Int Surg 2012;**97:**345–350

Effect of Shorter Term of Intravenous Infusion for Reduction of Catheter-Related Bloodstream Infection After Gastrectomy

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After gastrectomy, a longer period of intravenous alimentation is required than for other digestive surgeries, portending a higher risk of catheter-related bloodstream infection (CRBSI). From assessment of CRBSI occurring between 2004 and 2007 (preintervention group), the duration of intravenous infusion between 2008 and 2010 (postintervention group) was changed to shorter-term (6-day) infusion. To verify the effect of changes in injection schedule on the incidence of CRBSI, the occurrence of CRBSI was studied comparatively among preintervention and postintervention cases, excluding cases requiring intravenous infusion preoperatively, and cases requiring long-term intravenous infusion postoperatively due to postoperative complications. The rate of CRBSI in the postintervention group (0%; 0 of 298) was significantly lower than that in the preintervention group (1.7%; 8 of 477; $P = 0.026$). There was no significant difference between preintervention and postintervention groups in postoperative complications. Six-day infusion decreased the incidence of CRBSI after gastrectomy significantly, without increasing postoperative complications.

Key words: Gastrectomy – CRBSI – Sepsis – Infusion

Gastrointestinal surgery precludes postoperative oral intake, and thus requires intravenous infusion. Especially after gastrectomy, where the return to oral intake takes longer and quantitative intake is also insufficient, a longer period of intravenous alimentation is required than for other digestive surgeries, and gastrectomy portends a higher risk of catheter-related bloodstream infection (CRBSI). CRBSI is a sometimes serious or lethal problem that many surgeons have no doubt found

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difficult to treat. Although anastomotic and pancreatic juice leakage draw greater attention as serious postgastrectomy complications, the lower incidence of CRBSI has precluded much attention thus far. Catheter management guidelines focused on preventing CRBSI have already been created and are now observed in most facilities; nonetheless, CRBSI still occurs.[1–3]

In addition to the observance of such guidelines, we feel that efforts to shorten the term of infusion as much as possible are important for preventing CRBSI. Shorter terms of infusion will naturally lower the incidence of CRBSI; however, there are as yet no reports concerning this association, and it is unclear to what extent a shorter term of infusion decreases CRBSI effectively with no compromise of safety.

We therefore researched the occurrence of CRBSI as a basis to shorten infusion schedules and effect earlier return to oral intake after gastrectomy, in efforts to reduce the incidence of CRBSI. Here, we report favorable results from intervention with this strategy in all gastrectomy patients at our facility from 2008 to 2010.

Materials and Methods

CRBSI status in preintervention group

We investigated the occurrence of CRBSI among 585 patients who underwent gastrectomy for gastric cancer in our department between 2004 and 2007. In this study, the diagnostic criteria for CRBSI were defined as high fever (≥38.5°C) without any other febrile cause at the time, and positive blood culture for bacteria. However, in cases of peripheral venous CRBSI, redness, swelling, or pain at the injection site was treated as CRBSI even when blood was not cultured.

CRBSI occurred in 2.9% (17 of 585) of patients in the preintervention group who underwent gastrectomy for gastric cancer during 2004–2007 (Table 1). These included 2 patients requiring extended fasting and intravenous infusion for tumor bleeding or stenosis from the preoperative period; 7 patients requiring prolonged fasting and intravenous infusion for postoperative complications; and 8 patients for whom designation of a proper postoperative intravenous infusion schedule could have offered the potential to complete treatment without occurrence of CRBSI. The shortest duration of intravenous infusion before occurrence of CRBSI was 7 days. The mortality rate from CRBSI was 5.7% (1 of 17). The schedule for oral intake during this time frame was introduction of a semiliquid diet on postoperative day (POD) 5 and step-up by 2 days to a solid diet on POD 11. There was no regimented injection schedule in our department; however, injections were continued until at least POD 8 in all cases.

