Impact of the Fundamental Use of Surgical Energy Certification on Surgeons' Behavior and Awareness of Safe Use of Energy Devices: A Cross-Sectional Survey Research

Running head: Surgical Safety Behavior and Awareness

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Abstract

Background: The Fundamental Use of Surgical Energy (FUSE) program was established to educate surgeons and trainees to promote awareness and behaviors for the safe use of surgical energy devices. Despite its implementation, the impact of FUSE certification on surgeons' behavior and safety awareness regarding practice of energy devices remains unclear. This study aimed to identify the perceived impact of FUSE certification on surgeons' behavior and awareness regarding the safe use of surgical energy devices.

Methods: We performed a descriptive cross-sectional survey study, using non probabilistic purposive sampling, and distributed 22-item web-based questionnaires among all 59 FUSE-certified surgeons in Japan, excluding operating room nurses and medical students. The questionnaire items covered demographics, surgical techniques using various energy devices, changes in behavior and safety awareness, communication with colleagues about surgical energy devices, and educational activities related to energy devices.

Results: Fifty-seven participants completed the questionnaire (response rate 96.6%). Most surgeons (91.3%) could apply material learned from the FUSE program in practice, especially material related to monopolar electrosurgery. Fifty-six surgeons

(98.3%) reported increased awareness of surgical safety, and 35 (61.5%) reported increased communication with operating room personnel about the safe use of energy devices. Moreover, 56 participants (98.3%) indicated a need for systematic education in surgical energy, with participants recommending fellows (94.7% of participants specified that fellows should participate in further education), residents (75.4%), and attending surgeons (63.2%) as the target recipients of this training.

Conclusions: After FUSE certification, not only did surgeons' knowledge increase, but their energy-related surgical techniques in practice also improved. Furthermore, FUSE-certified surgeons felt that they were more aware of surgical-energy safety and were dedicated to its promotion.

Key Words: Fundamental Use of Surgical Energy (FUSE), certification, energy device, safe usage, surgeons' behavior, safety awareness

Introduction

Electrosurgery-related adverse events such as surgical burns, operating room (OR) fires, and unrecognized organ injuries can result in patient harm [1,2]. Therefore, surgeons should be well informed about the safe use of energy devices (e.g., monopolar electrosurgery, ultrasonically activated devices, or vessel sealing devices). However, recent data have shown that many surgeons, including those who are experienced, demonstrate knowledge gaps in the safe and effective use of energy devices [3,4]. To address this issue, the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) has established a web-based didactic curriculum, known as the Fundamental Use of Surgical Energy™ (FUSE) program [5]. In 2014, the FUSE program was introduced in Japan. The first hands-on seminar was held as a pre-congress workshop at the 27th annual meeting of the Japan Society for Endoscopic Surgery [6].

Previous studies have shown that a structured curriculum based on the FUSE program significantly increases surgical trainees' knowledge and self-perceived comfort with the safe use of electrosurgical devices, with retention after 3 months and 1 year [7,8]. Nonetheless, the impact of obtaining FUSE certification on surgeons' behavior in the OR and on changes in surgeons' safety awareness have not been investigated. Moreover, the extent to which institutions or communities have been influenced by

FUSE-certified surgeons in practice is unknown. Hence, the purpose of this study was to explore the perceived impact of the FUSE program on surgeons' behavior and safety awareness regarding the use of surgical energy devices.

Materials and Methods

Study Design and Population

We sent email invitations to each FUSE-certified surgeon in Japan (N = 59) through the Japan Association for Surgical Education to participate in a cross-sectional survey in March 2021. However, to adhere to the aim of investigating surgeons' behavior and awareness, the OR nurses and medical students were excluded from this study. Participants were asked to complete a web-based questionnaire developed using Google Forms and were given 3 weeks to complete the questionnaire (responses were anonymous). This study adhered to the Ethical Guidelines for Medical and Health Research Involving Human Subjects in Japan [9]. Ethical approval by the institutional review board of Kagawa University, Kagawa, Japan was exempted because this study did not involve any patients, affect the health of participants, or use their personal identification information. All participants provided written informed consent prior to completing the survey.

