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ORIGINAL CONTRIBUTIONS

eHealth Intervention via LINE® Social Media as an Adjunct for Postoperative Care After Bariatric-Metabolic Surgery: Single Institution Experience

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Abstract

Purpose Applying eHealth interventions via social media is common in modern medicine. LINE® is a popular communication app in Taiwan that can deliver messages 24 h a day. In addition to being free of charge, it also allows bariatric nurses (BNs) and patients to enjoy bidirectional communication via telecommunication services instead of direct, face-to-face contact for patients undergoing bariatric-metabolic surgery (BMS). We conducted this retrospective study to determine the frequency and reasons for early post-discharge of LINE® messages/calls and investigate the relationship between this frequency and contents of these messages and postoperative outcomes after BMS.

Materials and Methods A retrospective review of prospectively collected data was conducted in an Asian weight management center. The study period ran from August 2016 to December 2021, and a total of 143 native patients with severe obesity were enrolled. All patients were informed of the necessity of a postoperative dietitian consultation before bariatric surgery. The patterns of LINE® communication with the BN and associated actions to resolve patients' needs within 180 days after index BMS were analyzed.

Results Among the 143 enrolled patients, 100 underwent laparoscopic sleeve gastrectomy and 43 underwent laparoscopic Roux-en-Y gastric bypass. A total of 1205 messages/calls were analyzed concomitantly; most LINE® communications focused on diet problems (47.97%; $n = 578$), weight problems (11.54%; $n = 139$), and medications (9.21%; $n = 111$). Most problems could be resolved by LINE® communications directly, and only a small portion (5.6%) was directed to local clinics or emergency departments. During the COVID-19 pandemic, the usage of LINE® communications significantly increased (12.2 ± 10.4 vs. 6.4 ± 4.9; $p < 0.01$); nonetheless, a higher frequency of LINE® communications would not hinder the regular clinic visits ($r = 0.359$; $p = 0.01$).

Conclusion Based on our limited experience, the LINE® consultation service operated by the BN could effectively address patients' problems. Moreover, it might reduce the need for emergency department visits or unexpected clinic appointments for patients after BMS.

Ya-Wei Huang and Kuo-Feng Hsu contributed equally to this work.

Key Points

- Applying eHealth interventions via social media is common in modern medicine.
- LINE®, a popular communication app in Taiwan can deliver messages 24 h a day and is free of charge. LINE® also allows bariatric nurses (BNs) and patients undergoing bariatric-metabolic surgery (BMS) to enjoy bidirectional communication via telecommunication services instead of face-to-face contact.
- Based on our limited experience, the LINE® consultation operated by the BN could effectively address patients' problems/concerns.
- Moreover, it might reduce the need for emergency department visits or unexpected clinic appointments for patients after BMS.

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Keywords Bariatric-metabolic surgery · Bariatric nurse · eHealth intervention · Healthcare · Severe obesity

Introduction

The number of patients with severe obesity seeking bariatric-metabolic surgery (BMS) has increased substantially during the last few decades, and there is strong evidence that BMS procedures can be used to treat patients with severe obesity safely and efficiently [1–3]. In addition to the satisfactory recovery and perioperative safety, BMS has also been reported to be associated with an average hospital stay duration of 3.7 days for patients undergoing them in Taiwan [3, 4]. Given the rapid recovery and early discharge after BMS, the importance of postoperative follow-up and health care delivery in minimizing weight regain or nutritional complications cannot be over-emphasized [5, 6]. Moreover, the trend of shorter inpatient stays has stressed patient health care and education before discharge subsequently.

A comprehensive, multidisciplinary BMS program is essential to optimize follow-up care, and bariatric nurses (BNs) play a crucial role because of their unique position in delivering health care before and after BMS [7]. To thoroughly deliver health care and maintain its continuity, the adoption of patient-centered approaches to transmit related basic health care knowledge regarding BMS is necessary [5]. Moreover, the coronavirus disease 2019 (COVID-19) pandemic posed significant challenges to medical professionals practicing in outpatient facilities focused on chronic disease treatment and management, including BMS [8]. Such eHealth interventions have been proposed as useful adjuncts to help modern medical professionals provide post-BMS care, including online programs or internet modules, telephone interviews, video conferences, and mobile applications [8–11]. However, in spite of the recent abatement of the COVID-19 pandemic, the latter has created a peculiar situation whereby the method of postoperative follow-up for post-BMS patients had to change from in-person visits to other alternatives to ensure continuity in the provision of patient care while minimizing COVID-19 exposure [8, 9].

It was reported that Taiwanese people widely use social media, with approximately 82.6% of the population being active social media users. Among these social media platforms, LINE®, which is used by 88% of internet users aged 16–64 years, remains the number one messaging app [12]. Though it is a common phenomenon that patients undergoing BMS are given verbal and written instructions on contacting this free-of-charge LINE® consultation service, it still remains unclear whether accurate information regarding its effects and definite contents is given. To our knowledge, there is a paucity of data on the use of LINE® or similar social media platforms to facilitate post-BMS care [9–11, 13, 14]. Our primary aim is to verify whether LINE® could be used to provide health care consultation and support for patients with severe obesity undergoing BMS. Moreover, the detailed content of these LINE® messages/calls and the usage frequency during the pandemic were analyzed concomitantly.

