH, include recommendations for various components of treatment

and is considered a reference for standards of care. Therefore, some of these guidelines' recommendations may be candidates for process-related QIs.

The NCD, a nationwide registry of surgical procedures performed, was established in 2010 by ten academic societies, including the JSS, JSGS, and JSHBPS, that were affiliated with the board-certified surgeon (BCS) system.<sup>8</sup> More than 95% of surgeries performed in Japan are now registered with the NCD, enabling evaluation of risk-adjusted surgical outcomes of nine major surgical procedures, including hepatectomy.<sup>3-10,14</sup>

This study aimed to use Donabedian's model<sup>12</sup> to evaluate the quality of healthcare received by patients undergoing hepatectomy in Japan. To this end, a web-based questionnaire survey was administered to the departments registered with the NCD. QIs, including affiliations with various academic societies, number of board-certified doctors in each institute, and adherence to established clinical guidelines, were evaluated using risk-adjusted odds ratios (AOR) for operative mortality.

## 2 | METHODS

### 2.1 | Questionnaire survey

This project was approved by the Ethics Committee of Fukushima Medical University (No. 1057). An online questionnaire was installed in the NCD registration system and all departments that registered at least one hepatectomy during the survey period (from 1 October 2014 and 31 January 2015) were asked by email to complete this questionnaire. The QIs in the questionnaire related to the treatment of hepatocellular carcinoma (HCC) were classified as structure and process and are shown in Table 1. Q1 to Q8, categorized as structure QIs, were selected on the basis of the concepts described in the Introduction. Q9 to Q14, categorized as process QIs, were selected through discussions among the members of the JSH council. These QIs were mainly drawn from the

**TABLE 1** The quality indicators used for the questionnaire survey

QI#	Category	Contents
1	Structure	Is your institution accredited by or related to the JSS?
2	Structure	Is your institution certified by the JSGS?
3	Structure	Is your institution a board-certified training institution of the JSHBPS?
4	Structure	Is your institution a board-certified training institution of the JSH?
5	Structure	How many board-certified surgeons of gastroenterological surgery by JSGS does your institute have?
6	Structure	How many board-certified expert surgeons and instructors by JSHBPS does your institute have?
7	Structure	How many board-certified hepatologists by JSH does your institution have?
8	Structure	How many General Clinical Oncologist certified by the Japanese Board of Cancer Therapy does your institution have?
9	Process	Are two or more tumor markers measured for diagnosing HCC?
10	Process	Is dynamic CT or dynamic MRI performed for diagnosing HCC?
11	Process	Is contrasted-enhanced ultrasonography performed for diagnosing HCC?
12	Process	Is hepatic pedicle clamping performed during liver resection to decrease bleeding?
13	Process	Is TACE/TAE performed for advanced HCC with level A or B liver damage (inoperable and local therapy not indicated)?
14	Process	Is RFA performed as a primary choice for local therapy of HCC?

Abbreviations: HCC, Hepatocellular carcinoma; JSGS, Japanese Society of Gastroenterological Society; JSH, Japan Society of Hepatology; JSHBPS, Japanese Society of Hepato-Biliary-Pancreatic Surgery; JSS, Japan Surgical Society; QI, Quality indicator; RFA, radiofrequency ablation; TACE, transcatheter arterial chemoembolization; TAE, transcatheter arterial embolization.

more strongly recommended items related to diagnosis and treatment of HCC in the Clinical Practice Guidelines for HCC published in 2013.<sup>15</sup> For Q9 to Q14, the respondents were asked to select one of the following three responses: first choice in principle (Group A), no institutional recommendation (Group B), and recommended by the institution but performed at the doctor's discretion (Group C).

