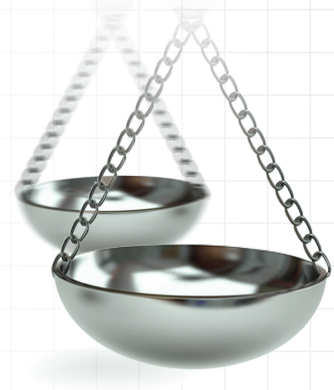
Preliminary Communication



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Usability evaluation of sufentanil sublingual tablet analgesia in patients following Enhanced Recovery After Surgery

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Aim: To evaluate the usability and satisfaction from the sufentanil sublingual tablet system analgesia in the Enhanced Recovery After Surgery pathway in patients, nurses and physical therapist. **Materials & methods:** A system usability scale was used to evaluate analgesia system in the prospective observational study in spine, orthopedic and thoracic patients. **Result:** In 111 cases the median system usability scale score was 90 (80–100) (patients) and 72.5 (57.5–82.5) (nurses). The median satisfaction score of the physiotherapist was 90 (75–100). **Conclusion:** The usability and the satisfaction of the patients and the caregivers from sufentanil sublingual tablet system analgesia in the context of Enhanced Recovery After Surgery protocol were good-to-excellent. The economic potential in the reduction of hospital stay should be studied.

Trial registration number: NCT03373851 (ClinicalTrial.gov)

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Keywords: enhanced recovery after surgery • satisfaction • sufentanil sublingual tablet system • usability

The concept of Enhanced Recovery After Surgery (ERAS) promotes preservation of functional abilities in postoperative period with the support of effective analgesia [1]. Although multimodal pain management is a standard of care in implemented ERAS programs, up to 20% of patients require intravenous (iv.) self-controlled analgesia for the relief of moderate to severe postoperative pain in first days after major surgery [2,3].

Known disadvantages of iv. patient-controlled analgesia (PCA) were extensively studied, they include invasive and congestive nature, reduced autonomy and mobility, and increased risk of adverse event, delaying rehabilitation and ERAS protocol goals achievement [4].

The challenges of postoperative analgesia in ERAS program consist in the need of noninvasive, strong and short-acting solutions for dynamic pain (associated with early mobilization, physical therapy and care) treatment [5,6].

Several noninvasive opioid analgesia systems were developed [7–9] such as sufentanil sublingual tablet system (SSTS), controlled by patient. The SSTS (Zalviso®; Grunenthal GmbH, Aachen, Germany, available and labeled for acute moderate-to-severe postsurgery pain treatment in Europe [10,11]) is a preprogrammed handheld medical device designed to deliver a sublingual tablet formulation of 15 µg sufentanil. With a refractory period of 20 min it can be used up to 72 h. A single use cartridge containing 40 nanotablets is charged in a dedicated and secured bed-side device. The safety and efficacy of this device has been demonstrated [12,13].

Such technology may present an alternative for classic morphine based iv. PCA offering a noninvasive fast onset and short-acting analgesia. However, the introduction of a new technology into the defined pathway may generate disruption and dissatisfaction in patients and caregivers.

Future Medicine

We evaluate the usability and satisfaction from the SSTS integrated in the ERAS pathway in patients, nurses and physical therapist (PT) at the tertiary hospital system.

Materials & methods

A prospective observational study was conducted in three surgical departments (orthopedic, spine and thoracic) of Hospices Civils de Lyon, a multiple sites university-affiliated hospital.

Eligible were: adult patients with the need of iv. PCA, for at least 48 h after surgery, with high potential for severe dynamic pain and included in ERAS protocol. Exclusion criteria were refusal to participate, language barrier, pregnancy and breastfeeding, existing opioid treatment for chronic pain, and drug addiction.

Before the implementation of the study, all nurses from participating sites were trained how to set up and to use the system. Specific hospital pharmacy circuit with a 24 h hotline was set to solve potential problems with SSTS device and to insure constant provision and disposal of sufentanil tablets.