Methods

This study was conducted at the Weight Management Center of a tertiary medical center, and the study protocol was approved by the Intuitional Review Board of the same hospital (No. KMUHIRB-20190250). All eligible patients are over 20 years old, and each of them had a body mass index (BMI) of $\geq$ 37.5 kg/m^2 or $\geq$ 32.5 kg/m^2, with obesity-related comorbidities. We excluded patients who underwent revisional BMS, those with direct surgical complications due to index BMS (bleeding, staple line leak, or anastomotic leak), or those undergoing BMS in other bariatric units. From August 2016 to December 2021, a total of 143 patients with severe obesity who underwent laparoscopic Roux-en-Y gastric bypass (LRYGB) or laparoscopic sleeve gastrectomy (LSG) were consecutively included.

In our protocol, physical examinations and associated workups, including gastroendoscopy, abdominal sonography, and blood biochemistry, were arranged during outpatient clinic visits 1 or 2 weeks before surgery. Every patient had to visit the dietitian and the certified BN in our unit. Preoperative education was conducted verbally, and a twenty-page education manual (Madeiran version) for scheduled BMS was offered to educate patients on how to prepare for the surgery, exercise, and dietary instructions before and after surgery. Moreover, programmed clinic visits (1st week, 1st month, 3rd month, and 5th month after BMS) during the first 180 days were instructed thoroughly. The BN simultaneously confirmed each patient's current medications, associated medical problems, and smoking status. After the surgical operation performed by a certified bariatric surgeon, the patients were mobilized as soon as possible, typically on the day of surgery. Upon discharge, every patient was placed on a clear liquid to liquid diet and wound care while monitoring the common postoperative discomforts, signs of complications, and associated medication use. The patients were given both verbal and written instructions on how and when to initiate 24-h LINE® consultation services, which were offered by only one BN.

We retrospectively gathered information on all calls and messages from LINE® consultation services between the

BN and the patients. Calls were defined as phone contact via LINE® with verbal communications, and messages were defined as non-verbal communications via LINE®, such as text messaging. The BN answering these LINE® messages/calls to complete a detailed Google form within the first 180 postoperative days. The information collected included basic demographic data, the dates of calls/messages, the operation date, procedures, main reason for reaching out, and the required action. The main reason for reaching out was recorded by selecting predetermined response categories. Questions on sugar control, high blood pressure, medications, wound problems, fever, diet, constipation, abdominal pain, vomiting/nausea, dizziness/syncope, black/tarry stool, weight management, gout attacks, issues of outpatient clinic visit dating, nutrition supplement, fitness, hair loss, acid regurgitation, and miscellaneous enquiries were retrospectively enrolled and categorized by separate professionals. The following alternatives were provided regarding the measures the BN took: instructions given by the BN, consultation with the surgeon, returning to the surgeon's clinic, directions to visit a nearby local clinic, or directions to visit the emergency department (ED). If the BN was unable to respond to the questions raised by patients, she would consult the surgeon immediately.

We used electronic medical records to gather information about gender, age, associated BMS procedures (LRYGB or LSG), and the length of hospital stay. All these variables between LRYGB and LSG are described in more detail in Table 1. Patients who were instructed to visit local clinics or ED via the LINE® messages/calls were followed up to record the definite assessment and further health care. Moreover, to ensure the functionality of the LINE® consultation service, all patients who contacted the LINE® service were followed up within 24 h and 1 week after the message/call to record illness or complications (i.e., any medical reasons resulting in a hospital revisit or readmission) and any self-initiated clinic visits made during the study period, regardless of whether or not they were instructed to visit the clinic.

Table 1 Participants demographics with frequency of clinic visit and LINE® Message/Call

	LRYGB $n = 43$	LSG $n = 100$	*P* value
Gender (F)	20	55	0.368[!]
Age (year)	40.2 ± 11.7	36.0 ± 9.2	0.04
BH (cm)	168.3 ± 8.0	167.7 ± 9.3	0.704
BW (kg)	132.9 ± 30.4	111.1 ± 21.1	< 0.001
BMI (kg/m^2)	46.7 ± 9.2	39.3 ± 5.4	< 0.001
LOS (day)	3.1 ± 2.5	2.3 ± 0.7	0.055
T2DM case (%)	18 (41.9)	35 (35)	0.455
Duration (month)	71.2 ± 64.9	52.0 ± 58.0	0.307
HbA1c	7.6	7.9	0.64
Insulin (%)	9 (50.0)	4 (11.4)	0.005[!]
Education			0.003[!]
College/university	25	83	
High school	18	17	
Residence			0.079[!]
Downtown	29	82	
Others (outbound)	14	18	
Insurance coverage			0.577[!]
Self-Paid	15	41	
National health insurance	28	59	
Frequency of clinic visit (1Y)	6.6 ± 3.2	5.6 ± 2.9	0.078
Frequency of clinic visit (180 days)	4.8 ± 3.8	2.2 ± 1.4	0.003
Number of LINE® message/call	10.9 ± 11.5	7.3 ± 5.2	0.057
Total weight loss (1Y) (%)	43.7 ± 16.2	28.0 ± 9.3	< 0.001
Total weight loss (6M) (%)	32.3 ± 11.6	23.2 ± 6.9	< 0.001

