

## Perioperative Management Center (PERIO) for Neurosurgical Patients

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### Abstract

Perioperative management is critical for positive neurosurgical outcomes. In order to maintain safe and authentic perioperative management, a perioperative management center (PERIO) was introduced to patients of our Neurosurgery Department beginning in June 2014. PERIO involves a multidisciplinary team consisting of anesthesiologists, dentists/dental hygienists/technicians, nurses, physical therapists, pharmacists, and nutritionists. After neurosurgeons decide on the course of surgery, a preoperative evaluation consisting of blood sampling, electrocardiogram, chest X-ray, and lung function test was performed. The patients then visited the PERIO clinic 7–14 days before surgery. One or two days before surgery, the patients without particular issues enter the hospital and receive a mouth cleaning one day before surgery. After surgery, postoperative support involving eating/swallowing evaluation, rehabilitation, and pain control is provided. The differences in duration from admission to surgery, cancellation of surgery, and postoperative complications between PERIO and non-PERIO groups were examined. Eighty-five patients were enrolled in the PERIO group and 131 patients in the non-PERIO group. The duration from admission to surgery was significantly decreased in the PERIO group ( $3.6 \pm 0.3$  days), compared to that in the non-PERIO group ( $4.7 \pm 0.2$  days). There was one cancelled surgery in the PERIO group and six in the non-PERIO group. Postoperative complications and the overall hospital stay did not differ between the two groups. The PERIO system decreased the duration from admission to surgery, and it is useful in providing high-quality medical service, although the system should be improved so as not to increase the burden on medical staff.

Key words: cancellation of surgery, complication, perioperative management, preoperative evaluation, rehabilitation

### Introduction

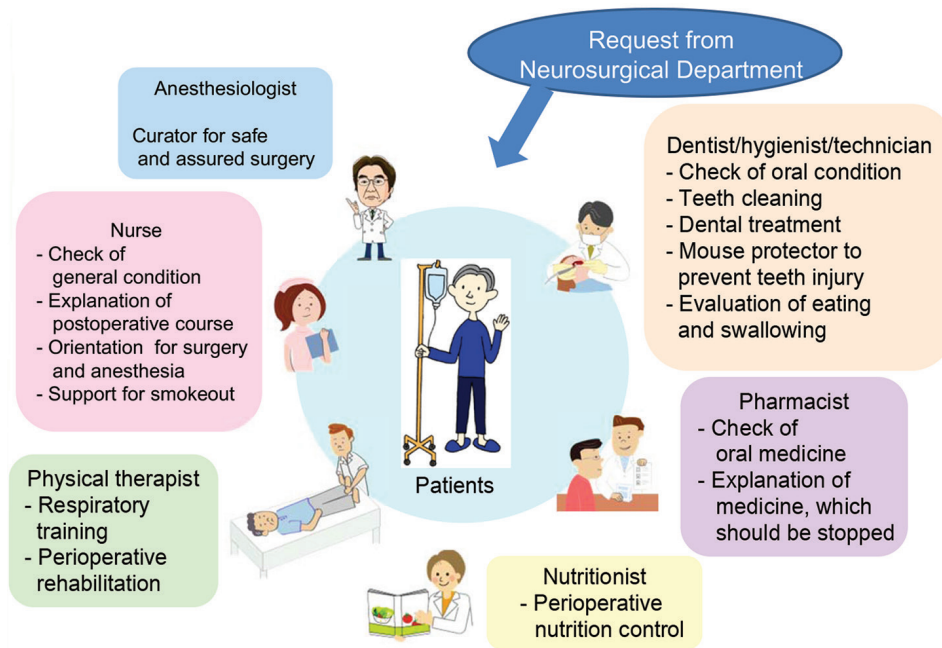
Perioperative management of surgery patients is critical for improving the overall outcomes of surgeries. In our hospital, there are nearly 10,000 operations performed annually, and 552 surgeries were performed in our Neurological Department in 2014. In order to maintain safe, authentic, and high-quality perioperative management, a perioperative

management center (PERIO) was established in 2008 and started to manage patients receiving respiratory surgery. PERIO was first introduced to the patients in our department in June 2014. In this manuscript, the actual efficacy of PERIO is shown.