## 2.2 | Investigation of clinical data

Analysis of AORs was performed based on the data of the patients who had undergone excision of one or more sections

of Healey and Schroy,<sup>16</sup> except left lateral sectionectomy (MOS<sup>3</sup>), in 2013 or 2014 at the institutions that responded to the questionnaire. Patients were excluded from analysis if they refused registration, had missing data with regard to sex and mortality, or did not provide informed consent. All clinical data, including background characteristics, surgical procedure, and operative mortality of the included patients were extracted from the NCD. Associations between the QIs and operative mortality in the corresponding department were evaluated using these patients' records. Operative mortality was defined as death within the index hospitalization period up to 90 days after surgery, as well as any death after discharge, up to 30 days after surgery. With hepatectomy, 90-day mortality is considered a fair outcome measure because it provides a more accurate indicator of the true risk of death than shorter term mortality.<sup>3,17-19</sup>

## 2.3 | Multivariable regression analysis

To clarify the relationships between the questionnaire responses and operative mortality, multivariable logistic regression models fitted with generalized estimating equations were used, with clustering of patients by hospital level. The following variables, which have previously been identified as favorable for constructing a risk model,<sup>3,7</sup> were used to adjust patient-level risk factors: age category, sex, activities of daily living within the 30 days before surgery (any assistance), chronic obstructive pulmonary disease, cancer metastasis/relapse, weight loss, white blood cell count <4500/ $\mu$ L, platelet count <120 000/ $\mu$ L, serum albumin <3.5 g/dL, blood urea nitrogen <8 mg/dL, serum Na <138 mEq/L, and prothrombin time-international normalized ratio >1.25. The results are expressed as adjusted odds ratios (AORs) for operative mortality and 95% confidence intervals (CIs).

## 2.4 | Statistical analysis

$\chi^2$  or Fisher's exact tests were performed to compare categorical data and their distributions as appropriate. Two-sided probability values <.05 were considered to denote statistical significance. All statistical calculations were performed using STATA 15 (STATA Corp.).

## 3 | RESULTS

### 3.1 | Patient entry, questionnaire survey, and crude operative mortality

In total, 749 departments responded to the questionnaire. Among them, 592 departments registered at least one

hepatectomy in 2013 or 2014, forming the study subjects. Based on the NCD, 1255 departments registered at least one hepatectomy in 2013 or 2014, thus, 47.2% of them responded to the questionnaire. Of 15 603 patients who had undergone MOS hepatectomies in 2013 or 2014 that were registered with the NCD, 8601 patients (55.1%) that had been registered with the NCD by departments responding to the questionnaire and had agreed to participate in this study were included in this analysis. Relevant patient characteristics and their relationships with crude operative mortality rates are shown in Table 2. Most of the previously identified risk model variables<sup>3</sup> showed statistically significant relationships with crude operative mortality rates.

The distribution of responses for each QI and the relationship between each QI and crude operative mortality rates are shown in Table 3. Responses to the questionnaire were received from 476 (56.2%) of the 847 institutions certified by the JSGS as of 2014, 167 (79.1%) of the 211 institutions certified by the JSHBPS as of 2014, and 212 (55.6%) of the 381 institutions certified by the JSH as of 2014. Total number of BCS by JSGS was 2478 in the 749 institutions responding to the questionnaire; that of BCS and board-certified instructors by JSHBPS was 450; that of board-certified hepatologists by JSH was 676; and that of board-certified oncologists by JBCT was 2470. Institutions that were certified by the JSGS (Q2), JSHBPS (Q3), or JSH (Q4) showed significantly lower crude operative mortality rates. The number of doctors board-certified by the JSGS (Q5), JSHBPS (Q6), or JHS (Q7), and the number of board-certified general clinical oncologists (Q8) affiliated with an institution all affected crude mortality rates.

Of the 592 departments that responded to the questionnaire, 472 (79.7%) gave the Group A response (“performed in principle”) for tumor markers (Q9), as did 504 (85.1%) for dynamic computed tomography (CT) or magnetic resonance imaging (MRI) (Q10), and 180 (30.4%) for contrast-enhanced ultrasonography (Q11). For hepatic pedicle clamping (Q12), transarterial chemoembolization/transarterial embolization (TACE/TAE) (Q13), and radiofrequency ablation (RFA) (Q14), 420 (70.9%), 331 (55.9%), and 260 (43.9%), respectively, responded “performed in principle” (Group A). For these questionnaire items, there were no significant differences in crude mortality rates between Group A, B, and C.