BH, body height; *BMI*, body mass index; *BW*, body weight; *F*, female; *HbA1c*, glycated hemoglobin; *LOS*, length of stay; *LRYGB*, laparoscopic Roux-en-Y gastric bypass; *LSG*, laparoscopic sleeve gastrectomy; *T2DM*, type 2 diabetes mellitus; *1Y*, first year; *6M*, first 6 month

[!]Fisher's Exact Test (2-sided)

Operative Technique

Laparoscopic Sleeve Gastrectomy

A 12 mm trocar is placed over the umbilicus, and a 12 mm trocar is placed about 3 cm on the left side of the umbilicus. Two 5 mm trocars are placed left and right subcostal area. A liver retractor entries the intraperitoneal cavity via subxyphoid area. We used a 32 French orogastric tube for bougie calibration. Omentum is dissected from the greater curvature to the left crus. We then start vertical gastrectomy with linear stapler about 4 cm away the pylorus. Reinforcement of the staple line is done by intracorporeal hand-sewn continuous suture.

Laparoscopic Roux-en-Y Gastric Bypass

The trocars are created similarly as the LSG. The gastric pouch is created first, and an about 3 cm gastrojejunostomy is created then. The length of the biliopancreatic limb and common limb are both 100 cm. The Petersen defect is closed via continuous suture.

Postoperative Follow-up Protocol

Patients undergoing LSG or LRYGB share the same frequency outpatient clinic follow-up. The first clinic visit is on the first week after discharge, and the second clinic visit is on the first month after discharge. Then, the patient visits the clinic every 3 months for the first year after discharge, and

the patient visit the clinic every 6 months for the second year after discharge. On the third year after discharge, the patient visits the clinic every year till the fifth year after discharge. Patients undergoing LSG or LRYGB receive consultations of nutritionist and specialist of physical fitness.

Between the clinic visits, the patients would return to clinic without obstacles once they encountered any discomfort.

Statistical Analysis

Statistical analyses were performed using IBM SPSS statistics version 26.0 (SPSS inc., Chicago, IL, USA) for Mac. Continuous variables were presented as means ± standard deviations while dichotomous/categorical variables were presented as frequencies and percentages. The two-tailed independent-sample t-test (Fisher's Exact Test) was used for continuous variables. The correlation between the personal usage frequency of LINE® for communication and the frequency of regular clinic visits during the first 180 days after index BMS was assessed using the Pearson correlation coefficient. A p-value of < 0.05 was considered statistically significant.

Results

All LINE® consultations (a total of 1205 messages/calls) were included in the analysis and the 30-day readmission rate was 2.8% (4/143) during the study period. The variables for which the two groups (LSG and LRYGB) differed in characteristics were the body weight and BMI (Table 1). The mean age was 36.0 ± 9.2 years for the LSG group and 40.2 ± 11.7 years for the LRYGB group. The average length of hospital stay was 2.3 days in LSG and 3.1 days in LRYGB, respectively. The total weight loss (%) within the first 6 months and 1 year for the LRYGB and LSG groups were 32.3 ± 11.6 vs. 23.2 ± 6.9 ($p < 0.001$) and 43.7 ± 16.2 vs. 28.0 ± 9.3 ($p < 0.001$), respectively. The average frequency of clinic visits within the first 180 days was 4.8 times in the LRYGB group and 2.2 times in the LSG group ($p = 0.003$). Moreover, the personal usage frequency of LINE® message/call services did not significantly differ between the LRYGB and LSG groups (10.9 ± 11.5 vs. 7.3 ± 5.2; $p = 0.057$).

Among these LINE® messages/calls, female patients accounted for 62.07 % ($n = 748$), and those receiving LSG accounted for 61.07% ($n = 736$). Most LINE® messages/calls (61.2 %; $n = 738$) came in within the first 30 days, 22.6% ($n = 272$) between day 31 and day 90, and 16.2% ($n = 195$) between day 91 and day 180 post-discharge. Generally, these LINE® messages/calls focused on diet problems (47.97%; $n = 578$), weight problems (11.54%; $n = 139$), medication use and related instructions (9.21%; $n = 111$), clinic visit appointments (5.98%; $n = 72$), and blood sugar control issues (4.73%; $n = 57$). Unlike in the LSG group, blood sugar problems were the third most common concern in the LRYGB group (6.39% vs. 3.66%; $p < 0.05$). Most of these LINE® messages/calls focused on diet problems (80.8%) were involved in food choices and the consumption of a balanced diet. Approximately 11.6% of them addressed the problem of food intolerance. The proportion of patients in the LSG group that reached out via LINE® consultation services for weight problems was higher than that in the LRYGB group (15.35% vs. 5.54%; $p < 0.01$). Among those who reached out for weight problems, most patients tabled the issue of insufficient weight loss (Table 2).

