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Bicitra® (Sodium Citrate) and Metoclopramide in Outpatient Anesthesia for Prophylaxis against Aspiration Pneumonitis

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To evaluate the effect of Bicitra® (Willen Drug Company, Baltimore, Maryland), a commercial preparation of sodium citrate and metoclopramide, on gastric contents 150 elective outpatients allocated into six groups with 25 patients in each group were studied. Patients in Group 1 served as controls. Patients in Groups 2, 3, 5, and 6 received Bicitra®, po, either 15 ml (Groups 2 and 5) or 30 ml (Groups 3 and 6). In addition, patients in Groups 5 and 6 also received metoclopramide 10 mg, iv; Group 4 patients received metoclopramide 10 mg, iv. Eighty-eight per cent of patients in the control group had a gastric *p*H ≤ 2.5, while 36% had a gastric content volume ≥ 25 ml with *p*H ≤ 2.5. Bicitra®, 15 ml and 30 ml, po, increased mean gastric *p*H and decreased the proportion of patients with a gastric *p*H ≤ 2.5 to 32 and 16%, respectively, in Groups 2 and 3. However, Bicitra® 15 ml and 30 ml, increased the mean gastric volume in Group 3 and also increased the proportion of patients with a gastric volume ≥ 25 ml to 56% in Group 2 and 84% in Group 3. The addition of metoclopramide 10 mg, iv, to Bicitra® reduced the proportion of patients with a gastric volume ≥ 25 ml in Groups 5 and 6 to 28 and 36%, respectively. Metoclopramide (Group 6) independently reduced mean gastric volume (15.6 ml *vs.* 32.7 ml) and the proportion of patients with a gastric volume ≥ 25 ml (20% *vs.* 36%). Bicitra® and metoclopramide combination significantly reduced the proportion of patients with gastric contents ≥ 25 ml with *p*H ≤ 2.5. (Key words: Anesthesia: outpatient. Complications: aspiration, pneumonitis. Gastrointestinal tract: aspiration, antacids. Pharmacology: Bicitra®, sodium citrate; metoclopramide.)

ASPIRATION PNEUMONITIS is an important entity in the clinical practice of anesthesia. According to most investigators, a gastric *p*H below 2.5 and a volume of 25 ml or greater are considered critical factors for the development of pulmonary damage in adults.[1–3] Reports investigating the potential risk of acid aspiration pneumonitis in adult outpatients demonstrated the presence of a gastric *p*H below 2.5 in 76–85% of patients, while volumes of gastric contents greater than 20–25 ml were seen in 52–85% of patients.[4–6]

Investigation in adult outpatients demonstrated that cimetidine and ranitidine increase the *p*H or decrease the volume of gastric contents in 80–90%, while glycopyrrolate failed to modify the risk of aspiration.[4–6] In addition to a small but unpredictable failure rate, these drugs need to be administered at least 30–60 min before induction of anesthesia, depending on the route of administration. Furthermore, intravenous administration of cimetidine may be associated with significant untoward side effects. Prophylactic administration of antacids has not been studied in adult outpatients. Although possibly effective, antacids may predispose patients for regurgitation because they increase gastric content volume.[7] It is presumed that the addition of metoclopramide, a potent gastrokinetic agent with antiemetic action, to antacid prophylaxis might provide reliable protection in most patients.[8,9]

As particulate antacids have been shown to cause pneumonitis,[10,11] recent attention was focused on the nonparticulate antacid sodium citrate. Several investigators[12–23] examined the efficacy of sodium citrate for increasing gastric *p*H and reported variable success. However, in most of these studies sodium citrate was prepared in the pharmacy. Bicitra® (Willen Drug Company, Baltimore, Maryland) is a commercial preparation in a clear liquid form containing sodium citrate and citric acid in a sugar-free base. Bicitra® was shown to cause minimal pulmonary damage in rabbits.[11] We are not aware of clinical studies evaluating the efficacy of Bicitra® for acid aspiration prophylaxis in outpatients.

Outpatient surgery now constitutes one-third to one-half of all surgical procedures.[24,25] Many outpatients receive anesthesia by face mask, and the time available for preparation of these patients may be too short for oral cimetidine and ranitidine to be effective because healthy patients undergoing elective surgery may not be seen by an anesthesiologist until the day of surgery at some institutions. Therefore, we have undertaken this prospective investigation to evaluate the effect of Bicitra® 15 ml and 30 ml with or without intravenous metoclopramide, 10 mg, in outpatients receiving general anesthesia for elective surgery.