Improvement of schedule

We then designed a new postoperative oral intake and infusion schedule based on the number of infusion days to occurrence of CRBSI in CRBSI-positive cases. Because all CRBSIs occurred on day 7 of intravenous infusion or thereafter, the schedule for oral intake and intravenous infusion in the postintervention group was changed to a 6-day infusion (*i.e.*, until POD 5), with introduction of a semiliquid diet on POD 4, and step-up every day to a solid diet on POD 8. Before oral intake or on the morning thereof, patients were checked for any anastomotic failure or pancreatic juice leakage by a Gastrografin (diatrizoate meglumine) meal study and amylase measurement in drainage fluid.

Comparison of CRBSI incidence

To verify the effect of changes in oral intake and injection schedule on the incidence of CRBSI, the occurrence of CRBSI was studied comparatively among preintervention (2004–2007) and postintervention (2008–2010) cases (346 cases), excluding cases requiring intravenous infusion preoperatively because of cancer or stenosis that precluded oral intake, and cases requiring long-term intravenous infusion postoperatively because of postoperative complications.

Comparison of postoperative complications

To assess the risk of an earlier return to oral intake and a shorter schedule of intravenous infusion, rates of postoperative complications other than CRBSI were compared in all preintervention versus postintervention cases.

Catheter placement and management

A central venous catheter was inserted in the right subclavian vein or right internal jugular vein under maximal barrier precautions. Before insertion, the insertion site was scrubbed twice with povidone-iodine solution. The insertion site was covered with a transparent dressing and disinfected weekly, and the dressing was changed completely twice a week.

Table 1 The risk of CRBSI patients before intervention

Patient no.	Age, y/Sex	ASA class	BMI (Kg/m/m)	Preoperative fasting	Operation	Postoperative complication requiring fasting	Blood access	Length of drip before BSI, d	Blood culture	Prognosis
1	76/M	2	18.1	+	DG	...	Central venous	27	*Acinetobacter baumannii,*[a] *Staphylococcus epidermidis*	Cure
2	73/M	2	20.5	+	DG	...	Central venous	14	*S epidermidis*	Cure
3	64/M	1	25.9	––	DG	Anastomosis stenosis	Peripheral	43	*Serratia marcescens*[a]	Cure
4	37/M	1	20.5	–	DG	Anastomosis stenosis	Peripheral	13	*A baumannii*[a]	Cure
5	68/F	1	22.6	–	DG	Chyloperitoneum	Central venous	17	*S epidermidis*	Cure
6	69/M	2	31.6	–	DG	Enteritis	Peripheral	10	*A baumannii*[a]	Cure
7	78/M	2	25.2	–	TG	Ileus	Central venous	15	*S epidermidis*	Cure
8	72/M	1	22.1	–	TG	Ileus	Peripheral	17	*Flavimonas oryzihabitans*[a]	Cure
9	70/M	3	21.1	–	DG	Pancreatic juice leakage	Central venous	26	*S epidermidis*	Cure
10	69/M	2	27.0	–	DG	...	Peripheral	7	*Bacillus* species	Cure
11	64/M	2	27.0	–	DG	...	Peripheral	10	Not executed	Cure
12	75/M	2	28.2	–	DG	...	Peripheral	10	*S marcescens*[a]	Cure
13	65/M	2	27.3	–	DG	...	Peripheral	7	*Klebsiella pneumoniae*[a]	Death
14	73/M	2	24.6	–	TG	...	Peripheral	10	Not executed	Cure
15	60/M	2	30.5	–	TG	...	Peripheral	9	*Bacillus cereus*	Cure
16	86/M	2	15.1	–	DG	...	Central venous	12	*Candida glabrata*	Cure
17	72/M	1	26.1	–	DG	...	Central venous	9	MRSA	Cure

BMI, body mass index; BSI, bloodstream infection; DG, open distal gastrectomy; MRSA, methicillin-resistant *Staphylococcus aureus*; TG, total gastrectomy.

[a]Gram-negative rods.

To maintain the peripheral route, a peripheral venous catheter was inserted in the forearm or the dorsal aspect of the hand in the operating room or on the surgical ward by personnel whose hands had been wiped with an alcohol-based antiseptic solution and who wore sanitary gloves. Before insertion, the insertion site was sterilized by 83% ethanol or 70% isopropyl alcohol. The insertion site was covered with a transparent dressing. The peripheral route was reestablished every 72 hours, and the line was replaced twice weekly.