Regarding patients' concerns during the different post-discharge stages (within the first 30 days, 31–90 days, and 91–180 days), diet problems remained the most dominant issues throughout postoperative recovery (Fig. 1). Medication use (including anti-diabetic medications, antihypertensive drugs, antihyperuricemia agents, and hypnotics) and related instructions remained the second most common concern within the first 30 days and were the third most common concern on days 31–90. After medication discontinuation due to the resolution of associated medical problems post-index BMS, weight problems ranked second on days 31–180 (Fig. 1).

From 2016 to 2021, the number of mean LINE® messages/calls increased from 2.7 ± 1.7 to 13.4 ± 15.0/person ($p < 0.001$), and the frequency of LINE® messages/calls was higher during the COVID-19 pandemic (12.2 ± 10.4 vs. 6.4 ± 4.9; $p < 0.01$; Fig. 2). Given the increasing trend in the use of LINE® messages/calls, the frequency of regular clinic visits during the first 180 days ($p = 0.968$) and the first year ($p = 0.545$) did not change accordingly. A Spearman's rank-order correlation was performed to determine the relationship between the frequency of LINE® service and the clinical visits within 180 days after discharge, and there was a positive correlation with statistically significance between the frequency of LINE® service and the clinical visits ($rs = .229$, $p = .006$) (Fig. 3).

Among those who reached out through these messages/calls, only six patients (0.49%) were transferred to the ED directly for presenting complaints of fever (LRYGB; seasonal flu), intractable hiccups (LSG; resolved spontaneously), abdominal pain (one for lactobezoar impaction after LRYGB and the other for menstrual pain after LSG, both resolved after conservative management), dyspnea (LRYGB; pulmonary embolism, oral anti-coagulant use), and generalized discomfort (LRYGB; Wernicke encephalopathy, resolved after treatment) (Table 2 and Fig. 4) [15]. Most patients' concerns (94.4%) could be resolved with LINE® consultation services only, either by giving instructions from the BN (76.0%) or supplementary physicians'

Table 2 Reasons of LINE® message/call per category

	No. of calls		No. of patients instructed to visited ED	No. of all message/call	% of message/call
	LRYGB (n = 469)	LSG (n = 736)			
Diet problem	226[a]	352[a]	0	578	47.97
Weight problem	26	113 [b]	0	139	11.54
Medication	46 [b]	65 [c]	0	111	9.21
Blood sugar control	30 [c]	27	0	57	4.73
Hair loss	18	19	0	37	3.07
Blood pressure control	7	15	0	22	1.83
Dating of clinic visit	26	46	0	72	5.98
Wound problem	6	16	0	22	1.83
Constipation	6	13	0	19	1.58
Acid regurgitation	2	19	0	21	1.74
Dizziness/syncope	13	9	0	22	1.83
Black/tarry stool	7	2	0	9	0.75
Gout attack	3	8	0	11	0.91
Abdominal pain	14	15	2	29	2.41
Fever	2	4	1	6	0.50
Others (dysmenorrhea/rashes/acnes/blurred vision/headache/ common cold/ musculoskeletal pain/sleep problem/ psychologic problem/dysuria)	37	13	3	50	4.15

Noted: patients' messages/calls could be categorized as more than one reason

[a]The largest number of messages/calls

[b]The second number of messages/calls

[c]The third number of messages/calls

consultations (18.4%). Of all 1,205 LINE® messages/calls, 5.1% of calls (n = 61) were directed to a local medical doctor for further management, mostly focusing on abdominal pain (n = 11), dermatologic problems (n = 8), dizziness/syncope (n = 7), musculoskeletal pain (n = 6), dysmenorrhea (n = 5), gout attack (n = 4), and others (n = 20).

Discussion

In this study, we identified the major reasons for utilizing the LINE® consultation service after BMS in an Asian BMS center. According to our findings, the problems for which the service was most effective for further improvement and patient health care education were diet problems, weigh-off issues, and related medication usage. Our results showed that LINE® consultations could efficiently address patients' concerns and might reduce unnecessary ED utilization (0.49%) after BMS. During the COVID-19 pandemic, the increasing use of LINE® consultation services could meet the need and ensure adequate health care for patients undergoing BMS.

eHealth interventions have been recognized as effective adjuncts to support weight loss, improve eating behavior, enhance physical activity, and promote the acquisition of health knowledge [8–11]. LINE® was one of the most popular apps in East Asia and Taiwan thanks to its user-friendly interface and free-of-charge availability [12]. Hence, consultation services via LINE® are commonly used in health care; it has been used to target patients undergoing BMS and continue post-discharge health care in our center since August 2016. Moreover, the personal usage frequency of LINE® messages/calls grew annually and significantly increased during the COVID-19 pandemic (12.2 ± 10.4 vs. 6.4 ± 4.9; $p < 0.01$; Fig. 2). It has been proven that the pandemic led to the rapid growth of health care delivery via eHealth strategies for patient safety and the maintenance of health care continuity, including BMS [8].