### Practice of PERIO

PERIO consists of anesthesiologists, dentists/dental hygienists/technicians, nurses, physical therapists, pharmacists, and nutritionists. As shown in Fig. 1,

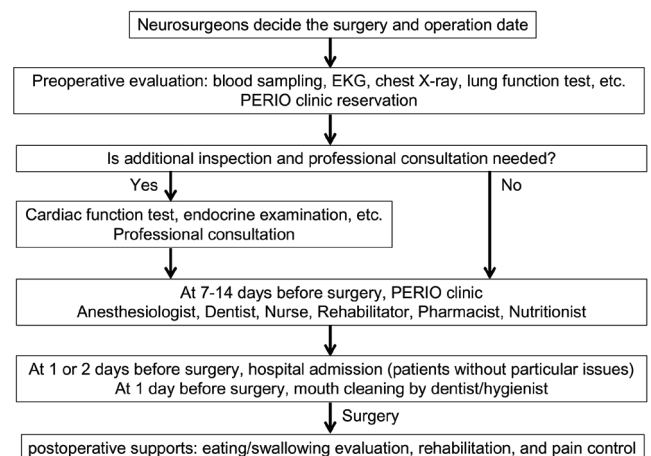
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**Fig. 1 PERIO system for neurosurgical patients.** After the request from the Neurosurgical Department, the multi-disciplinary team starts to manage the perioperative conditions of surgery patients to ensure a safe and assured surgical procedure.

the PERIO staff focused on the patients' safety during perioperative periods. Anesthesiologists had overseen all the PERIO staff members to insure safe and effective perioperative management. Dentists/dental hygienists/technicians performed preoperative mouth cleaning and made a tooth protector to prevent dental damage in patients with unstable teeth. Additionally, the eating/swallowing function was evaluated before and after surgery. Specialized nurses gathered information on the patients, checked their general condition, and informed them of the perioperative course to build a feeling of safety. Physical therapists evaluated perioperative physical conditions and promoted recovery from surgeries. Pharmacists checked the oral medicine and confirmed its discontinuation period. Nutritionists controlled perioperative alimentation.

The protocol of PERIO is shown in Fig. 2. First, neurosurgeons decided on the course of surgery for patients in our clinic. Preoperative evaluation by blood sampling, electrocardiogram (EKG), chest X-ray, and lung function test was performed, with a subsequent reservation in the PERIO clinic. After checking the results of preoperative evaluation, additional tests, such as cardiac function test and endocrine examination were ordered, if needed. The patients visited the PERIO clinic 7–14 days before surgery. One or two days before surgery, the patients entered the hospital and received a mouth



**Fig. 2 Time course of the PERIO system.** The flow chart shows the protocol of the PERIO system after the course of surgery has been decided.

cleaning one day before surgery. If the patients had particular issues including cardiac problems requiring heparinization, diabetes mellitus (DM) requiring glycemic control, poor general condition requiring nutritional amelioration, poor physical function, or severe pain, the length of hospital stay before surgery was set longer than usual. After surgery, postoperative support involving eating/swallowing evaluation, rehabilitation, and pain control was provided.

## Patients and Methods

This is a retrospective study. In this study, a total of 552 surgical cases treated in our Neurosurgical Department in 2014 were enrolled. PERIO started to participate in cases involving unruptured cerebral aneurysms and brain tumors from June 2014 and in cases of spinal diseases, ischemic diseases, hydrocephalus, and bone defects requiring cranioplasty from October 2014. Pediatric cases, emergent cases, cases with intravascular surgeries, stereotaxic surgeries, and surgeries under local anesthesia were excluded. Duration from admission to surgery, the sudden cancellation of surgery, damage to teeth, postoperative complications, and related factors were evaluated. In order to reduce the effects of patients requiring longer hospital stay for preoperative feeder embolization and for heparinization, duration from admission to surgery was also evaluated. Subsequently, clinical staff members were given a questionnaire to evaluate the efficacy of PERIO. The questionnaire consisted of five questions using a scale of 1–5, with 1 being “strongly disagree” and 5 being “strongly agree.” Following these questions, staff members were allowed to freely assess the PERIO system.