### 3.2 | Relationships between the board certification systems and AORs

The results after risk adjustment using the factors listed in the Methods are shown in Figure 1. The numbers of the patients who showed operative death in the departments not accredited by or related to JSS was only 1 (0.4%). Therefore, Q1 did not proceed to multivariable analysis. For Q2 and Q3, AORs

were significantly lower for departments that were certified as training sites for academic surgical societies (JSGS;  $P < .03$ , JSHBPS;  $P < .001$ ) than for those that were not certified. For Q4, AORs were also significantly lower for departments of board-certified training institutions by JSH than for those that were not certified ( $P = .001$ ). The impact of the number of BCSs or board-certified doctors affiliated with each department was evaluated by Q5-Q8. AORs tended to be lower for institutions with more JSGS-BCSs (Q5) or JHS board-certified doctors (Q7); however, these differences were not statistically significant. AORs tended to be lower for institutions with more JSHBPS board-certified expert surgeons or instructors, and were significantly lower for institutions with three or more JSHBPS-certified experts or instructors than for those with none. Institutions with three or more, two, one, and no JSHBPS-certified experts or instructors performed a mean of 28, 15, eight, and three hepatectomies per year, respectively. The number of general clinical JBCT-certified oncologists affiliated with an institution (Q8) did not have a significant impact on AORs.

### 3.3 | Relationships between process QIs and AORs

Relationships between the rates of implementation of the addressed QIs and AORs are shown in Figure 2. Most departments (79.7%) responded “the first choice” (Group A) for measuring two or more tumor markers (Q9). The majority of responding departments (85.1%) gave Group A responses to Q10, which assesses performance of dynamic CT or MRI. Hepatic pedicle clamping during liver transection (Q12) was reported as the first choice (Group A) by majority (70.9%) of respondents. There were no significant differences in AORs between the groups for any of the above-listed QIs.

## 4 | DISCUSSION

This study aimed to evaluate the impact of the board certification system and adherence to established clinical practice guidelines in Japan on the quality of healthcare in the field of liver surgery by using structure QIs and process QIs, AORs for operative mortality being the primary endpoint. Board certification of institutions by the JSGS, JSHBPS, and JSH significantly decreased AORs for operative mortality after hepatectomy, which may enhance the importance of multidisciplinary diagnosis and treatment of HCC. The number of BCSs and board-certified physicians affiliated with an institution tended to be associated with lower AORs, as was affiliation with an institution of three or more JSHBPS-certified expert surgeons or instructors. Responses to a web-based questionnaire survey by departments registered with the NCD

**TABLE 2** Patient characteristics and crude operative mortality rates (8601 patients in total)

Variables	Mortality (n = 251)		Alive (n = 8350)		P
	No.	%	No.	%	
Age					
-59	17	6.8%	1616	19.4%	<.001
60-64	24	9.6%	1182	14.2%	
65-69	44	17.5%	1482	17.7%	
70-74	61	24.3%	1763	21.1%	
75-79	59	23.5%	1490	17.8%	
80-	46	18.3%	817	9.8%	
Male	201	80.1%	5820	69.7%	<.001
Emergent surgery	5	2.0%	63	0.8%	.048*
ADL within 30 days before surgery (any assistance)	23	9.2%	187	2.2%	<.001
COPD	14	5.6%	230	2.8%	.008
Preoperative pneumonia	55	21.9%	109	1.3%	<.001
Ascites (any)	17	6.8%	176	2.1%	<.001
ASA class 3, 4, 5	83	33.1%	994	11.9%	<.001
Intrahepatic cholangiocarcinoma	27	10.8%	963	11.5%	.704
Hilar bile duct carcinoma	7	2.8%	40	0.5%	<.001*
Gallbladder cancer	16	6.4%	146	1.7%	<.001
Hemoglobin <10g/dL	43	17.1%	583	7.0%	<.001
Platelet <120 000/ $\mu$ L	47	18.7%	837	10.0%	<.001
Platelet <80 000/ $\mu$ L	14	5.6%	154	1.8%	<.001
Albumin <3.5 g/dL	108	43.0%	1277	15.3%	<.001
Albumin <3.0 g/dL	47	18.7%	382	4.6%	<.001
AST >40 U/L	124	49.4%	2284	27.4%	<.001
PT-INR >1.1	58	23.1%	1050	12.6%	<.001
Hepatectomy with S1	70	27.9%	1334	16.0%	<.001
Hepatectomy with S7	153	61.0%	3974	47.6%	<.001
Hepatectomy with S8	162	64.5%	4121	49.4%	<.001
hepatectomy with revascularization	13	5.2%	122	1.5%	<.001
left tri-sectionectomy with S1 resection	7	2.8%	84	1.0%	.017*