Indication of central venous catheter

Central venous catheters were inserted into patients requiring preoperative fasting; those in whom tumor bleeding, stenosis, or postoperative complications were projected to require 1 week or longer of intravenous infusion; and those with peripheral vessels too fine for easy catheter insertion.

Statistical analysis

Student t test and Pearson χ^2 test were used for statistical evaluation of differences between the two groups. SPSS 16.0 for Windows (SPSS Inc, Chicago, Illinois) was used for statistical analysis. $P < 0.05$ was considered significant.

Results

Comparison of patient background

Among 585 patients undergoing gastrectomy for gastric cancer during 2004–2007 (preintervention group), 29 required fasting and preoperative intravenous infusion for tumor bleeding or stenosis, and 79 required extension of intravenous infusion because of postoperative complications; 477 patients had no such requirements. Among 346 patients undergoing the same procedure during 2008–2010 (postintervention group), 13 required fasting and preoperative injection for tumor bleeding or stenosis, and 35 required extension of

intravenous infusion because of postoperative complications; 298 patients had no such requirements. Mean age was significantly higher in the postintervention group (66.2 years; n = 477) than the preintervention group (63.6 years; n = 298), but no significant difference was seen in sex and body mass index. The number of American Society of Anesthesiologists (ASA) class 3 or 4 cases was higher in the postintervention group (20.5%) than the preintervention group (10.7%). In the postintervention group, mean surgical time was significantly shorter (213.6 versus 266.0 minutes), and blood loss was also lower (122.1 versus 227.1 mL). There was no significant difference in surgical procedures (Table 2).

Comparison of the rate of CRBSI

The rate of CRBSI in the postintervention group (0%; 0 of 298) was significantly lower than that in the preintervention group (1.7%; 8 of 477; $P = 0.026$). There were 2 cases of CRBSI in the postintervention group; however, one required preoperative injection, and in the other, enteritis required prolonged intravenous infusion.

Comparison of non-CRBSI postoperative complications

There was no significant difference between preintervention and postintervention groups in the non-CRBSI complications of anastomotic leakage, ileus, anastomotic stenosis, pancreatic juice leakage, and intra-abdominal abscess, and in the overall rate of postoperative complications (Table 3). Postoperative hospital stay in the postintervention group (17.0 ± 5.7 days) was significantly shorter than in the preintervention group (23.0 ± 10.8 days; $P = 0.000$).

Relationship of age, ASA, surgical time, and blood loss to CRBSI

Given the significant differences observed between preintervention and postintervention groups in age, ASA classification, surgical time, and blood loss, the effects of these parameters on occurrence of CRBSI were analyzed for all cases undergoing gastrectomy from 2004 to 2010 (Table 4). Mean age was higher in CRBSI-positive cases (69.4 versus 64.9 years), but not significantly ($P = 0.081$). There was no significant difference in CRBSI status with regard to ASA classification, surgical time, or blood loss.

Discussion

The incidence of CRBSI in surgical patients is reportedly 0.49% to 0.9%, with a mortality rate of 15% to 19.6%, and patients undergoing upper gastrointestinal surgery reportedly comprise 31.3% of patients with postoperative CRBSI.[3–6] In our department, the incidence of CRBSI in surgical patients from 2004 to 2010 was 0.6% (40 of 6620), virtually the same as reported, and among these cases, gastrectomy patients were the prevalent group, comprising 47.5% (19 of 40). Although some term of intravenous infusion is necessary after gastrectomy until oral intake is sufficient, unnecessary injection therapy should be avoided to reduce the incidence of CRBSI.[7] The number of days of intravenous infusion before occurrence of CRBSI differs depending on the place of insertion (longer durations for hospital wards than emergency departments) and type of catheter (longer duration for central venous catheters than peripheral venous catheters), but the reported mean is 3.7 to 15.4 days.[4,5] In this study, all catheters were inserted in a hospital ward or operating room, and the mean period from insertion to CRBSI was 15.3 days; however, the shortest duration was 7 days. This finding suggested that no CRBSI at all would have occurred if intravenous infusion had been completed within 6 days. In this study, we therefore designated a target 6-day duration of intravenous infusion. Although no reports to date have addressed a shorter intravenous infusion schedule as an initiative to decrease the incidence of CRBSI, we attribute this fact to a lack of theory. The results in our study reduced the incidence of CRBSI significantly, and in fact no cases of CRBSI were observed in the postintervention group.