## Results

In 2014, 85 patients underwent surgery with an evaluation by the PERIO clinic (PERIO group) and 131 patients underwent surgery without a PERIO clinic evaluation (non-PERIO group). The duration from admission to surgery significantly decreased in the PERIO group ( $3.6 \pm 0.3$  days,  $P < 0.05$ , Mann-Whitney's U test, Fig. 3), compared to that in the non-PERIO group ( $4.7 \pm 0.2$  days). Analyses of subgroups (cerebrovascular diseases, brain tumor, spinal diseases, and miscellaneous diseases) showed a significant shortening of the duration for the PERIO group involving cases of cerebrovascular diseases and brain tumor [ $2.7 \pm 0.3$  ( $n = 28$ ) and  $4.2 \pm 0.3$  days ( $n = 44$ ), respectively], compared to those cases for the non-PERIO group ( $4.0 \pm 0.5$  [ $n = 20$ ] and  $5.1 \pm 0.3$  days [ $n = 56$ ], respectively). For spinal diseases, the PERIO group showed a tendency of shortened duration from admission to surgery ( $3.0 \pm 0.6$  days [ $n = 6$ ],  $P = 0.058$ ), compared to the non-PERIO group ( $5.0 \pm 0.4$  days [ $n = 37$ ]). There were no differences in the duration of cases with other diseases between the PERIO and non-PERIO groups ( $4.8 \pm 2.1$  [ $n = 8$ ] and  $3.9 \pm 0.5$  days [ $n = 17$ ],  $P = 0.294$ ). The overall hospital stay of both groups was not significantly different. There were 69 patients with neither preoperative feeder embolization nor

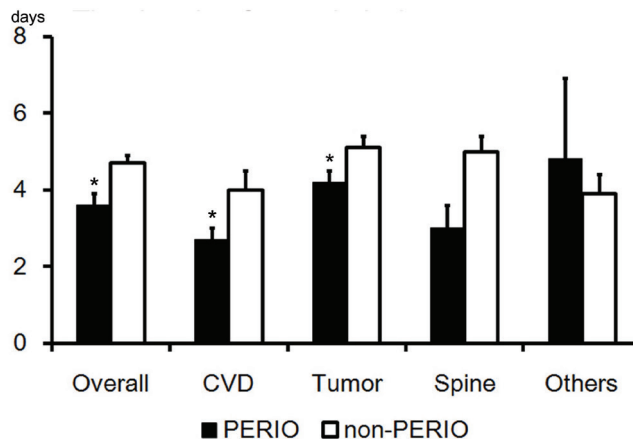


Fig. 3 The duration from admission to surgery. The graph shows the differences in the duration from admission to surgery between the PERIO and non-PERIO groups. The data are shown as mean  $\pm$  standard error for overall values and for subgroups of cerebrovascular diseases, brain tumor, spine disease, and others (\* $P < 0.05$ , Mann-Whitney's U test).

Table 1 Cancellation cases and associated reasons for the PERIO and non-PERIO groups

	PERIO	non-PERIO
Case	1 (1.2%)	6 (4.6%)
Reason	Sudden fever	Poor control of blood sugar Hepatic damage Symptom amelioration Sudden fever Familial refusal Bereavement

heparinization in PERIO group (embolization: 12; heparinization: 4 in total 85) and 113 patients in non-PERIO group (embolization: 7; heparinization: 11 in total 131). As is the case with the overall data, the duration from admission to surgery of patients with neither embolization nor heparinization significantly decreased in the PERIO group ( $3.3 \pm 0.3$  days,  $P < 0.05$ ), compared to that in the non-PERIO group ( $4.5 \pm 0.2$  days).

