

Patient Satisfaction Survey on Portable Infusion Pumps for Colorectal Cancer Chemotherapy: Hard-Shelled or Soft-Shelled?

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Purpose: Elastomeric infusion pumps are widely used in colorectal cancer chemotherapy. However, no studies to date have investigated patient preferences regarding different infusion pump types.

Patients and Methods: Twenty patients with unresectable colorectal cancer undergoing chemotherapy were initially treated with a portable hard-shelled continuous infusion pump, followed by a soft-shelled continuous infusion pump. The respondents used a numerical rating scale (0–10) to rate their comfort when using each pump, their ease of carrying it, the pump size and shape, its weight, their ease of reading its memory, and their overall satisfaction with it. They were then asked to determine which pump they would ultimately prefer.

Results: In terms of comfort, significantly higher user satisfaction was reported for the soft-shelled pump during the daytime and when going out ($P < 0.001$, $P < 0.001$, respectively). For pump portability, size, shape, and weight, the soft-shelled type also outperformed the hard-shelled one ($P < 0.001$, $P = 0.0011$, $P < 0.001$, respectively). However, the hard-shelled pump scored significantly better in terms of ease of viewing memory ($P < 0.001$). Overall satisfaction was significantly higher for the soft-shelled pump than the hard-shelled type ($P = 0.0095$). Finally, 13 patients (65%) indicated that they would prefer a soft-shelled pump for their next treatment, while only one patient (5%) preferred a hard-shelled alternative. A preference for soft-shelled pump was observed, particularly in female patients and those with a body mass index of $< 22 \text{ kg/m}^2$.

Conclusion: The selection of portable elastomeric infusion pumps should consider the preferences of patients with colorectal cancer, as these devices have the potential to enhance their quality of life.

Keywords: colorectal cancer, chemotherapy, infusion pump, elastomeric infusion pump, portable infusion pump, patient preference

Introduction

The FOLFOX and FOLFIRI chemotherapy regimens for treating colorectal cancer require continuous intravenous (IV) infusion of 5-fluorouracil (5-FU) for 46 h. Consequently, portable disposable pumps have been developed to provide these treatments on an outpatient basis and in-home settings, enhancing patient convenience.^{1–4} Moreover, disposable portable infusion pumps—particularly elastomeric ones—have been developed that are reliable, consistent, easy to use, and have become widely available.⁵ In our department, all patients who receive a continuous intravenous infusion of 5-FU for 46 h are not hospitalized. Instead, they are treated on an outpatient basis using an elastomeric infusion pump.

Although there are several types of elastomeric infusion pumps, in Japan, physicians and pharmacists at various facilities are likely to select pumps mainly based on cost and convenience. Elastomeric infusion pumps can be broadly

classified into two types: those with hard or soft outer shells. To the best of our knowledge, no study has investigated whether hard- or soft-shelled pumps are preferable for patients undergoing pump-based treatments. Therefore, we aimed to investigate patient preferences regarding the shell types of portable, disposable, elastomeric infusion pumps used for continuous IV infusion of 5-FU for treating colorectal cancer. Additionally, we aimed to assess the possibility of further improving patient satisfaction and quality of life with such treatments.

Materials and Methods

Patients

We recruited 20 outpatients aged ≥ 20 years who used portable disposable continuous IV infusion pumps for the delivery of chemotherapy drugs between October 1, 2020, and December 31, 2020, at the Multidisciplinary Treatment Center of Kurume University Hospital, and who had the cognitive ability to answer our questionnaire. Patients < 20 years of age and those deemed to have insufficient cognitive ability to answer the questionnaire were excluded.

Study Design

Patients were first treated using the DIB Infuser[®] (DIB International Co., Ltd., Tokyo, Japan), a portable hard-shelled continuous infusion pump (Figure 1A) and completed a questionnaire before the next treatment (hard-shelled arm). The patients then received the second treatment using HOMEPUMP[®] (Avanos Medical Japan, Inc., Yokohama, Japan), a portable soft-shelled continuous infusion pump (Figure 1B), and completed the same questionnaire before the next treatment (soft-shelled arm). They were then asked to select the pump they would ultimately prefer for further treatments. The pharmacists who dispensed the drugs by injecting them into the pumps were also asked to complete a questionnaire as an ancillary study.

Questionnaire for Patients

All patients who received chemotherapy using either type of pump were asked via a paper-based questionnaire about the comfort of the pump (during the day, while out and about, and while sleeping), the ease of carrying the pump, the size and shape of the pump, the weight of the pump, the readability of the memory, and their overall satisfaction. A numerical rating scale was used to grade the responses.⁶ The score was converted to 0 if the patient indicated they were not comfortable at all and 10 if they were very comfortable. Finally, the participants were asked to determine the pump they would prefer to use in the future. A free-response field was also added to the survey (Figure 2).