During a pre-anesthesia evaluation, after informed consent, patient received an oral instruction on the SSTS use. At the day of surgery the SSTS system was set up by a trained nurse and given to patient before the discharge from the postanesthesia care unit. Patients received a recall instruction on the SSTS use. Surgery-specific anesthesia ERAS protocols were unchanged. All nurses dealing with the SSTS were trained to use the new device. Physical therapists were informed of the present study.

Although different surgeries were involved, a standard postoperative pain management strategy included multimodal anesthesia in all patients (the use of acetaminophen and ketoprofen [nonsteroid inflammatory drug] and local infiltration anesthesia or regional anesthesia).

After 72 h of the introduction of the SSTS, the usability of the device was evaluated in patients and nurses. Physical therapists' satisfaction with the device as a facilitator of rehabilitation goals in these patients was measured as well. Unused sufentanil cartridges were disposed at the hospital pharmacy following dedicated protocol.

The primary end point was the SSTS usability, assessed with the system usability scale (SUS) score (Supplementary Material 1) [14]. The score consists of a ten-item questionnaire with five Likert-like response options – from 'strongly agree' to 'strongly disagree', totaling from 0 to 100. It reflects perceived ease-of-use, a global measure of system satisfaction and subscales of usability and learnability. A SUS score >50 reflects an acceptable usability, >70 is considered as good and >85 is considered as excellent [15].

The secondary end points were the SUS score in nurses and the satisfaction in physical therapists from the use of SSTS in patients, using a numerical scale from 0 (completely dissatisfied) to 100 (completely satisfied), the sufentanil consumption (number of tablets taken), the duration of use of SSTS, and the frequency of side effects (nausea, vomiting, pruritus, dizziness, drowsiness and respiratory depression).

Statistical analysis

We calculated a sample size for our descriptive study with a single group using the data published by Ringold *et al.*, with reported SUS score 87 ± 14 [16]. For a continuous variable (SUS) with a precision of five points, a standard deviation of 14 at 5% alpha risk, the sample size was estimated at 30 patients [17]. Given the variability in management at the different participating centers, a sample of at least 30 patients was needed from each participating center.

Continuous variables are presented as median and interquartile range. Categorical variables are presented as counts and percentages. Likert-like responses are analyzed as continuous variable with medians. Alpha Cronbach test was used to evaluate the agreement in the reported SUS score items between participating centers (sites) [18]. For group comparisons, we used nonparametrical tests. A p-value < 0.05 was considered as statistically significant. The statistical analysis was performed using JMP 11 software (SAS Institute, Inc., NC, USA).

The study has been approved by the ethics committee (Hospices Civils de Lyon). No written consent was required from patients as the SSTS system has approval for postoperative analgesia in France, and since the study was noninterventional. This trial has been registered with ClinicalTrial.gov, NCT03373851.

Results

From July 2018 to May 2019 a total of 111 patients were included: 33 orthopedic, 39 from spine surgery department and 39 from thoracic surgery. There were no patients refused SSTS in the postanesthesia care unit. The baseline characteristics are shown in Table 1.

Table 1. Characteristics of the patients and caregivers.

Characteristics	Total (111)	Thoracic surgery (39) Video-assisted thoracic surgery	Spine surgery (39) Multilevel spine fusion surgery	Orthopedic surgery (33) Uni-and bilateral total knee arthroplasty	p-value
Age, years	60 (47–71)	58 (45–71)	56 (48–72)	63 (49–72.5)	0.1002
Sex, female	49 (44%)	13 (33.3%)	19 (49%)	17 (52%)	0.2338
BMI, kg/m^2	25.9 (23.1–29.3)	24.1 (21.2–27.5)	27 (23.9–30.5)	26.6 (23.6–29.4)	0.0331
Nurses trained†, n		53	65	116	n/a
Dedicated physical therapist, n		4	4	6	n/a

†Includes PACU anesthesia nurses and floor nurses.
Medians (interquartile range).
n/a: Not applicable; PACU: Postanesthesia care unit.

Table 2. System usability scale score in patients, nurses and satisfaction in physiotherapists.