Survey Design

The questionnaire had 22 items and was divided into the following sections: demographics (4 items), surgeons' use of surgical techniques with various energy devices (4 items rated on 5-point Likert scale including a free description item), changes in surgeons' behavior and safety awareness (4 items rated on 5-point Likert scale including a free description item), frequency of communication with colleagues about electrosurgery-related topics (4 items rated on 5-point Likert scale), and educational activities related to energy devices that the surgeons participated in or conducted (6 items rated using single-choice, multiple choice, and 5-point Likert scale, including a free description item; Table 1). The questionnaire was developed by FUSE certified surgeons (AK, YN), who were experienced in designing educational activities on surgical energy devices; they listed potential items by exploring the degree of application among FUSE-certified individuals. Finally, the questionnaire was drafted through a discussion with surveyor/educational researcher (YW)—a SAGES FUSE committee member. The questionnaire items were validated by beta testing them with two FUSE-certified individuals. For scoring purposes, Likert-responses 1, 2, 3 were considered negative, while Likert-responses 4 and 5 were considered positive. Free description items required self-reported responses for the following: *1)* contents that are

lacking in the FUSE program for clinical practice application, *2)* content-changes required for teaching usage of surgical energy devices, and *3)* barriers in teaching the FUSE program.

Statistical Analysis

The survey results were analyzed using descriptive statistics. Responses from gastrointestinal surgeons and from physicians with other specialties were compared using a Pearson's chi-squared test.

Results

Of the 59 FUSE-certified physicians in Japan, 56 surgeons and 1 anesthesiologist completed the questionnaire (response rate 96.6%), as shown in Table 2. Almost half of the participants were general surgeons (n=28, 49.1%), followed by gynecologists (n=17, 29.8%). Twenty-four (45.3%) participants had obtained FUSE certification within the past 1–3 years, and 18 (31.6%) had obtained certification more than 3 years ago. Most participants completed the FUSE examination owing to their interest in energy devices (n=49, 86%) or to understand the proper use of energy devices (n=43, 75.4%). However, there were no significant differences across item responses among surgical specialties.

Surgical techniques using energy devices (Table 3)

Most participants (n=52, 91.3%) applied knowledge acquired from the FUSE program in clinical practice. Similarly, most participants acknowledged that they changed the way they used monopolar electrosurgery devices (n=50, 87.8%) and reported improvements in surgical techniques (n=47, 82.5%). In contrast, a positive change in perception was acknowledged by only approximately 50% of participants using ultrasonic activating devices (USADs) or vessel sealing systems (VSSs). The majority of participants reported a need for more detailed explanations within the FUSE content related to USAD as well as further explanations for VSS, specific energy devices, and advanced features of electrosurgical units (e.g., soft coag mode).

Changes in behavior and safety awareness (Table 4)

Almost all respondents (98.3%) reported an increase in surgical safety awareness, and 35 participants (61.5%) attempted to promote the safe use of energy devices at their institutions. For 46 (80.7%) participants, methods of teaching colleagues about energy devices changed. Based on the 34 descriptive answers offered by those who completed the survey, half of the respondents felt that changes occurred primarily when they were teaching surgical trainees about the fundamental principles and appropriate use of electrosurgery, as detailed in Supplemental Text 1.

Communications with surgeons and OR nurses (Table 5)

In terms of dispersive electrodes, while 38.6% of the participants had interactive communication with surgeons or surgical trainees, participants had more opportunities to communicate with OR nurses (49.2%). Overall, more than 70% of respondents had increased communication with surgeons or nurses about the importance of cleaning burnt materials (e.g., eschar) from the active electrode. The frequency of communication with other surgeons/trainees and OR nurses about a topic was similar for "electrosurgery setting" (61.4% and 59.6%, respectively) and "placement of the handpiece (active electrode) when not in use" (43.9% and 45.6%, respectively).