Materials and Methods

One hundred fifty outpatients scheduled for elective surgery without history or symptoms of gastrointestinal disease were studied. The protocol was approved by our Institutional Review Committee, and informed consent was obtained from all patients. Obese patients (body weight 20% above ideal weight) were not included in this

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TABLE 1. Patient Characteristics

Groups	Number of Patients	Sex (M/F)	Age (yr) (mean ± SEM)	Height (cm) (mean ± SEM)	Weight (kg) (mean ± SEM)
Group 1 Control	25	15/10	32.8 ± 2.4	174 ± 2.3	72.9 ± 3.9
Group 2 Bicitra® 15 ml, po	25	18/7	31.1 ± 2.9	172 ± 2.1	72.2 ± 3.0
Group 3 Bicitra® 30 ml, po	25	13/12	36.2 ± 3.0	174 ± 2.7	72.7 ± 3.0
Group 4 Metoclopramide 10 mg, iv	25	12/13	32.8 ± 2.3	173 ± 1.9	69.7 ± 2.9
Group 5 Bicitra® 15 ml, po + metoclopramide 10 mg, iv	25	16/9	31.7 ± 2.5	175 ± 2.2	76.1 ± 3.5
Group 6 Bicitra® 30 ml, po + metoclopramide 10 mg, iv	25	16/9	32.6 ± 2.5	176 ± 1.9	71.2 ± 2.9

study. All patients fasted for a minimum of 8 h before induction of anesthesia. They were randomly allocated into six groups with 25 patients in each group. Patients in Group 1 served as controls. Patients in Groups 2, 3, 5, and 6 received Bicitra®, po, either 15 ml (Groups 2 and 5) or 30 ml (Groups 3 and 6). In addition, patients in Groups 5 and 6 also received metoclopramide 10 mg, iv. Patients in Group 4 received metoclopramide 10 mg, iv and did not receive Bicitra®. All the patients were premedicated with diazepam 5 mg, iv. Bicitra®, metoclopramide, and diazepam were all administered 30–90 min before induction of anesthesia.

After satisfactory induction of anesthesia and stabilization of the patient's condition, a #18 Salem sump tube was passed into the stomach, and all available gastric contents were aspirated by suction into a graduated mucus trap. The position of the gastric tube was confirmed by auscultation over the epigastrium during insufflation of a small amount of air through the gastric tube; *p*H was determined by a Corning® *p*H meter with an Ag/AgCl combination electrode. A standardized anesthetic technique was employed with the use of thiopental, succinylcholine, and isoflurane. The persons evacuating stomach contents and technicians measuring the *p*H were not aware of premedication.

Patients with a gastric $pH \leq 2.5$ or a volume ≥ 25 ml were defined to be at risk of pulmonary damage in the event of aspiration. Risk factors were analyzed in combination and independently. In addition to grouping *p*H values, each individual *p*H reading was converted to absolute values of H^+ concentration, and mean H^+ concentration was calculated.

Statistical analyses were performed by analyses of variance (ANOVAs) and chi-square tests. One-way analyses of variance with Duncan's multiple range follow-up tests were used to test the significance of differences among the means of six groups. Two-way (3 × 2) ANOVAs were used to test the effects of Bicitra® dosage and addition of metoclopramide. Overall, 6 × 2 chi-square tests of independence with 2 × 2 chi-square follow-up tests were used to test the significance of differences between the proportions at risk in the six groups. Results were considered statistically significant if *P* values were less than 0.05.

Results

Statistical information concerning patient characteristics, fasting periods, and drug administration for the six groups is presented in tables 1 and 2. Sex distribution, age, height, weight, fasting period, drug dosages, and time from administration of Bicitra® and/or metoclopramide to gastric sampling were comparable in all the groups.

GASTRIC *p*H

There were significant differences with respect to mean gastric *p*H among the six groups, $P = 0.0001$ (table 3). Four groups receiving Bicitra® (Groups 2, 3, 5, and 6) had significantly higher gastric *p*H than the control (Group 1), and the metoclopramide group (Group 4), $P < 0.05$. There were no significant differences among the four Bicitra® groups.

The six groups also differed in terms of the proportion of patients with $pH \leq 2.5$, $P = 0.0001$. The four Bicitra® groups (Groups 2, 3, 5, and 6) had significantly fewer patients with $pH \leq 2.5$ than the two non-Bicitra® groups (Groups 1 and 4), $P < 0.05$. There were no significant differences either among the four Bicitra® groups or the two non-Bicitra® groups.

The six groups also differed significantly with respect to hydrogen ion concentration (H^+), $P = 0.0001$. It was also shown that the four Bicitra® groups (Groups 2, 3, 5, and 6) had significantly lower H^+ than the other two groups (Groups 1 and 4), $P < 0.05$.