	Total (111)	Thoracic surgery (39)	Spine surgery (39)	Orthopedic surgery (33)	p-value
SUS score for patients	90 (80–100)	80 (72.5–87.5)	97.5 (87.5–100)	95 (87.5–97.5)	<0.0001
SUS score for nurses	72.5 (57.5–82.5)	70 (62.5–80)	62.5 (42.5–72.5)	82.5 (72.5–90)	0.0002
Satisfaction of physiotherapists	90 (75–100)	80 (70–90)	100 (100–100)	85 (77.5–95)	<0.0001

Medians (interquartile range).
SUS: System usability scale.

The median SUS score in patients was 90 (80–100) (excellent), significantly different between three departments, 97.5 (87.5–100) at the spine surgery department, 95 (87.5–97.5) at the orthopedic and 80 (72.5–87.5) at thoracic, $p < 0.0001$. Despite these differences, the obtained scores are good-to-excellent. An overall alpha Cronbach was 0.9851 (high correlation). We noticed a sex difference in the SUS score reported by patients. In overall, women expressed higher score than men (95 [85–100] vs 87.5 [77.5–95], accordingly, $p = 0.0230$). Department-specific differences were significant for patients from orthopedic surgery (97.5 [92–100] in women and 91.25 [80–625–92.5] in men), and nonsignificant in spine and thoracic surgery patients (Table A0, Supplementary Material 2).

The median overall SUS score in nurses was 72.5 (57.5–82.5), higher in orthopedic surgery (82.5 [72.5–90]), 70 (62.5–80) in thoracic surgery and lower (62.5 [42.5–72.5]) in spine surgery department, significantly different (0.0002), with high correlation (alpha Cronbach 0.8336). The median satisfaction in PT was 90 (75–100), the highest one in orthopedics (Table 2).

The item analysis of patients' score revealed difficulties in user control and understanding of function integration in thoracic surgery patients. In nurses, significant differences in proportions of agreement degree were noted for all items by sites (Tables A1 and 2 in Supplementary Material 2). The lowest SUS score, reported by nurses from spine surgery department, was obtained because of important frequency of neutral responses (around 30% – neutral on Likert scale) in seven out of ten domains: frequency of use (49%), complexity of use (33%), function integration (33%), incoherence (41%), learnability (33%), burden of use (31%) and confidence (28%). Interestingly, nurses from thoracic surgery were concerned by user control difficulty (62%) and learnability (41%). Learnability was a concern for thoracic and orthopedics nurses as well (58%).

The median duration of SSTS use was 2 [1–3] days, longer in spine surgery patients, followed by thoracic and orthopedic surgery patients; significantly different. None of patients needed neither systemic nor peroral morphine after the SSTS withdrawal. The median consumption of sufentanil was 16 [5–27] tablets, more important in spine patients, following by orthopedic and thoracic surgery patients; significantly different (Table 3). No sex-related differences in SSTS consumption were found.

A total of 37 side effect events were recorded in 111 patients (33%). The most frequent side effect (Table 4) was nausea and vomiting (21,6%), others included drowsiness (6%) and dizziness (5%). No respiratory depression was registered. In one case, nausea and vomiting has led to withdrawal of the SSTS device; however, no opioid were needed anymore. No other events related to the system such as programming error or failure were noted, no hotline or pharmacy calls were registered.

Table 3. Consumption and duration of use of sufentanil sublingual tablet system.

	Total (111)	Thoracic surgery (39)	Spine surgery (39)	Orthopedic surgery (33)	p-value
Duration of use, days	2 (1–3)	2 (1–3)	3 (2–3)	2 (1–2.5)	<0.0001
Consumption, tablets, count	16 (5–27)	7 (3–17)	30 (14–43)	11 (3–20)	<0.0001

Medians (interquartile range).

Table 4. Adverse events from the sufentanil sublingual tablet system use.

	Total (111)	Thoracic surgery (39)	Spine surgery (39)	Orthopedic surgery (33)	p-value
Nausea and vomiting	24 (21.6%)	7 (18%)	8 (21%)	9 (27%)	0.5633
Dizziness	6 (5%)	2 (5%)	3 (8%)	1 (3%)	0.7147
Drowsiness	7 (6%)	1 (3%)	4 (10%)	2 (6%)	0.5653

Medians (interquartile range).