Educational activities about energy devices (Table 6)

Fifty-six participants (98.2%) reported the need for systematic education in surgical energy, with participants targeting fellows (94.7% of participants specified that fellows should participate in further education), residents (75.4%), and attending surgeons (63.2%) as recipients of this training. Thirty-one participants (54.4%) had some experience teaching about energy devices to colleagues and OR staff, including didactic lectures or workshops. Of the descriptive responses offered by 26 participants, 12 (46.2%) felt that senior surgeons' lack of interest in the FUSE content created a barrier to teaching activities.

Discussion

This study aimed to explore the impact of the FUSE program on surgeons' behavior and safety awareness regarding the use of surgical energy devices. Therefore, the current study survey responses suggested that participants perceived their behavior and awareness regarding safe use of energy devices to be improved after FUSE certification, regardless of surgical specialty. Most participants reported that post-certification, their promotion of safe use of energy devices to OR personnel increased and that their teaching approaches changed. Moreover, FUSE-certified surgeons have acted at various levels (institutional, regional, and national) to disseminate knowledge about the safe use of energy devices. This is the first study to explore the effect of FUSE certification on surgeons' behavioral changes and safety awareness in practice using Kirkpatrick's model, which is a widely used model to evaluate the results of educational curriculum [10].

There is a variety of evidence about the effectiveness of the FUSE program in fulfilling knowledge gaps about the safe use of energy devices [7,8,11]. Previous studies have shown that the knowledge and confidence levels of surgical trainees improved significantly after educational intervention based on FUSE; this knowledge and

confidence were retained after three months and after one year [7,8]. In other studies, most trainees reported satisfaction with the program content and potential contributions to patient safety, and that they would recommend the FUSE program to colleagues [11]. Although previous studies have reported the effectiveness of the FUSE program, the degree of application and changes in individual clinical practice due to the FUSE certification are unexplored. Therefore, this study aimed to bridge this gap by exploring the individual changes in clinical practice for surgical safety after obtaining the FUSE program certification.

FUSE-certified surgeons in this study consistently reported improvement in their monopolar electrosurgery surgical techniques; some felt the need for more detailed content regarding USADs. USAD content accounts for only approximately 6% of the FUSE program, whereas monopolar electrosurgery content accounts for approximately 50%. While the FUSE program focuses on the fundamentals of the safe use of energy devices, content regarding cavitation, drilling, and appropriate range of grasping the tissue and its effect of thermal spread, which can potentially cause injury, are not currently explained in detail. Since USADs are widely and more frequently used devices in laparoscopic surgery, this information should be explained further in the FUSE program.

The majority of FUSE-certified surgeons reported increased awareness of surgical safety and more frequent communication with colleagues and OR nurses about electrosurgery-related topics. These findings of our study may indicate surgeons' improved safety behavior and awareness while using surgical energy devices in practice after obtaining the FUSE certification. Accordingly, FUSE-certified surgeons could increasingly contribute to enhancing the safety of patients who require surgical treatment. However, the frequency of conversation among surgeons around dispersive electrodes barely changed. This result may be because the majority of surgeons are not likely to place a dispersive electrode by themselves. Nonetheless, appropriate placement of the dispersive electrode should be taught to surgeons. While most respondents reported experience, or intentions of, conducting educational activities, intra-operative teaching activities of energy-device-related topics must be structured and optimized.

Importantly, almost half of the study participants felt that the lower interest of senior colleagues in the FUSE content was a barrier to conducting teaching activities. The majority of respondents also felt that both attending surgeons and surgical trainees should receive training in FUSE. Attending surgeons must also learn the safe use of energy devices, as previous studies have shown that surgeons have knowledge gaps in the safe and effective use of energy devices, regardless of experience[3,4]. Therefore,

buy-in and support from senior surgeons regarding the FUSE program is crucial for further dissemination of educational activities that promote a safety culture around surgical energy. Multidisciplinary approaches involving anesthesiologists, OR nurses, and clinical engineers are likely to play a significant role in improving the safe use of energy devices.