GASTRIC VOLUME

The six groups differed significantly with respect to mean gastric volume $P = 0.0001$ (table 4). Gastric volume was significantly greater in the group receiving 30 ml Bicitra® and no metoclopramide (Group 3) than in the other five groups, $P < 0.05$. The latter five groups did not differ significantly (Groups 1, 2, 4, 5, 6).

TABLE 2. Mean Values for Fasting Periods, Drug Dosages, and Time Intervals from Drug Administration to Gastric Sampling

Groups	Duration of Fasting (min) (mean ± SEM)	Bicitra Dosage (ml/kg) (mean ± SEM)	Time Interval From Bicitra® Administration to Sampling (min) (mean ± SEM)	Metoclopramide Dosage (mg/kg) (mean ± SEM)	Time Interval From Metoclopramide Administration to Sampling (min) (mean ± SEM)
Group 1 Control	662 ± 31	—	—	—	—
Group 2 Bicitra® 15 ml, po	708 ± 27	0.22 ± 0.01	45.4 ± 3.5	—	—
Group 3 Bicitra® 30 ml, po	725 ± 32	0.43 ± 0.02	45.6 ± 3.5	—	—
Group 4 Metoclopramide 10 mg, iv	728 ± 32	—	—	0.15 ± 0.01	60.4 ± 3.3
Group 5 Bicitra® 15 ml po + metoclopramide 10 mg, iv	709 ± 28	0.21 ± 0.01	50.0 ± 3.5	0.14 ± 0.01	50.0 ± 3.5
Group 6 Bicitra® 30 ml, po + metoclopramide 10 mg, iv	703 ± 34	0.44 ± 0.02	50.4 ± 3.6	0.15 ± 0.01	50.4 ± 3.6

There were significant differences among the six groups with respect to the proportion of patients with a volume ⩾ 25 ml, $P = 0.0001$. Group 3 had a significantly greater proportion of patients at risk than the other groups, with the exception of Group 2, $P < 0.05$. In addition, significantly more patients were at risk in Group 2 than in Group 4, $P < 0.05$. Group 3 also had significantly more patients with a volume ⩾ 50 ml than the other five groups, $P < 0.05$.

To evaluate the overall effect of Bicitra® and metoclopramide on gastric volume, pooled means of gastric volume were calculated for several different combinations of the six groups (table 5). Statistical analyses showed that the three groups receiving metoclopramide had a significantly lower pooled mean than the three groups not receiving metoclopramide, $P = 0.0001$. The pooled means of the groups receiving different dosages of Bicitra® also differed significantly, $P = 0.0077$. In addition, the Bicitra® groups with no metoclopramide had a significantly higher pooled mean than the two groups with no Bicitra® and the two receiving Bicitra® and metoclopramide, $P < 0.05$.

COMBINED RISK OF *p*H AND VOLUME

There were significant differences among the six groups with respect to the proportion of patients with a combination of *p*H ⩽ 2.5 and volume ⩾ 25 ml, $P = 0.0276$ (table 4). The control group (Group 1) had a significantly greater number of patients at risk than Groups 5 and 6, $P < 0.05$. There were no significant differences among the five treatment groups.

OPTIMAL TIME INTERVAL

Polynomial regressions showed that the linear, quadratic, and cubic relationships of time from administration of Bicitra® and metoclopramide to gastric sampling on

TABLE 3. Gastric *p*H Characteristics

	*p*H		H^+ Concentration* (mean ± SEM)	Patients with *p*H ≤ 2.5
	Mean ± SEM	Range		
Group 1 Control	2.12 ± 0.23	1.27–6.85	0.018 ± 0.002	22 (88%)
Group 2 Bicitra® 15 ml, po	3.20 ± 0.21	1.56–4.74	0.005 ± 0.002	8 (32%)
Group 3 Bicitra® 30 ml, po	3.72 ± 0.17	1.75–4.64	0.002 ± 0.001	4 (16%)
Group 4 Metoclopramide 10 mg, iv	2.41 ± 0.25	1.42–6.16	0.013 ± 0.002	18 (72%)
Group 5 Bicitra®, 15 ml, po + metoclopramide, 10 mg, iv	3.40 ± 0.29	1.56–7.89	0.006 ± 0.002	9 (36%)
Group 6 Bicitra® 30 ml, po + metoclopramide 10 mg, iv	3.71 ± 0.30	1.48–7.68	0.004 ± 0.002	7 (28%)
Direction and significance of values	1 = 4 < 2 = 3 = 5 = 6		1 = 4 > 2 = 3 = 5 = 6	1 = 4 > 2 = 3 = 5 = 6

* H^+ concentration: g Eq/l.