Discussion

In our observational study the usability of the SSTS device integrated in the ERAS pathway was good-to-excellent for patients and physical therapists, and acceptable for nurses. The overall median duration of the SSTS use was 2 days, and during this time patients consumed about 16 nanotablets. The side effects were marked mostly by nausea and vomiting in almost a quarter of cases, with no serious or life threatening events.

ERAS pathway is a set of multimodal evidence-based strategies, applied to the conventional perioperative care. The main goal of the ERAS is to reduce postoperative complications and to achieve early recovery. This requires an organized team effort to implement a multitude of nonspecific techniques including analgesia. The use of invasive analgesia (iv. PCA or any other indwelling method like epidurals or peripheral nerve catheters) is not systematically encouraged by the ERAS concept. However, if postoperative pain is not fully controlled by a multimodal analgesia, ERAS Society recommends the use of patient-controlled delivery systems allowing individualized analgesics dosage [19].

SSTS is a patient-activated, noninvasive analgesic system for the management of moderate-to-severe acute pain in adult patients in the hospital setting. Based on the well-known, potent and short-acting opioid sufentanil, it enables patients to tailor their needs regarding analgesic treatment according to their requirements without binding them to bed as it would be the case with iv. PCA.

The efficacy of the SSTS as a primary analgesia after surgery has been studied in thoracic surgery [20,21], orthopedic surgery [22–26], abdominal surgery [16,22,24,27,28], gynecologic surgery [27–29] and spine surgery [27], focusing mostly on pain (efficacy) and side effects (safety) of the device. Two recent systematic reviews [30,31] confirm high satisfaction in patients using the SSTS device for acute postoperative pain.

We chose three different surgeries such as video assisted thoracic surgery, spinal fusion (mini-open oblique and posterior multilevel lumbar interbody fusion) and total knee arthroplasty (TKA) because these surgery are of important potential for dynamic pain generation – especially in the first 24 h postoperatively [32]. In all three sites a multimodal pain control strategy included systematical use of paracetamol and NSAID preoperatively. Thoracic surgery patients received serratus or erector spine block, all TKA patients received adductor canal block, and in spinal patients a local anesthetic infiltration of surgical wound was systematically used.

We did not evaluate postoperative pain scores because of different types of surgeries and distinct pain genesis in the immediate postoperative period. Moreover, little correlation between pain relief and satisfaction has been reported by several studies [33–36].

We observed sex-related differences in SUS score, mostly in patients from orthopedic surgery. Although the difference was statistically significant, we are not sure about clinical relevance of this difference. Other studies have been demonstrated conflicting results regarding the influence of gender on patient-oriented outcomes [37–39].

The site-related differences in SUS scores and satisfaction were noticed. Less presented in patients and physical therapists, these differences were apparent in nurses. The most important discrepancy in satisfaction from the use of SSTS between patients and caregivers was noted in spine patients, receiving vertebral fusion procedures. High in patients and physical therapists and quite low (although >60 points – e.g. 'acceptable') in nurses, it reflects

that the patients' need in self-control pain management was met, and physical therapists were able to meet their rehabilitation goals.

We were not able to find any studies reporting satisfaction and usability testing in clinicians regarding postoperative analgesia system. In our study, a perceived ease-of-use, as a global measure of system satisfaction, was acceptable to good for nurses, varying from acceptable (>50 but <70) in spinal surgery, to good (70 and more) in thoracic and orthopedics departments. The SUS score in nurses from the spinal surgery was affected by a neutral opinion on the most of tested usability domains. It may point out some imperfections in the implementation of training and communication plan. Nurses concerns about user control difficulty and learnability may suggest the importance of dedicated expert nurses to reduce uncertainties and handling mistakes.

Surprisingly, thoracic surgery nurses were concerned about an eventual external help regarding the system use (item 4). In the settings of our pilot evaluation, a dedicated hotline was available for any questions regarding the set up, use and safety of the device. However, no calls were registered to solve an eventual problem with the system. Such observation may result from the reluctance of healthcare providers to adopt changes in established routine [40,41] despite the established communication and training plan.