Figure 1 Two types of elastomeric pumps were used in this study. (A) the hard-shelled DIB Infuser[®]. (B) the soft-shelled type HOMEPUMP[®].

questionnaire

Comfort of pump

0 1 2 3 4 5 6 7 8 9 10

Not comfortable at all ←————→ Very comfortable

During the day () /10

During going out () /10

During sleep () /10

Ease of carrying

0 1 2 3 4 5 6 7 8 9 10

Very difficult to carry ←————→ Very easy to carry

() /10

Size and shape of pump

0 1 2 3 4 5 6 7 8 9 10

Not at all satisfied ←————→ Very satisfied

() /10

Weight of pump

0 1 2 3 4 5 6 7 8 9 10

Not at all satisfied ←————→ Very satisfied

() /10

Ease of viewing memory

0 1 2 3 4 5 6 7 8 9 10

Not at all satisfied ←————→ Very satisfied

() /10

Overall satisfaction

0 1 2 3 4 5 6 7 8 9 10

Not at all satisfied ←————→ Very satisfied

() /10

Which pump would you prefer to receive ?

A. Hard-shelled type, B. Soft-shelled type, C. Either is fine

Please feel free to describe your impression

Figure 2 The questionnaire used in this study (translated; the original version administered was in Japanese).

Statistical Analysis

To ensure the comparability of the results, both types of pumps (hard-shelled and soft-shelled) were used for each patient. Therefore, the Wilcoxon signed-rank sum test was used to analyze the results. All statistical analyses were performed using JMP version 16.0 (SAS Institute, Inc., Cary, NC, USA), and P-values of <0.05 were considered statistically significant.

Ethical Consideration

This investigative study was performed at Kurume University Hospital (Kurume, Japan). It conformed to the principles of the Declaration of Helsinki and was approved by the Ethics Committee of Kurume University (approval number: 20146). All patients and pharmacists provided written informed consent prior to enrollment.

Results

The 20 respondents with unresectable, advanced, recurrent colorectal cancer included seven men and 13 women. Regarding the questionnaire on hard-shelled and soft-shelled types, all 20 patients responded to all the questions listed in Figure 2. There were no omissions. They had a median age of 68 years, median height of 162.5 cm, median weight of 55.2 kg, and a median body mass index (BMI) of 22.0 kg/m² (Table 1). Their responses regarding pump comfort revealed significantly higher satisfaction with the soft-shelled type during the daytime and when going out ($P < 0.001$, $P < 0.001$, respectively), but no significant difference when sleeping ($P=0.05$). In terms of portability, size, shape, and weight, the soft-shelled pump also scored higher than the hard-shelled type ($P < 0.001$, $P=0.0011$, $P < 0.001$, respectively). However, the hard-shelled type scored significantly better than the soft-shelled type in terms of ease of viewing the device's memory ($P < 0.001$). The overall satisfaction was significantly higher for the soft-shelled type than for the hard-shelled type ($P=0.0095$; Table 2). At the end of the assessment, 13 of the patients (65%) preferred a soft-shelled pump for their next treatment, one patient (5%) preferred a hard-shelled pump, and six patients (35%) indicated that either type of pump would be acceptable. In terms of cost, the unit price of each pump was 3564 yen (including tax) for the DIB Infuser[®] and 3500 yen (including tax) for the HOMEPUMP[®], with minimal difference in the economic burden on the patient for either pump.

Using the median BMI (22 kg/m²) as the cut-off, we also found that patients with BMIs of < 22 kg/m² ($n=10$) were significantly more satisfied with the soft-shelled type than those with BMIs ≥ 22 kg/m² ($n=10$) in terms of comfort during the day, portability, size and shape, and weight (Table 3). We also found that women significantly preferred soft-shelled pumps over men, although there were no significant differences between the BMIs (Table 4).

Table 1 Patient Characteristics

Variable	Total (n=20)
Age, median, year (range)	68 (47–79)
Sex	
Male	7
Female	13
Height, median, cm (range)	162.5 (143.2–176.5)
Weight, median, kg (range)	55.2 (39.3–96.0)
BMI, median, kg/m ² (range)	22.0 (17.6–30.8)

Abbreviation: BMI, body mass index.