Abbreviations: ADL, activity of daily living; ASA, American Society of Anesthesiologists; AST, aspartate aminotransferase; BUN, blood urea nitrogen; COPD, chronic obstructive pulmonary disorder; PT-INR, prothrombin time international normalized ratio.

\*Fisher's exact test.

showed that the majority of the six process QIs were highly performed. However, implementation of these items was not associated with significant differences in post-hepatectomy AORs. These findings will likely facilitate improvements in the quality of surgical care in Japan.

Although institutional board certification by the JSGS or JSHBPS was associated with significantly lower AORs, certification by the JSS was not. Board certification of a surgeon by the JSS, JSGS, and JSHBPS occur stepwise in

that order; additionally, board certification of an institution by each of these societies requires the presence of BCSs. Moreover, board certification by the JSS, JSGS, and JSHBPS requires more than 150 surgical procedures per year, more than 200 procedures including 40 major procedures (surgery for esophageal cancer, distal gastrectomy, total gastrectomy, surgery for colon cancer, surgery for rectal cancer, surgery for ileus, partial hepatectomy, two or more segmentectomies of the liver, or pancreaticoduodenectomy) per year on

**TABLE 3** The response distributions and relationship between each quality Indicator and the crude operative mortality (In total, 592 departments and 8601 patients)

Questionnaire item	No. of departments	Operative mortality (n = 251)		Alive (n = 8350)		Total	Mortality rate
		No. of patients	%	No. of patients	%		
Q1 Institution accredited by or related to JSS							
No	11	1	0.4%	36	0.4%	37	<i>P</i> = .185* 0.4% 2.7%
Accredited	503	234	93.2%	7974	95.5%	8208	2.9% 95.4%
Relater	78	16	6.4%	340	4.1%	356	4.1% 4.5%
Q2 Institution certified by JSGS							
Yes	476	230	91.6%	7912	94.8%	8142	<i>P</i> = .030 2.8% 94.7%
No	116	21	8.4%	438	5.2%	459	4.6% 5.3%
Q3 Board-certified training institution by JSHBPS							
Yes	167	131	52.2%	5572	66.7%	5703	<i>P</i> < .001 2.3% 66.3%
No	425	120	47.8%	2778	33.3%	2898	4.1% 33.7%
Q4 Institution certified by JSH							
Yes	212	134	53.4%	5433	65.1%	5567	<i>P</i> < .001 2.4% 64.7%
No	380	117	46.6%	2917	34.9%	3034	3.9% 35.3%
Q5 No. of BCS by JSGS							
0	20	3	1.2%	87	1.0%	90	<i>P</i> < .001* 1.0% 3.3%
1	82	18	7.2%	345	4.1%	363	5.0% 4.2%
2-3	250	90	35.9%	2062	24.7%	2152	4.2% 25.0%
4-	240	140	55.8%	5856	70.1%	5996	2.3% 69.7%
Q6 No. of board-certified experts or instructors by JSHBPS							
0	332	68	27.1%	1816	21.7%	1884	<i>P</i> < .001 3.6% 21.9%
1	160	91	36.3%	2474	29.6%	2565	3.5% 29.8%
2	56	48	19.1%	1638	19.6%	1686	2.8% 19.6%
3-	44	44	17.5%	2422	29.0%	2466	1.8% 28.7%
Q7 No. of hepatologists certified by JSH							
0	290	70	27.9%	2509	30.0%	2579	<i>P</i> = .009 2.7% 30.0%
1	150	87	34.7%	2146	25.7%	2233	3.9% 26.0%
2	74	33	13.1%	1091	13.1%	1124	2.9% 13.1%
3-	78	61	24.3%	2604	31.2%	2665	2.3% 31.0%
Q8 No. of board-certified oncologists							
0	52	7	2.8%	301	3.6%	308	<i>P</i> = .021* 2.3% 3.6%