A strength of this study is its excellent response rate, which yields a more accurate interpretation of the results. However, the data should be interpreted with caution given the potential of bias. This study only collected views of FUSE certified personnel, who might be strongly motivated and interested in the FUSE certification. This study has other limitations as well. First, although differences between surgical specialties might have affected results, the differences were not adequately considered for interpretation. Surgeons prefer to use a variety of energy devices, preferences that would change for each specialty. However, as this study focused on more general topics of energy, tool preference by specialty would not be a significant factor. Second, surgeons' training, and clinical and teaching experiences vary; therefore, the impact of their experiences on their responses must be accounted for when interpreting the results. Third, the current study results may reflect a response bias because only self-reported data were collected without any pre-tests before obtaining FUSE certification. Fourth, the generalizability

of this study may be limited, as only FUSE-certified surgeons in Japan were included. Moreover, inferential statistics using pre- and post-FUSE certification tests would be required to achieve more reliable results, and further survey studies are required with international FUSE-certified surgeons. Fifth, the institutional impact of certified surgeons was not investigated. Although certified surgeons reported that they changed their practice, actual improvements in behavior and awareness regarding surgical energy in the OR remain unclear. It also remains unclear if perceived changes occurred in other areas. Finally, this was not a comparative study between the group of FUSE-certified surgeons and the control group. FUSE is an educational program contributing to improving OR safety. The rate of electrosurgery related adverse events needs to be collected to demonstrate the definitive effectiveness of the educational program. Although a comparative study is vital to present the definitive effectiveness of FUSE certification, collecting the comparative data would be challenging, due to the immense effort required and lack of feasibility.

FUSE-certified surgeons reported behavioral changes and increased awareness of the safety of applying energy devices in their practice. They were more open to conversation and teaching about the fundamentals of energy devices with and to other OR personnel. Study findings suggest that FUSE certification has positive effects on the

safe use of energy devices in the OR. Based on these findings that FUSE certification could achieve behavioral change and improved consciousness to use energy devices safely and appropriately, our goal is to disseminate the FUSE program or its concept among all surgeons to promote safe surgery.

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Disclosures

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Table 1. Questionnaire content

Section	No. of items	Type of questions and scales
1. Participant demographics	4	-
2. Surgical techniques using various energy devices	4	Likert-scale: (1) Strongly disagree - (5) Strongly agree (1) Definitely not changed/improved - (5) Definitely changed/improved Free description
3. Changes in behavior and safety awareness	4	Likert-scale: (1) Definitely not changed - (5) Definitely changed Free description
4. Frequency of communications with colleagues about electrosurgery-related topics	4	Likert-scale: (1) Definitely not changed - (5) Every case
5. Educational activities on energy devices	6	Single-choice, Multiple-choice Likert-scale: (1) Strongly disagree - (5) Strongly agree Free description

Table 2. Participant demographics (n = 57)

	n (%)
Specialties	
General surgery	28 (49)
Gynecology	17 (29.8)
Urology	4 (7)
Pediatric surgery	4 (7)
Thoracic surgery	1 (1.8)
Endocrine surgery	1 (1.8)
Otolaryngology	1 (1.8)
Anesthesiology	1 (1.8)
Reasons for learning about energy devices via the FUSE program[a]	
Professional curiosity about energy devices	49 (86)
Learning the proper use of energy devices	43 (75.4)
Teaching surgical trainees	19 (33.3)
Years since date of FUSE certification	
< 0.5 year	8 (14)
0.5–1 year	7 (12.2)
1–3 years	24 (42.1)
> 3 years	18 (31.6)

Table 3. Self-reported changes in surgical technique using each energy device (n = 57)

	Strongly disagree				Strongly agree
	1	2	3	4	5
			n (%)		
Changes in the use of energy devices in practice	0 (0)	1 (1.8)	4 (7)	25 (43.9)	27 (47.4)
	Definitely not changed				Definitely changed
	1	2	3	4	5
			n (%)		
Changes in surgical technique:					
Monopolar electrosurgery	0 (0)	1 (1.8)	6 (10.5)	12 (21.1)	38 (66.7)
USAD	3 (5.3)	4 (7)	19 (33.3)	25 (43.9)	6 (10.5)
VSS	2 (3.5)	4 (7)	21 (36.8)	23 (40.4)	7 (12.3)
	Definitely not improved				Definitely improved
	1	2	3	4	5
			n (%)		
Improvements in surgical technique:					
Monopolar electrosurgery	0 (0)	0 (0)	10 (17.5)	23 (40.4)	24 (42.1)
USAD	2 (3.5)	5 (8.8)	20 (35.1)	28 (49.1)	2 (3.5)
VSS	2 (3.5)	4 (7)	20 (35.1)	28 (49.1)	3 (5.3)