In this historical cohort study, it was important to assess factors other than the shortening of intravenous infusion. Patient backgrounds in the two respective groups reflected differences in age, ASA classification, surgical time, and blood loss. Differences in age and ASA classification may have reflected a rapid shift in the age composition of patients due to demographic aging in Japan. Shortening of surgical time and decreased blood loss were likely the result of surgical team experience. The relationship between age and CRBSI was reported in a multinational survey among 4 European countries and showed that the rate of CRBSI was low in young individuals up to age 35 years and elderly individuals older than 85 years; in other words, CRBSI showed an inverted U-shaped de-

Table 2 Background of patients before and after intervention groups

	Before intervention group (n = 477)	After intervention group (n = 298)	*P*
Age, y	63.6 ± 10.8	66.2 ± 12.1	0.002
Sex, No. (%)			
Male	348 (73.0)	207 (69.4)	0.326
Female	129 (27.0)	91 (30.5)	
BMI (Kg/m/m)	22.9 ± 3.2	22.6 ± 3.1	0.192
ASA class, No. (%)			
1 or 2	426 (89.3)	237 (79.5)	0.000
3 or 4	51 (10.7)	61 (20.5)	
Operation time, min	266.0 ± 66.4	213.6 ± 55.7	0.000
Blood loss, mL	227.1 ± 259.1	122.1 ± 164.8	0.000
Operation, No. (%)			
DG	305 (63.9)	183 (61.4)	0.599
TG	166 (34.8)	109 (36.6)	
RG	6 (1.3)	6 (2.0)	

BMI, body mass index; DG, distal gastrectomy; RG, resection of gastric remnant; TG, total gastrectomy.

pendence on age.[6] This pattern, however, does not apply to gastrectomy patients because this population rarely includes juveniles and the very old. Table 4 shows that old age was instead a risk for CRBSI in this study, and that CRBSI decreased in the postintervention group despite the fact that this age group was more susceptible to CRBSI. No report has

Table 3 Comparison of postoperative complications between before and after intervention except CRBSI

	Before intervention group (n = 585)	After intervention group (n = 346)	*P*
Anastomotic leakage, No. (%)			
+	11 (1.9)	4 (1.2)	0.591
−	574 (98.1)	342 (98.8)	
Ileus, No. (%)			
+	12 (2.1)	5 (1.4)	0.617
−	573 (97.9)	341 (98.6)	
Anastomotic stenosis, No. (%)			
+	16 (2.7)	14 (4.0)	0.337
−	569 (97.3)	332 (96.0)	
Pancreatic juice leakage			
+	10 (1.7)	4 (1.2)	0.588
−	575 (98.3)	342 (98.8)	
Intra-abdominal abscess, No. (%)			
+	9 (1.5)	6 (1.7)	0.794
−	576 (98.5)	340 (98.3)	
Total, No. (%)			
+	79 (13.5)	35 (10.1)	0.147
−	506 (86.5)	311 (89.9)	

Table 4 Comparison between patients with and without CRBSI

	$CRBSI^-$ (n = 912)	$CRBSI^+$ (n = 19)	*P*
Age, y	64.9 ± 11.3	69.4 ± 10.1	0.081
ASA class			
1 or 2	773 (84.8)	17 (89.5)	0.754
3 or 4	139 (15.2)	2 (10.5)	
Operation time, min	249.0 ± 70.1	251.1 ± 67.1	0.897
Blood loss, mL	215.0 ± 297.4	276.7 ± 208.4	0.222

investigated CRBSI and ASA classification, surgical time, and blood loss, and their relationships remain unclear, but in our study, no associations were observed. These findings suggest that the reason for the decreased incidence of CRBSI was indeed an effect of the shortened intravenous infusion schedule.