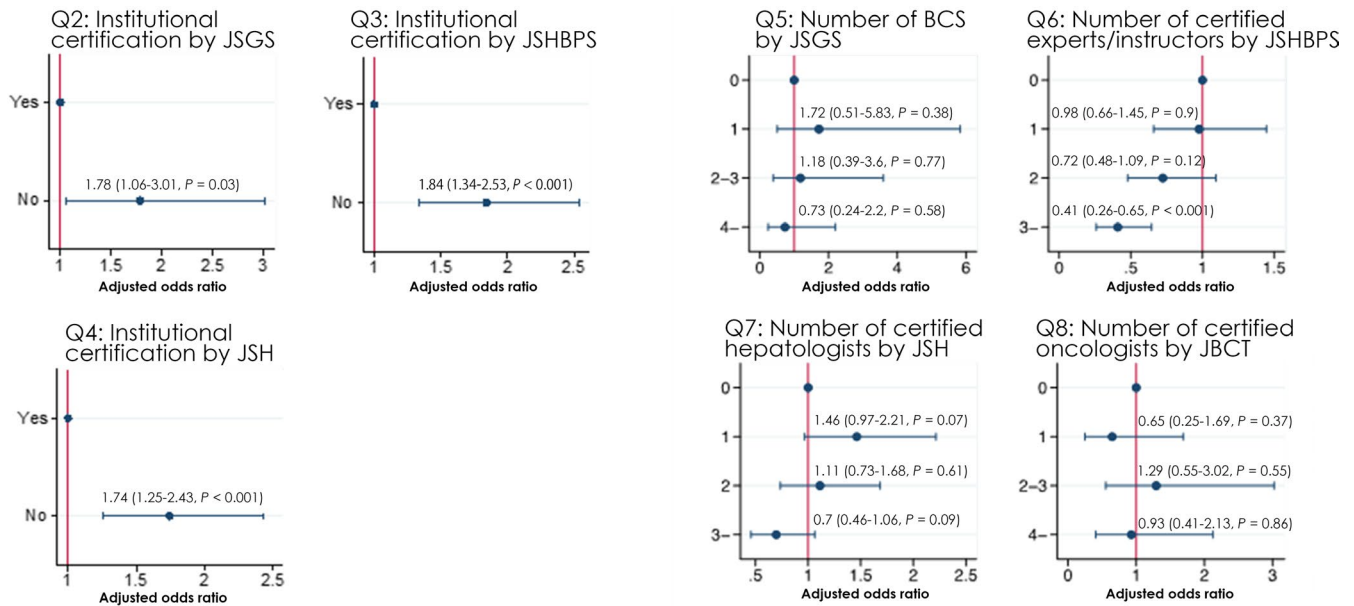
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TABLE 3 (Continued)