USAD = ultrasonic activating device; *VSS* = vessel sealing system

Table 4. Self-reported changes in behavior and safety awareness (n = 57)

	Definitely not changed				Definitely changed
	1	2	3	4	5
	n (%)				
Awareness of surgical safety	0 (0)	0 (0)	1 (1.8)	25 (43.9)	31 (54.4)
Content of the teaching	0 (0)	0 (0)	11 (19.3)	26 (45.6)	20 (35.1)
	Definitely not approached				Definitely approached
	1	2	3	4	5
	n (%)				
Approaches to promote the safe use of energy devices in each institution	1 (1.8)	4 (7)	17 (29.8)	23 (40.4)	12 (21.1)

Table 5. Frequency of communication with surgeons and operating room nurses about the following topics (n=57)

	With surgeons / ORNs	Definitely not changed 1	2	3	4	Every case 5
			n (%)			
Electrosurgery setting	Surgeons	4 (7)	6 (10.5)	12 (21.1)	26 (45.6)	9 (15.8)
	ORNs	4 (7)	7 (12.3)	12 (21.1)	28 (49.1)	6 (10.5)
Dispersive electrode	Surgeons	6 (10.5)	9 (15.8)	20 (35.1)	17 (29.8)	5 (8.8)
	ORNs	7 (12.3)	6 (10.5)	16 (28.1)	23 (40.4)	5 (8.8)
Placement of the handpiece (active electrode) when not in use	Surgeons	5 (8.8)	12 (21.1)	15 (26.3)	20 (35.1)	5 (8.8)
	ORNs	8 (14)	7 (12.3)	16 (28.1)	24 (42.1)	2 (3.5)
Cleaning burnt materials (e.g., eschar) from active electrode	Surgeons	4 (7)	5 (8.8)	8 (14)	25 (43.9)	15 (26.3)
	ORNs	3 (5.3)	6 (10.5)	7 (12.3)	27 (47.4)	14 (24.6)

ORN = operating room nurse

Surgeons include senior or junior surgeons and surgical trainees

Table 6. Energy device educational activities (n=57)

	n (%)
Participated in FUSE workshop	
Yes	45 (78.9)
No	12 (21.1)
Need for systematic education in surgical energy	
5 strongly agree	46 (80.7)
4	10 (17.5)
3	1 (1.8)
2	0 (0)
1 strongly disagree	0 (0)
Preferred targets for education[a]	
Medical students	21 (35.8)
Residents	43 (75.4)
Fellows	54 (94.7)
Attending surgeons	40 (70.2)
Attending surgeons with teaching responsibilities	36 (63.2)
Experience teaching surgical energy (e.g., didactic lecture or workshop)	
Yes	31 (54.4)
No	26 (45.6)
If "No," intention of conducting teaching activities	
Yes	21 (80.7)
No intention	1 (3.9)
Unknown	4 (15.4)

FUSE = Fundamental Use of Surgical Energy

[a]Respondents could choose more than one response

Supplementary Material

Supplemental Text 1. Self-reported content changes teaching about surgical-energy devices (34 descriptive responses summarized)

- Logical explanations based on principles
- Teaching with hands-on demonstrations
- Explanations of practical use focusing on tissue effect, activation time
- Importance of lower voltage output
- Use low voltage continuous outputs (“cut mode output”) to seal vessels
- Applications and practical use of the cut mode output
- Differences in output modes (eg, cut mode vs. coag mode)/power and practical applications of each mode
- Lateral thermal spread among output modes
- Positions of dispersive electrodes
- Potential adverse effect of electrosurgery (eg, residual heat injury, capacitive coupling, operating room fire) and how to avoid it
- Avoid open activation (not activating the electrode before it becomes in contact with the targeted tissue)
- Controlling current density by changing the contact area of active electrode