In terms of the cancellation and suspension of surgeries within 3 days before the scheduled date of surgery, only one case (1/85: 1.2%) was cancelled or suspended in the PERIO group, while six cases (6/131: 4.6%) were cancelled or suspended in the non-PERIO group. There were no significant differences in the cancellation incidence in both groups ( $P = 0.1676$ , Chi-square test). The reasons for the cancellation or suspension are described in Table 1. Since 2014, there were no cases involving errors in stopping oral medicine before surgery, including antiplatelet or anticoagulant medication,

**Table 2 Postoperative complications in the PERIO and non-PERIO groups**

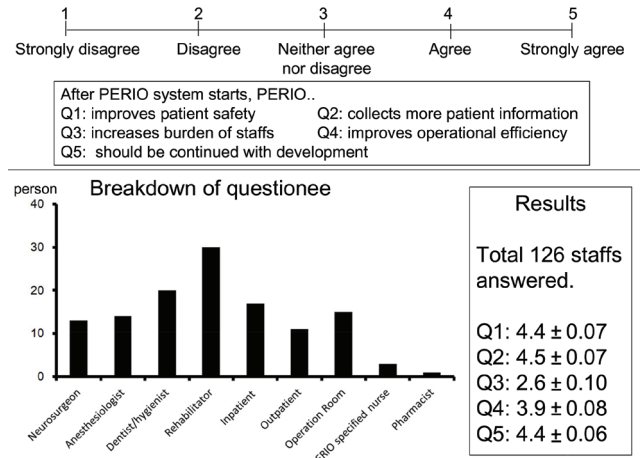
	PERIO	non-PERIO
Case	7 (8.5%)	5 (3.8%)
Patient management complications	Pneumonia	Delirium, pneumonia delirium
Surgical complications	Infection ( <i>n</i> = 2) brain edema, epilepsy hematoma, visual disturbance cerebral infarct ( <i>n</i> = 2)	Infection hematoma, hemiparesis visual disturbance

although we had experienced a total of two cases involving errors in stopping oral medicine with a subsequent cancellation of surgery in 2012 and 2013. Regarding dental issues, all cases in the PERIO group underwent plaque removal on the day before surgery. In 15 cases, a tooth protector was made for surgery, and there were no cases resulting in damage to the teeth. As for postoperative complications at 90 days after surgery, seven cases (7/85: 8.2%) suffered from complications in the PERIO group and five cases (5/131: 3.8%) did so in the non-PERIO group. There were no significant differences in the complication rate in both groups ( $P = 0.1661$ , Chi-square test). Detailed information on the postoperative complications is shown in Table 2. As for patient management complications excluding surgical complications, one case (1/85: 1.2%) suffered from pneumonia in the PERIO group and two cases (2/131: 1.5%) suffered from delirium with or without pneumonia in the non-PERIO group. The PERIO system enhanced functional recovery after surgery by consistent rehabilitation. Seventy percent of cases in the PERIO group received perioperative rehabilitation, including all cases of spine diseases.

The results of the questionnaire given to the clinical staff are shown in Fig. 4. The results indicated the satisfaction of the neurosurgeons in all of the questions without a remarkable increase in occupational burden. On the other hand, the occupational burden for some of the clerks in the outpatient unit, the dentists, the anesthesiologists, and the physical therapists might increase. Respondents of all job types supported the development and continuation of the PERIO clinic.

### Discussion

In this manuscript, the PERIO system is shown to successfully reduce the duration from admission to surgery. In addition to that, it might prevent or reduce the cancellation incidence of surgery and intraoperative teeth damage. We know of no similar system for managing patients in the perioperative period



**Fig. 4 The questionnaire and the results. Upper column: The content of questionnaire is shown. Lower column (left): The breakdown of the respondents is shown in the graph. Lower column (right): The results are shown. The data are shown as mean ± standard error.**

involving a multi/transdisciplinary team consisting of anesthesiologists, dentists/dental hygienists/technicians, nurses, physical therapists, pharmacists, and nutritionists.

A recent paper on preoperative tests before cataract surgery revealed that 53% of patients received at least one test, even though the operative stress and surgery time was quite limited.<sup>1</sup> For patients undergoing a neurosurgical operation, fixed preoperative tests are needed to endure the operative stress and long operative time. Perioperative management of glucose level in blood,<sup>2</sup> cardiovascular function,<sup>3</sup> or coagulopathy monitoring<sup>4,5</sup> is important for minimizing the complications related to diabetes mellitus, cardiovascular events, or anti-coagulant therapy. Recently, self-assessment of cardiac risks before surgery plays a certain role in preoperative evaluation of patients.<sup>6</sup> The multidisciplinary team that includes pharmacists and specialized nurses favorably affects surgery patients in our PERIO system.