Questionnaire item	No. of departments	Operative mortality (n = 251)		Alive (n = 8350)		Total	
		No. of patients	%	No. of patients	%	No. of patients	%
1	106	21	8.4%	989	11.8%	1010	11.7%
2-3	222	99	39.4%	2547	30.5%	2646	30.8%
4	212	124	49.4%	4513	54.0%	4637	53.9%
Q9 Two or more tumor markers							
First choice in principle	472	224	89.2%	7258	86.9%	7482	87.0%
No institutional recommendation	15	5	2.0%	167	2.0%	172	2.0%
Recommended by institution but doctor's discretion	105	22	8.8%	925	11.1%	947	11.0%
Q10 Dynamic CT or MRI							
First choice in principle	504	227	90.4%	7580	90.8%	7807	90.8%
No institutional recommendation	12	8	3.2%	168	2.0%	176	2.0%
Recommended by institution but doctor's discretion	76	16	6.4%	602	7.2%	618	7.2%
Q11 Contrast-enhanced ultrasonography							
First choice in principle	180	76	30.3%	2884	34.5%	2960	34.4%
No institutional recommendation	202	81	32.3%	2700	32.3%	2781	32.3%
Recommended by institution but doctor's discretion	210	94	37.5%	2766	33.1%	2860	33.3%
Q12 Hepatic pedicle clamp							
First choice in principle	420	195	77.7%	6541	78.3%	6736	78.3%
No institutional recommendation	43	16	6.4%	587	7.0%	603	7.0%
Recommended by institution but doctor's discretion	129	40	15.9%	1222	14.6%	1262	14.7%
Q13 TACE/TAE							
First choice in principle	331	168	66.9%	5990	71.7%	6158	71.6%
No institutional recommendation	61	20	8.0%	573	6.9%	593	6.9%
Recommended by institution but doctor's discretion	200	63	25.1%	1787	21.4%	1850	21.5%
Q14 RFA							
First choice in principle	260	130	51.8%	4166	49.9%	4296	49.9%
No institutional recommendation	103	36	14.3%	1220	14.6%	1256	14.6%
Recommended by institution but doctor's discretion	229	85	33.9%	2964	35.5%	2964	35.5%

Abbreviations: JSGS, Japanese Society of Gastroenterological Society; JSH, Japan Society of Hepatology; JSHBPS, Japanese Society of Hepato-Biliary-Pancreatic Surgery; JSS, Japan Surgical Society; QI, Quality indicator; RFA, radiofrequency ablation; TACE, transcatheter arterial chemoembolization; TAE, transcatheter arterial embolization.

\*Fisher's exact test.



**FIGURE 1** Relationship between the institutional board certification or number of board-certified doctors at the department and the risk-adjusted odds ratio for operative mortality. The results show point estimates of odds ratio and 95% confidence intervals. Q2: Institution certified by the JSGS. Q3: Training institution certified by the JSHBPS. Q4: Institution certified by the JSH. Q5: Number of board-certified surgeons by the JSGS. Q6: Number of board-certified expert surgeons or instructors by the JSHBPS. Q7: Number of board-certified hepatologists by the JSH. Q8: Number of general clinical oncologists certified by the JBCT