The consumption of sufentail tablets was different across surgeries, which is consistent with the intensity and duration of postoperative pain. It has been already shown that patients after spinal surgery have highest intensity of acute pain during the first postoperative day and elevated need in opioid analgesia [32]. Such consumption of sufentanil tablets reflects a high incidence of moderate-to-severe dynamic pain episodes in these patients; however, no literature available reporting the frequency of severe dynamic pain and analgesics needs for such type of pain in postoperative period.

The spectrum and the rate of side effects registered in patients used SSTS, was comparable to that already reported by other studies analyzing side effect with iv. PCA and SSTS [20,21]. Nausea and vomiting were the most frequent reported adverse effects, but less prevalent comparing to the data from recent meta-analysis (up to 51%). The management of side effects (such as conditional antiemetics prescription) and vitals surveillance of sufentanil administration (respiration rate, sedation level, blood pressure and heart rate) was standardized across all sites, and was similar to the standard surveillance of morphine iv. PCA. No case of malfunctioning or system failure of SSTS was reported in 111 patients.

Our study has some limits. This is a single center study, however realized in different hospitals. Included patients followed ERAS pathway, which has similar goals in the term of analgesia, early mobilization and avoidance of invasive postoperative care. Each center had an independent nurses and physical therapist team witch was unequal in size and working organization – such as permanent day staff and an interchangeable night pool staff. We did not identify if evaluating nurses were already familiar with the clinical use of the device. However, all potentially participating nurses had received the appropriate training for the SSTS use. We included patients with three very different surgeries in the term of postoperative pain and functional limitation; however, in three groups obtained SUS score was good-to-excellent.

The SSTS device is preprogramed and secured, which has a potential in reducing the risk of error of programming and preparation comparing to a traditional iv. PCA [42]. We did not evaluate such security and the potential benefit from the avoided programming errors.

The cost of the SSTS device may be seen as limitation. However, the actual cost of the iv. PCA including the hidden cost due to the error of programming and of preparation, the cost of time for the preparation and the cost of a longer stay due to a lack of an optimal rehabilitation may also be substantial [43,44]. The economic potential from the SSTS integration into the ERAS program may be seen in the reduction of the total hospital length of stay because of effective acute dynamic pain control, and has to be evaluated in a randomized controlled study.

Conclusion

The usability of SSTS device and the satisfaction in patients and physical therapists involved in ERAS protocol were good-to-excellent, and acceptable in nurses. A noninvasive fast and short-acting postoperative opioid analgesia may have benefits in the term of better dynamic pain control, responding to the ERAS requirements. A pilot usability testing may provide important information to prevent dissatisfaction in caregivers. A pharmaco-economical effect from the SSTS device in the reduction of hospital stay should be studied.

Executive summary

- The introduction of a novel analgesia system into the implemented Enhanced Recovery After Surgery (ERAS) process may lead to altered satisfaction of patients and clinicians.
- Alternative analgesia system implemented in the ERAS protocol had good-to-excellent usability score in patients and physical therapists, and was acceptable in nurses.
- A system usability scale score provides quantitative metrics of ease-of-use, a global system satisfaction and subscales of usability and learnability in the ERAS.
- A pilot measurement of usability may present a useful tool in the development of ERAS protocols.

Supplementary data

To view the supplementary data that accompany this paper please visit the journal website at: www.futuremedicine.com/doi/suppl/10.2217/cer-2020-0239

Author contributions

H Amson, P Lasselin, B Naegels and G Pardey Bracho contributed to the implementation of study, acquisition and interpretation of the data, drafted the manuscript and approved the final version. M Dziadzko and F Aubrun participated in the design and implementation of the study, performed statistical analysis, contributed to drafting and revision of the paper, and approved the final version. All authors have read and approved the final manuscript.

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Financial & competing interests disclosure

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No writing assistance was utilized in the production of this manuscript.

Ethical conduct of research

This study has been approved by the ethics committee of the Hospices Civils de Lyon. No written consent was required from patients as the SSTS has approval for postoperative analgesia in France, and since the study was noninterventional.

Data sharing statement

All data are the property of the Hospices civils de Lyon and will not be shared. ClinicalTrial.gov identifier: NCT03373851.

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