Identifying the most common postoperative patients' concerns could help experts efficiently prioritize health care interventions regarding BMS. It was believed that most patients had diet problems after BMS, including food tolerance issues and eating behavior modification. In several

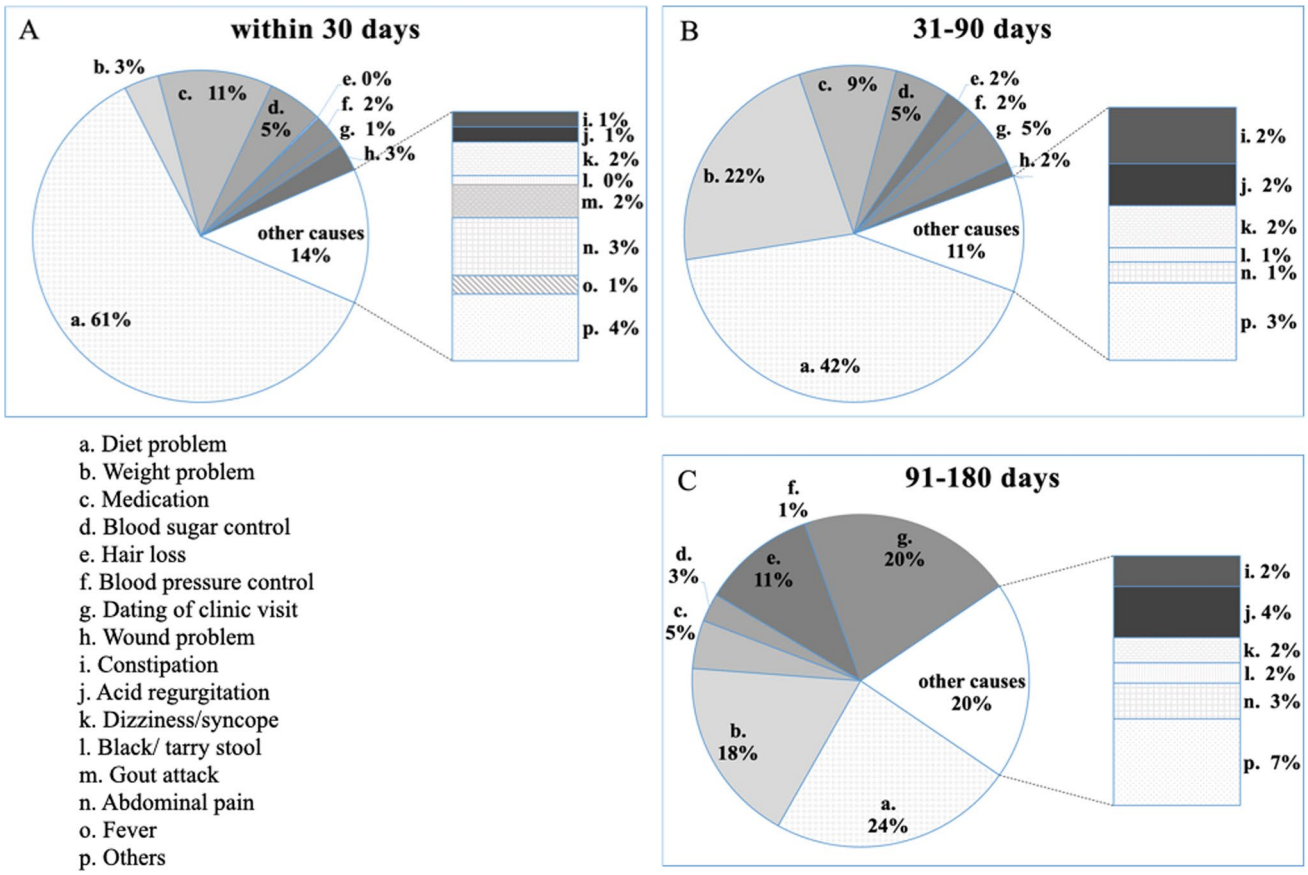

Fig. 1 Reasons of LINE® message/call during different stages after discharge

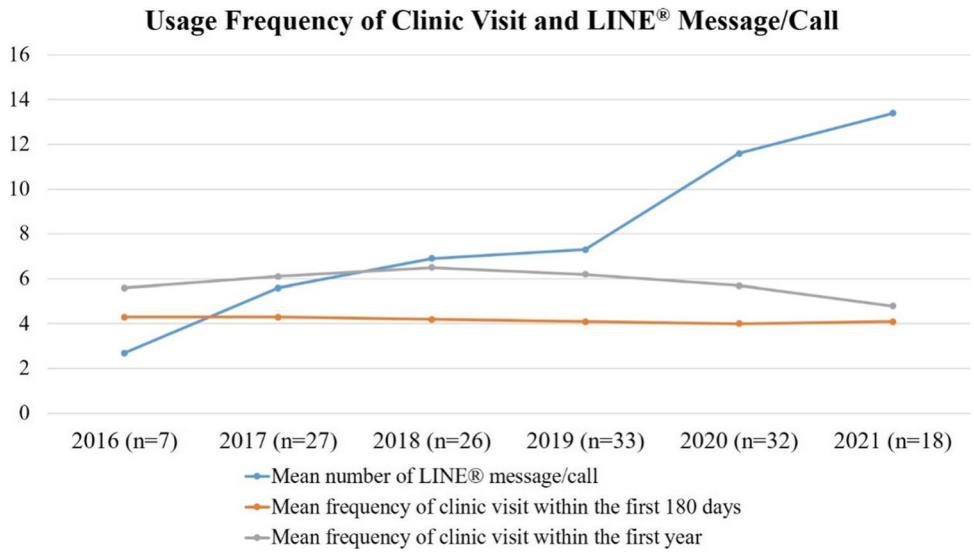

Fig. 2 Personal Usage frequency of clinic visit and LINE® message/call in different years