Table 2 Survey Results of Patients

Parameter	Hard-Shelled Arm (N=20)	Soft-Shelled Arm (N=20)	P-value
	Mean \pm SD	Mean \pm SD	
Comfort			
Daytime	5.65 \pm 2.73	7.75 \pm 2.10	< 0.001
Going out	4.90 \pm 3.16	7.70 \pm 2.10	< 0.001
Sleeping	6.60 \pm 5.26	7.80 \pm 6.65	0.050
Portability	6.20 \pm 5.05	8.40 \pm 7.41	< 0.001
Shape and size	5.95 \pm 2.76	8.30 \pm 1.87	0.0011
Weight	6.80 \pm 2.40	8.65 \pm 1.93	< 0.001
Ease of viewing memory	7.80 \pm 2.35	4.70 \pm 2.60	< 0.001
Overall satisfaction	6.15 \pm 2.48	7.50 \pm 1.99	0.0095

Abbreviation: SD, standard deviation.

Table 3 Survey Results of Patients by Body Mass Index (BMI)

Parameter	BMI < 22 kg/m ² (N=10)			BMI ≥ 22 kg/m ² (N=10)		
	Hard-Shelled Arm Mean ± SD	Soft-Shelled Arm Mean ± SD	P-value	Hard-Shelled Arm Mean ± SD	Soft-Shelled Arm Mean ± SD	P-value
Comfort						
Daytime	4.90 ± 2.81	7.20 ± 1.69	0.0156	6.40 ± 2.59	8.30 ± 2.41	0.0859
Going out	4.20 ± 3.22	7.20 ± 1.69	0.0039	5.60 ± 3.10	8.20 ± 2.44	0.0391
Sleeping	6.70 ± 2.79	7.30 ± 1.77	0.4844	6.50 ± 3.10	8.30 ± 3.02	0.1563
Portability	5.60 ± 2.50	8.00 ± 1.70	0.0078	6.80 ± 2.39	8.80 ± 2.49	0.0547
Shape and size	5.70 ± 2.79	8.60 ± 1.26	0.0039	6.20 ± 2.86	8.00 ± 2.36	0.1367
Weight	5.90 ± 2.28	8.80 ± 1.32	0.0078	7.70 ± 2.26	8.50 ± 2.46	0.2813
Ease of viewing memory	8.40 ± 2.01	4.50 ± 2.80	0.0195	7.20 ± 2.62	4.90 ± 2.51	0.0039
Overall satisfaction	6.00 ± 2.71	7.00 ± 1.63	0.1875	6.30 ± 2.36	8.00 ± 2.26	0.0859

Abbreviations: BMI, body mass index; SD, standard deviation.

Table 4 Survey Results of Patients by Sex

Parameter	Male (N=7) Median BMI: 23.8 kg/m ²			Female (N=13) Median BMI: 21.7 kg/m ² (p=0.2125)		
	Hard-Shelled Arm Mean ± SD	Soft-Shelled Arm Mean ± SD	P-value	Hard-Shelled Arm Mean ± SD	Soft-Shelled Arm Mean ± SD	P-value
Comfort						
Daytime	7.57 ± 2.15	8.42 ± 1.90	0.2500	4.61 ± 2.50	7.38 ± 2.18	0.0063
Going out	7.14 ± 2.67	8.43 ± 1.91	0.1250	3.69 ± 2.78	7.30 ± 2.17	0.0024
Sleeping	7.28 ± 2.36	8.42 ± 1.71	0.2500	6.23 ± 3.13	7.46 ± 2.78	0.2598
Portability	8.00 ± 1.82	8.71 ± 1.97	0.1250	5.23 ± 2.24	8.23 ± 2.24	0.0034
Pump shape, size	8.14 ± 1.77	8.42 ± 1.39	0.7813	4.76 ± 2.49	8.23 ± 2.13	0.0029
Pump weight	8.14 ± 1.95	8.80 ± 1.32	0.1250	6.07 ± 2.36	8.50 ± 2.46	0.0117
Ease of viewing memory	7.85 ± 2.26	5.85 ± 1.95	0.0625	7.76 ± 2.48	4.07 ± 2.75	0.0027
Satisfaction	7.71 ± 1.79	7.85 ± 1.57	0.7663	5.30 ± 2.42	7.30 ± 2.21	0.0195

Abbreviations: BMI, body mass index; SD, standard deviation.

The pharmacists who injected the 5-FU into each of the infusion pumps included eight male and four female pharmacists, with a median age of 36.0 years and a median of 13.0 years of experience as a pharmacist (Table S1). There was no significant difference between the two pumps in terms of the ease of drug injection ($P=0.1211$); however, satisfaction with the hard-shelled type was significantly higher than with the soft-shelled type in terms of the ease of viewing the device's memory ($P < 0.0010$). Overall satisfaction with the hard-shelled type was significantly higher than that with the soft-shelled option ($P=0.0352$; Table S2).