Yet, even if CRBSI decreases, shortening of intravenous infusion and an earlier return to oral intake are meaningless if other complications increase. Shortening of the oral intake schedules risks an increased incidence of anastomotic leakage, ileus, or pancreatic juice leakage; however, the fact that no significant difference was observed between the preintervention and postintervention groups in our study, including differences in non-CRBSI complications, indicates that this level of accelerated oral intake had no adverse effect on postoperative progress.

Given that CRBSI can occur even within a 6-day period of intravenous infusion, we might then ask whether intravenous infusion need be shortened even further.[5] However, the fact that no cases of CRBSI occurred within a 6-day period in our research indicates that such instances represent special cases, such as severe diabetes mellitus. On this basis, we see no present need at our facility for a greater shortening of intravenous infusion to control CRBSI.

The next issue to consider may be the reduction of CRBSI in cases where tumor-induced stenosis or hemorrhage requires transvenous feeding preoperatively, or where postoperative complication requires extended intravenous infusion. In this study, we did not observe improvement in the incidence of CRBSI in such cases when comparing preintervention and postintervention groups. Such cases may require development of new measures for catheter management, for example, use of chlorhexidine-impregnated sponges for disinfection.[8] When infection did occur, culturing indicated that the bacterial species observed were not the normal bacterial skin flora, and moreover, that 36.8% (7 of

19) were highly endotoxic Gram-negative rods, whose sensitivity should be matched to the antibiotics selected.[3,4,7,9]

Conclusion

Completion of intravenous infusion on POD 5 decreased the incidence of CRBSI after gastrectomy significantly, without increasing postoperative complications. We believe that shortening of the intravenous infusion time frame is useful for preventing CRBSI.

References

1. O'Grady NP, Alexander M, Dellinger EP, Gerberding JL, Heard SO, Maki DG *et al*. Guidelines for the prevention of intravascular catheter-related infections: Centers for Disease Control and Prevention. *MMWR Recomm Rep* 2002;**51**(RR-10):1–29
2. Crosby CT, Tsj E, Lambert PA, Adams D. Preoperative skin preparation: a historical perspective. *Br J Hosp Med* 2009;**70**(10): 579–582
3. Popovich KJ, Hota B, Hayes R, Weinstein RA, Hayden MK. Effectiveness of routine patient cleansing with chlorhexidine gluconate for infection prevention in the medical intensive care unit. *Infect Control Hosp Epidemiol* 2009;**30**(10):959–963
4. Velasco E, Soares M, Byington R, Martins CA, Schirmer M, Dias LM *et al*. Prospective evaluation of the epidemiology, microbiology, and outcome of bloodstream infections in adult surgical cancer patients. *Eur J Clin Microbiol Infect Dis* 2004;**23**(8):596–602
5. Pujol M, Hornero A, Saballs M, Argerich MJ, Verdaguer R, Cisnal M *et al*. Clinical epidemiology and outcomes of peripheral venous catheter-related bloodstream infections at a university-affiliated hospital. *J Hosp Infect* 2007;**67**(1):22–29
6. Humphreys H, Newcombe RG, Enstone J, Smyth ET, McIlvenny G, Fitzpatrick F *et al*. Four country healthcare associated infection prevalence survey 2006: risk factor analysis. *J Hosp Infect* 2008;**69**(3):249–257
7. Zingg W, Pittet D. Peripheral venous catheter: an underevaluated problem. *Int J Antimicrob Agents* 2009;**34**(suppl 4): S38–S42
8. Timsit JF, Schwebel C, Bouadma L, Geffroy A, Garrouste-Orgeas M, Pease S *et al*. Chlorhexidine-impregnated sponges and less frequent dressing changes for prevention of catheter-related infections in critically ill adults: a randomized controlled trial. *JAMA* 2009;**301**(12):1231–1241
9. Weakley S, Hopkins WE, Mays ET. Epidemic gram-negative septicemia in surgical patients. *Am J Surg* 1972;**124**(3):363–367