similar studies, patients usually complained of the typical problem of vomiting due to food intolerance [16–18]. In particular, readmission usually occurs within 30 days after primary discharge for index BMS, and dehydration was the most common reason for postoperative ED visits and readmission within 30 days after primary discharge [19, 20]. Though no food tolerance surveillance was conducted in this study, most LINE® communication services focused on dietary problems in our group (47.97%) (Table 2). Therefore, it is crucial to educate patients on how to eat and proper

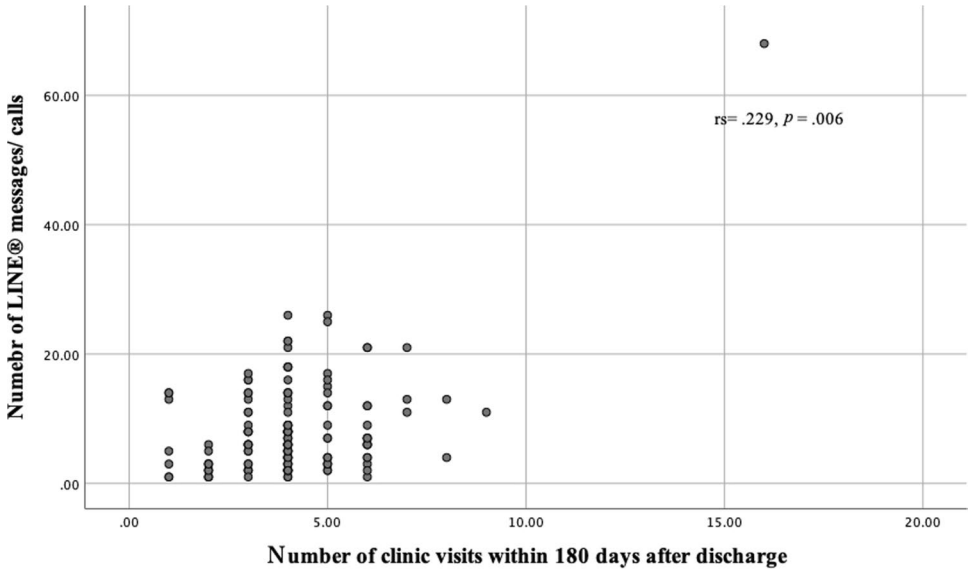

Fig. 3 Correlation between personal frequency of LINE® message/call and number of clinic visits

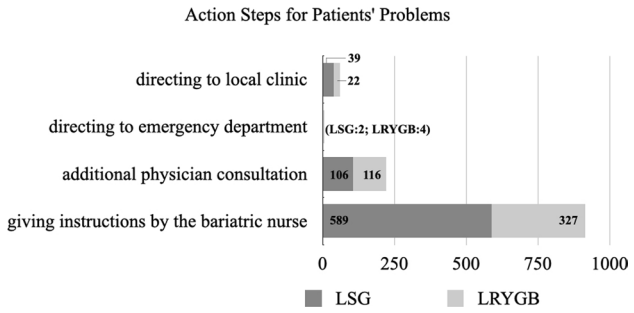

Fig. 4 Action steps were taken to resolve the patients' problems

food choices during the initial post-discharge care via clear descriptions/illustrations to promote healthy eating, choosing authentic foods, and preventing possible catastrophic complications after BMS [15].

Weight problems and medication counseling were the 2nd and 3rd most common reasons why patients used LINE® communication services in the LSG group. Patients in the LRYGB group had more blood sugar problems than those in the LSG group (6.39% vs. 3.66%; $p < 0.05$; Table 2). Not only was there a higher proportion of diabetic patients using insulin (50.0% vs. 11.4%; $p = 0.005$) and more elderly patients (40.2 ± 11.7 vs. 36.0 ± 9.2; $p = 0.04$) in the LRYGB group than in the LSG group (Table 1), a higher rate of reactive hypoglycemia was also reported in the LRYGB group than in the LSG group [21]. This might make patients undergoing LRYGB aware of the significance of blood sugar monitoring and predispose them to reach out more via LINE® messages/calls regarding blood sugar control after surgery in our series. Moreover, patients' health literacy and numeracy might have contributed to the higher portion of blood sugar problems though no related health literacy assessment was available in this study [22, 23].

In addition to the most dominant concern of diet problems throughout the postoperative recovery period, weight problems ranked second on days 31–180 (Fig. 1). The mean total weight loss (%) of patients in the LRYGB group by 6 months was higher than that of patients in the LSG group in our series (32.3 ± 11.6 vs. 23.2 ± 6.9; $p < 0.001$), which is in line with the findings of previously published studies [24]. This could explain the higher proportion of LINE® messages/calls focusing on weight problems in the LSG group in this study (15.35% vs. 5.54%; $p < 0.01$). Though it was reported that the weight loss in the LRYGB group was similar to that in the LSG group during long-term follow-up, most previous studies reported that patients undergoing LRYGB experienced greater and more rapid weight loss in the early postoperative phase, even for those with BMIs of > 50 kg/m^2 [4, 24–26]. Given the clinical significance of maximal changes in the dietary intake and related adherence within 6 months after index BMS, one should recommend diet counseling to augment maximal weight loss during healthcare delivery [27].