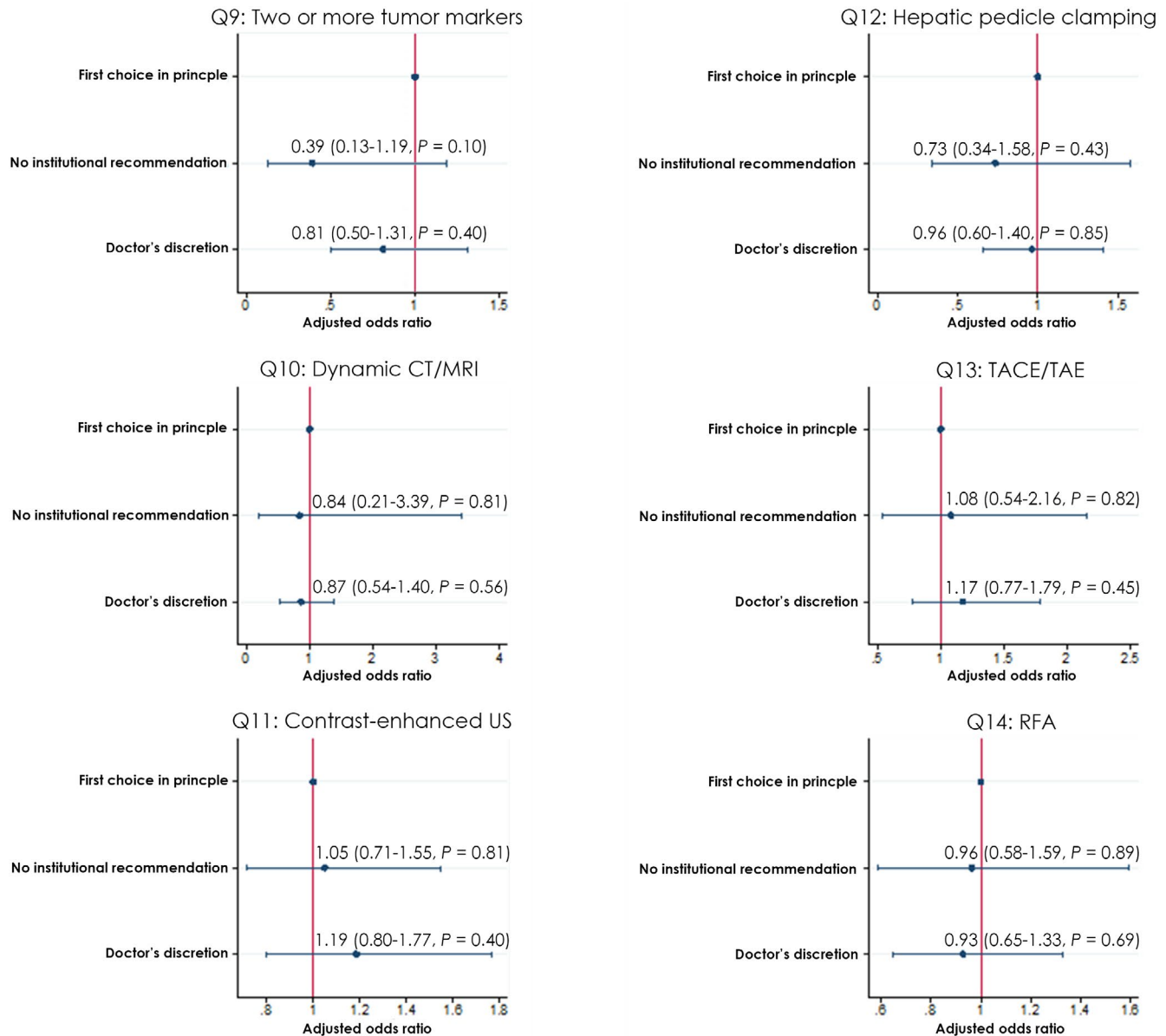
average, and 50 (Level A) or 30 (Level B) high-level HBP surgical procedures per year, respectively. In addition, board certification of experts by JSHBPS required video review of candidates' operation. The present findings indicate that certification by the subspecialty (JSGS) and super-subspecialty (JSHBPS) societies contributes to improving the quality of hepatectomy in Japan.

In this study, the more numerous the JSGS-certified surgeons affiliated with an institution, the lower AORs tended to be; however, this difference was not statistically different. Konno et al have demonstrated that affiliation of four or more JSGS-certified surgeons with an institution is associated with a significantly lower operative mortality after hepatectomy.<sup>20</sup> Their results differ somewhat from ours, possibly because of differences in the study cohorts (whole hepatectomies in 2011 and 2012 vs. MOS hepatectomies at questionnaire-responding institutions in 2013 and 2014). However, the tendencies were similar in the two studies. Additionally, in the present study the larger the number of JSHBPS-certified experts or instructors affiliated with an institution, the lower were the post-hepatectomy AORs. It is reasonable to assume that a high-risk surgical procedure like hepatectomy is better performed by a specialized team rather than by a single highly skilled surgeon. Indeed, affiliation of a greater number of JSHBPS-certified experts or instructors with an institution was associated with a greater number of hepatectomies performed in the institution per years. Given that it has been reported that the number of hepatectomies that one surgeon or one surgical team performs is reflected in their short-term results,<sup>21,22</sup> whether

institutional volume affects short-term results requires further evaluation. In the present study, we found that institutional board certification by the JHS had a significant impact on AORs and that the number of JSH-certified hepatologists affiliated with an institution tended to be associated with more favorable AORs; however, this difference was not statistically significant. These results highlight the importance of multidisciplinary treatment for HCC, suggesting that it could be a benchmark for institutional quality.