Discussion

The advent of FOLFOX and FOLFIRI as chemotherapy regimens for patients with unresectable, advanced, and recurrent colorectal cancer has not only improved life expectancy but also made a significant contribution to quality of life by making outpatient treatment possible.⁷⁻⁹ Continuous IV infusion of 5-FU is necessary to provide these treatments in an outpatient setting, necessitating the use of a portable continuous infusion pump. However, some patients using infusion

pumps report inconveniences in their daily lives during continuous administration while at home.^{10,11} To the best of our knowledge, this is the first report on patient preferences regarding portable disposable pumps for continuous IV infusion of 5-FU at home.

Our patient surveys showed that overall satisfaction with the soft-shelled infusion pump was higher than that with the hard-shelled infusion pump, with 65% of the patients indicating they would prefer to be treated with a soft-shelled pump. This was because soft-shelled pumps are easier to carry, have more convenient shapes and weights, and are less bulky than the hard-shelled type. This also makes them more comfortable for use during the day and while sleeping, meaning they are less obstructive to activities of daily living. Our Results were consistent with a previous study on whether soft-shelled or hard-shelled devices for the at-home administration of antibiotics were preferred, wherein 20/24 patients (83%) reported a preference for soft-shelled devices.¹⁰ However, several respondents in our study preferred hard-shelled pumps because of scales on their sides that allow them to monitor liquid levels.

Furthermore, our results showed a strong preference for soft-shelled infusion pumps, particularly among patients with BMI < 22 kg/m². Patients with lower BMIs are generally lighter and have less fat and muscle mass than standard-weight individuals, potentially making them more sensitive to the shapes and weights of their pumps. This suggests that soft-shelled infusion pumps have lower levels of physical impact on patients. Of the 13 patients (65%) in this study who ultimately requested treatments with soft-shelled pumps, 10 were women. The reason women prefer soft-shelled pumps over men despite no significant differences in BMI levels may be because they feel the effects of the pump more than men, although this could not be verified in this study because of the small number of participants.

In our survey, the majority of the patients preferred soft-shelled infusion pumps over hard-shelled ones. However, most of the pharmacists who added the medicines to the pumps preferred hard-shelled versions in terms of overall satisfaction. This was because the force applied to the syringe when mixing the medications was lighter than what was needed for the soft-shelled infusion pumps, and the scale made preparation easier because it could be checked as required. Consequently, soft-shelled infusion pumps were preferred by patients, whereas hard-shelled ones were preferred by the pharmacists who prepared them.

Healthcare professionals are aware of adverse events such as nausea, vomiting, anorexia, other gastrointestinal symptoms, and peripheral neuropathy while administering FOLFOX, FOLFIRI, and other therapies. Therefore, focusing on the quality of life after the pump is attached may also ease some of the treatment-related burdens on patients. It is presumed that in several facilities, physicians and pharmacists decide on the type of portable continuous infusion pump to be used based on convenience and cost. However, from the perspective of the patient's quality of life, the use of portable continuous infusion pumps that reflect patient preferences should also be considered. In particular, this highlights that physicians and pharmacists, as members of the cancer chemotherapy team, should not only manage regimens, dosing schedules, and adverse events but also make every effort to improve the quality of life of their patients.

Nevertheless, this study had several limitations. First, the small sample size of infuser pumps available meant that only a small number of patients could be included. Second, only one questionnaire was completed for each infusion pump used; therefore, repeated long-term assessments of quality of life were not possible. Third, the satisfaction rating was only assessed using the numerical rating scale. Future studies should consider these factors when focusing on the notable factors of BMI and the preferences of female patients.

Conclusion

Our study revealed that more patients generally preferred soft-shelled infusion pumps over hard-shelled ones for delivering continuous colorectal cancer chemotherapy, particularly those patients with BMIs of < 22 kg/m² and female patients. These results suggest that, in the future, the selection of portable continuous infusion pumps that consider patient preferences may also help further improve patient quality of life.

Data Sharing Statement

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

Acknowledgments

We express our gratitude to all the patients and pharmacists who participated in this study. We would also like to thank Editage for their English-language editing. This paper has been uploaded to Research Square as a preprint (<https://www.researchsquare.com/article/rs-3699012/v1>).

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Funding

The authors received no particular funding for this work.

Disclosure

Dr Takumi Kawaguchi reports lecture fees from ASKA Pharmaceutical Co., Ltd., Taisho Pharmaceutical Co., Ltd., Kowa Company, Ltd., AbbVie GK., Eisai Co., Ltd., Novo Nordisk Pharma Ltd., Janssen Pharmaceutical K.K., and Otsuka Pharmaceutical Co., Ltd., outside the submitted work. The authors declare that this study was conducted in the absence of any other commercial or financial relationships that could be construed as potential conflicts of interest.

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