Considering the faster recovery with early discharge for patients after BMS, LINE® consultation services could be used to recognize patients who indeed required further healthcare counseling to prevent possible adverse events leading to readmissions, such as dehydration or acute kidney injury [3, 4, 19]. Based on our results, most LINE® messages/calls (61.2%) came in within the first 30 days, which is the period during which patients are most vulnerable due to possible early postoperative complications after index BMS. Thus, we should prioritize healthcare education content, particularly the type focusing on dietary counseling and alerting patients about early symptoms/signs originating from these postoperative complications [28].

The certified BN could single-handedly handle more than 75% of LINE® messages/calls, which indicated that the LINE® consultation service can reduce healthcare-related expenditure while simultaneously improving the quality of care (Fig. 4). Only 0.49% of LINE® messages/calls were directed to EDs for truly acute illnesses, such as lactobezoar-related obstruction, pulmonary embolism, and Wernicke encephalopathy, with the acceptable 30-day readmission rate of 2.8% in our series [15]. Lactobezoars are common in infant patients. In many Asian countries, soy milk is a preferred substitute to dairy because lactose intolerance is frequent among people of Asian descent. One patient in our series undergoing LRYGB consumed 300 mL of concentrated soy milk after being discharged, and presented to emergency room with vomiting and intractable belching. Abdomen computed tomography disclosed a potential lactobezoar impacted at the patient's gastrojejunal anastomosis, which was ante-gastric fashion [15]. To minimize the risk of delayed referral because instructions came only from the BN, we maintained instant, bidirectional communication between the BN and BMS surgeon through LINE® in our center.

The main strength of the present study was that most patients were compliant to medical instructions (both verbal and written) on how and when to call the LINE® consultation services given upon discharge. They diligently performed self-monitoring of blood sugar levels and blood pressure levels and reported to the BN after discharge because they valued their own health, which reflects the patients' personal health literacy and they adhered tightly to our instructions [22, 23]. Moreover, LINE® could definitely receive every message/call, which allowed for detailed documentation and clearly classification of information during in the study period. We are positive that this LINE® consultation service could be provided with an appropriate, patient-centered approach for health assessment [5]. Also, data entry was performed entirely by the BN, which limited inter-person variability.

Nevertheless, our study had certain limitations. First, the sample size was relatively small (143 participants with 1,205 LINE® messages/calls) and the study period was short (6 months), both of which may hinder the generalizability of our results. Further expansions of the entire investigation with longitudinal follow-up are necessary to draw a firm conclusion. Second, this study did not cover all relevant information on BMS patients in our institution. For example, patients experiencing gout attacks suddenly after discharge probably take painkillers at midnight or visit physicians in local clinics without first calling the LINE® consultation service even if they realized this service is available round the clock. These possibilities were not taken into account in our study. Also, there may have been some misunderstanding between the BN and patients during communication using LINE® messages/calls since this LINE® consultation service was managed by a BN and not the bariatric surgeon directly. The presence of the BN as an intermediary may have reduced the accuracy of the information and data interpretation. To minimize these errors, LINE® messages/calls were reviewed by two separate professionals. Lastly, this was a retrospective, observational study focusing on the utility of LINE® to provide healthcare services following BMS. A randomized control study will be needed to highlight the clinical significance of our findings.

Conclusion

Our results demonstrated that the LINE® consultation service could efficiently address patients' problems. Such a patient-centered eHealth intervention might reduce the need for unexpected emergency or clinic visits and improve post-BMS follow-up care.

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Declarations

Ethics Approval For this type of study formal consent is not required.

Informed Consent Informed consent was obtained from all individual participants included in the study.

Conflict of Interest The authors declare no competing interests.

Statement of Human and Animal Rights All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

References

1. Chooi YC, Ding C, Magkos F. The epidemiology of obesity. Metabolism. 2019;92:6–10.
2. Welbourn R, Hollyman M, Kinsman R, et al. Bariatric surgery worldwide: baseline demographic description and one-year outcomes from the fourth IFSO global registry report 2018. Obes Surg. 2019;29(3):782–95.
3. Arterburn DE, Telem DA, Kushner RF, et al. Benefits and risks of bariatric surgery in adults: a review. JAMA. 2020;324(9):879–87.
4. Taiwan Bariatric Registry of Taiwan Society for Metabolic and Bariatric Surgery 365 (TSMBS). Available from: https://www.tsmbs.org.tw.
5. Montastier E, Chalret du Rieu M, Tuyeras G, et al. Long-term nutritional follow-up post bariatric surgery. Curr Opin Clin Nutr Metab Care. 2018 Sep;21(5):388–93.