The concept of “enhanced recovery after surgery (ERAS)” is now well known to hasten the recovery of patients and to reduce hospital stay.<sup>7-10</sup> PERIO consists of multidisciplinary staff members to prevent perioperative complications and to improve the postoperative course. The systemic flow after neurosurgeons decide on the course of surgery saves time and effort in ordering preoperative evaluations. The consistent care of rehabilitation and nutrition started before surgery enhanced the postoperative therapeutic effects for patients.

There are several studies on postoperative pain control. Intravenous scheduled administration of acetaminophen for patients receiving hip surgery

reduced the hospital stay and narcotic use and ameliorated the outcomes of patients.<sup>11</sup> Recently, a specialized transdisciplinary team for pain control in diverse situations, such as perioperative, acute medical, and palliative care has been formed.<sup>12</sup> In our PERIO system, anesthesiologists and pharmacists play a key role in pain control using scheduled administration of analgesic drugs after surgery.

Nutrition care is equally important for postoperative patients. Specialized nutritional therapy was considered critical for patients with special conditions.<sup>13,14</sup> In our PERIO system, nutritionists plan a perioperative meal based on the information obtained from the nurses. Postoperatively, dentists carefully check the swallowing function and occlusal support so that patients with a high risk of swallowing disturbances can safely restart meals.

In previous reports, perioperative dental injuries occur with relatively high incidence (0.13%), especially for patients with dental problems.<sup>15</sup> Once dental injuries occur during anesthesia, the cost of treatment and compensation is problematic, and the patient-doctor relationship can deteriorate.<sup>16</sup> A tooth protector is useful for preventing dental injuries and can sometimes improve intraoral conditions after oral injuries.<sup>17</sup> In our PERIO system, dentists preoperatively check the patient's oral condition when dental cleaning is performed one day before surgery, although this may increase the burden on dentists.

In terms of the cancellation of surgery, a recent study showed a high cancellation rate, at least partly because the preoperative evaluation was so close to the surgery time.<sup>18</sup> In order to reduce the rate of cancellation, a multidisciplinary team improves the instructing of patients, the correspondence procedure to the caregivers, and the arrangement system for rescheduling after cancellation, all of which results in a successful reduction of cancellation.<sup>19</sup> The cancellation depends on many factors, including the patients' conditions and social factors. However, reduced rates of cancellation could lead to more efficient utilization of operating rooms and medical resources. In regard to this point, the steady preoperative evaluation of surgery patients generated by a PERIO system is a strong option, although the burden on staff should be considered.

The limitation of this study is that this is a retrospective study in a singly institute.

After evaluation by PERIO, patients with particular issues including cardiac problems, DM, poor general conditions, or severe pain were sometimes recommended to get hospitalized earlier for heparinization, glycemic control, nutritional amelioration, pain control, or other reasons. Additionally, there were several inevitable social factors. PERIO was

gradually introduced to our department and some patients in PERIO group entered the hospital a few days before surgery in the early period. Bed occupancy was sometimes taken into account. Furthermore, for some patients receiving high-risk surgery, doctors required a little more time before surgery to strengthen the patient-doctor relationship. Thus, the data might be influenced by various factors, although PERIO surely reduced the duration from admission to surgery.

## Conclusions

The PERIO system was introduced to our Neurosurgical Department in 2014 and has since contributed to the safe and assured management of patients undergoing surgery. The PERIO system decreased the duration from admission to surgery, although there was no significant difference in the complication rate or incidence of unexpected cancellation of surgery between the PERIO and non-PERIO groups. We will expand the use of the PERIO system to provide high-quality medical service, although the system should be improved so as to reduce the burden on the medical staff.

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## COI Disclosure

All authors declare that we have no COI to be disclosed related to this manuscript. Additionally, the authors who are members of JNS have registered online Self-reported COI Disclosure Forms through the website for JNS members.

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