The six process QIs were based on the recommendations with higher grades in the Japanese Clinical Practice Guidelines published in 2013.<sup>15</sup> To our knowledge, the present study is the first to assess the clinical impact of implementing clinical guidelines in the field of hepatectomy. Two or more tumor markers were measured in most responding institutions; however, contrast-enhanced ultrasonography was less commonly performed (group A: 30.4%). Hepatic pedicle clamping to decrease bleeding during hepatectomy was implemented in most institutions. None of these items was significantly associated with lower AORs, which is in contrast with the findings for esophagectomy by Toh et al,<sup>23</sup> hemicolectomy by Kobayashi et al,<sup>24</sup> and pancreaticoduodenectomy by Mizuma et al.<sup>25</sup> In all three of these studies, lower post-surgery AORs were significantly associated with implementation of some of the relevant clinical practice guidelines. Most such previous reports focused on surgical decisions and follow-up treatment. In contrast, three of the six process QIs selected in the present study were related to procedures for diagnosing HCC, two to non-surgical treatment,





**FIGURE 2** Relationship between the rate of implementation of each process-related quality indicator and the risk-adjusted odds ratio for operative mortality. The results show point estimates of odds ratio and 95% confidence intervals. Q9: Measurement of two or more tumor markers. Q10: Performance of dynamic CT/MRI. Q11: Performance of contrast-enhanced ultrasonography. Q12: Hepatic pedicle clamping during liver transection. Q13: TACE/TAE for advanced HCC in patients with level A or B liver damage. Q14: Performance of RFA as a primary choice for local therapy for HCC

namely TACE and RFA, only one being directly related to the surgical procedure. This was because it has been difficult to establish strong consensus concerning surgical procedures, resulting in a paucity of strong recommendations regarding them in the clinical practice guidelines for liver cancer. All of the above-mentioned factors may contribute to explaining the differences in results. Besides the present analysis, a study addressing the relationship between board certification and adherence to clinical guidelines would be worth conducting.

Higashi et al drew on the Nationwide Survey of Primary Liver Cancer in Japan to investigate implementation rates of

six process QIs,<sup>26</sup> two of these six QIs, namely, tumor markers and TACE, being similar to those selected for the present study. In that study, all six QIs were implemented relatively frequently (between 64.4% and 91.1%). It was not possible to directly compare their results with ours for the following reasons. First, Higashi et al used clinical data registered in a nationwide survey to calculate the implementation rates of each QI, whereas we used data from responses to our questionnaire to calculate the proportion of institutions implementing the selected QIs. Second, they used clinical data from between 2002 and 2003, whereas our questionnaire

survey was performed between 2014 and 2015. The findings obtained in both studies may be important to consider the future investigations.

The limitations of this study are similar to those of previously studies.<sup>23-25</sup> First, we cannot exclude the possibility of bias in the responses to the questionnaire survey. The respondents were all registered with the NCD as its users but were not necessarily representative of their departments. Moreover, it was possible that surgeons instead of gastroenterologists answered the QIs regarding contrast-enhanced ultrasonography and RFA, which were usually performed by gastroenterologists. Thus, their responses do not necessarily reflect their departments' policies. Second, fewer than half of the invited institutions participated in the survey. Rates of implementation of the selected QIs or the mortality of hepatectomy may have differed between responding and non-responding institutions. Third, although the QIs were carefully selected by discussions between expert members of the JSH, the possibility that the selected QIs are not the most optimal for assessing the quality of liver surgery requires further discussion, especially considering they were selected from the limited number of recommendations in the clinical practice guidelines. Furthermore, process QIs were selected from clinical practice guidelines for HCC, which were not aimed only for liver surgery. However, process QIs based on clinical guidelines were assessed in order to evaluate the quality of health care, not limited to treatment of HCC, for each institution.

In conclusion, institutional board certification by the JSGS, JSHBPS, and JSH, and affiliation of three or more JSHBPS-certified experts or instructors with an institution was associated with significantly lower AORs after hepatectomy. Use of appropriate QIs may improve the outcomes after hepatectomy.

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## CONFLICT OF INTEREST

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## ORCID

Junichi Arita  <https://orcid.org/0000-0003-1929-8479>

Kiyoshi Hasegawa  <https://orcid.org/0000-0001-8734-740X>

Mitsukazu Gotoh  <https://orcid.org/0000-0001-8839-3192>

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