6. Istfan NW, Lipartia M, Anderson WA, et al. Approach to the patient: management of the post-bariatric surgery patient with weight regain. J Clin Endocrinol Metab. 2021;106(1):251–63.
7. Kaur V, Bowen L, Bano G, et al. Multidisciplinary team in bariatric surgery: structure and role. In: Obesity, Bariatric and Metabolic Surgery: A Comprehensive Guide: Springer International Publishing; 2022. p. 1–8. https://doi.org/10.1007/978-3-030-54064-7_15-1.
8. Chao GF, Ehlers AP, Telem DA. Improving obesity treatment through telemedicine: increasing access to bariatric surgery. Surg Obes Relat Dis. 2021;17(1):9–11.
9. Messiah SE, Sacher PM, Yudkin J, et al. Application and effectiveness of eHealth strategies for metabolic and bariatric surgery patients: a systematic review. Digit Health. 2020;7(6):2055207619898987.
10. Wright C, Mutsekwa RN, Hamilton K, et al. Are eHealth interventions for adults who are scheduled for or have undergone bariatric surgery as effective as usual care? A systematic review. Surg Obes Relat Dis. 2021;17(12):2065–80.
11. Coldebella B, Armfield NR, Bambling M, et al. The use of telemedicine for delivering healthcare to bariatric surgery patients: a literature review. J Telemed Telecare. 2018;24(10):651–60.
12. Hootsuite Digital Report 2021. https://www.linkedin.com/pulse/7-facts-taiwan-digital-marketing-social-media-2021-lopez
13. Elvin-Walsh L, Ferguson M, Collins PF. Nutritional monitoring of patients post-bariatric surgery: implications for smartphone applications. J Hum Nutr Diet. 2018;31(1):141–8.
14. Lee HI, Park JS. The effect of pre-operative information through audiovisual media on self-care knowledge, self-efficacy, and state anxiety of patients before bariatric surgery. Korean J Adult Nurs. 2020;32(4):421–31.
15. Chang PC, Liu YW, Chen KH. Acute pouch outlet obstruction due to lactobezoar after Roux-en-Y gastric bypass. Surg Obes Relat Dis. 2020;16(2):352–3.
16. Cano-Valderrama O, Sánchez-Pernaute A, Rubio-Herrera MA, et al. Long-term food tolerance after bariatric surgery: comparison of three different surgical techniques. Obes Surg. 2017;27(11):2868–72.
17. Al Khalifa K, Al AA. Quality of life, food tolerance, and eating disorder behavior after laparoscopic gastric banding and sleeve gastrectomy - results from a middle eastern center of excellence. BMC Obes. 2018;27(5):44.
18. Yue TP, Mohd Yusof BN, Nor Hanipah ZB, et al. Food tolerance, nutritional status and health-related quality of life of patients with morbid obesity after bariatric surgery. Clin Nutr ESPEN. 2022;48:321–8.
19. Argueta PP, Salazar M, Vargo JJ, et al. Thirty-day readmission after bariatric surgery: causes, effects on outcomes, and predictors. Dig Dis Sci. 2022;67(3):834–43.
20. Ivanics T, Nasser H, Leonard-Murali S, et al. Dehydration risk factors and impact after bariatric surgery: an analysis using a national database. Surg Obes Relat Dis. 2019;15(12):2066–74.
21. Belligoli A, Sanna M, Serra R, et al. Incidence and predictors of hypoglycemia 1 year after laparoscopic sleeve gastrectomy. Obes Surg. 2017;27(12):3179–86.
22. Marciano L, Camerini AL, Schulz PJ. The role of health literacy in diabetes knowledge, self-care, and glycemic control: a meta-analysis. J Gen Intern Med. 2019;34(6):1007–17.
23. Mahoney ST, Strassle PD, Farrell TM, et al. Does lower level of education and health literacy affect successful outcomes in bariatric surgery? J Laparoendosc Adv Surg Tech A. 2019;29(8):1011–5.
24. van de Laar AW, Nienhuijs SW, Apers JA, et al. The Dutch bariatric weight loss chart: a multicenter tool to assess weight outcome up to 7 years after sleeve gastrectomy and laparoscopic Roux-en-Y gastric bypass. Surg Obes Relat Dis. 2019;15(2):200–10.
25. Sharples AJ, Mahawar K. Systematic review and meta-analysis of randomised controlled trials comparing long-term outcomes of Roux-en-Y gastric bypass and sleeve gastrectomy. Obes Surg. 2020;30(2):664–72.
26. Gomes-Rocha SR, Costa-Pinho AM, Pais-Neto CC, et al. Roux-en-Y gastric bypass vs sleeve gastrectomy in super obesity: a systematic review and meta-analysis. Obes Surg. 2022;32(1):170–85.
27. Kanerva N, Larsson I, Peltonen M, et al. Changes in total energy intake and macronutrient composition after bariatric surgery predict long-term weight outcome: findings from the Swedish Obese Subjects (SOS) study. Am J Clin Nutr. 2017;106(1):136–45.
28. Chang SH, Freeman NLB, Lee JA, et al. Early major complications after bariatric surgery in the USA, 2003-2014: a systematic review and meta-analysis. Obes Rev. 2018;19(4):529–37.

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