TABLE 4. Characteristics of Gastric Volume

	Volume in ml		Patients with Volume ≥ 25 ml	Patients with Volume ≥ 50 ml	Patients with pH ≤ 2.5 and Volume ≥ 25 ml
	Mean ± SEM	Range			
Group 1 Control	32.7 ± 7.6	5–180	9 (36%)	5 (20%)	9 (36%)
Group 2 Bicitra® 15 ml, po	32.4 ± 5.5	5–100	14 (56%)	4 (16%)	3 (12%)
Group 3 Bicitra® 30 ml, po	58.4 ± 8.9	2–210	21 (84%)	14 (56%)	3 (12%)
Group 4 Metoclopramide 10 mg, iv	15.6 ± 2.6	1–50	5 (20%)	2 (8%)	5 (20%)
Group 5 Bicitra® 15 ml, po + metoclopramide, 10 mg iv	21.8 ± 4.1	3–80	7 (28%)	4 (16%)	1 (4%)
Group 4 Bicitra® 30 ml, po + metoclopramide 10 mg, iv	26.0 ± 5.5	3–100	9 (36%)	5 (20%)	2 (8%)
Direction and significance of values	3 > 1–6		1 = 2 2 > 4 3 > 1 = 4–6 3 = 2	3 > 1–6	1 = 2–4 1 > 5 = 6 2 = 3–6

gastric *p*H were not statistically significant. However, polynomial regressions of time from administration of Bicitra® and metoclopramide to gastric sampling on gastric volume showed significant indirect linear effects, $P < 0.05$. That is, the results showed that, as time from administration of Bicitra® to gastric sampling increased, gastric volume decreased, and that as time from administration of metoclopramide to sampling increased, gastric volume decreased.

A few people in the Bicitra® groups (in Group 2, 3; in Group 3, 3; in Group 5, 4; and in Group 6, 7) had the gastric sampling more than 60 min after the administration of Bicitra®. Because Dewan *et al.*[22] have recently indicated that sodium citrate effectiveness is decreased after 60 min, the analyses were repeated with those patients for whom gastric sampling was more than 60 min after Bicitra® administration dropped from the analyses. The results for mean *p*H and mean H^+ were virtually identical to those reported in table 3.

COMPARISON OF BICITRA® WITH CIMETIDINE AND RANITIDINE

Data from our previous studies[5,6] with similar methods evaluating the effects of cimetidine and ranitidine in outpatient surgery were compared with the four Bicitra® groups (with or without metoclopramide) in this study (table 6). While age, height, weight, and fasting periods were similar in all three studies, significant differences were found with respect to gastric *p*H, $P = 0.0001$; gastric volume, $P = 0.0001$; and time from drug administration to gastric sampling, $P = 0.0001$. Mean gastric *p*H was significantly greater for the ranitidine and cimetidine groups than for the four groups in the present study, $P < 0.05$, and was significantly greater for the ranitidine group than for the cimetidine group, $P < 0.05$. The other four groups did not differ significantly. Mean gastric volume was less for the ranitidine and cimetidine groups than for the other four groups, but only the difference between the ranitidine and cimetidine groups and the two sodium citrate with no metoclopramide groups was statistically significant, $P < 0.05$. Mean time from drug administration to gastric sampling was significantly greater for the ranitidine and cimetidine groups than for the four groups in the present study, $P < 0.05$.

With respect to patients with gastric volume ≥ 25 ml, there was a significantly greater proportion of patients in the groups treated with Bicitra® and no metoclopramide than the groups treated with cimetidine and ranitidine, $P < 0.05$. However, there was no significant difference among the groups receiving Bicitra® with or without metoclopramide, cimetidine, and ranitidine in regards to the proportion of patients with gastric *p*H ≤ 2.5 with volume ≥ 25 ml.

TABLE 5. Pooled Mean Gastric Volumes for Combinations of Six Groups

Pooled Groups	Volume (ml) (mean ± SEM)	Statistical Significance
1. 1, 2, and 3 No metoclopramide	41.2 ± 4.5	
2. 4, 5, and 6 Metoclopramide	21.2 ± 2.5	1 > 2
3. 2 and 3 Bicitra®	45.4 ± 5.5	
4. 5 and 6 Bicitra® and metoclopramide	23.9 ± 3.4	3 > 4
5. 1 and 4 No Bicitra®	24.2 ± 4.2	
6. 2 and 5 Bicitra® 15 ml	27.1 ± 3.5	5 = 6 < 7
7. 3 and 6 Bicitra® 30 ml	42.2 ± 5.7	

TABLE 6. Comparison of Effects of Bicitra® with Cimetidine and Ranitidine

	Gastric *p*H					
	Mean ± SEM	Time Interval from Drug Administration to Sampling (min)	Patient With Gastric *p*H ≤ 2.5	Gastric Volume (ml) Mean ± SEM	Patients with Gastric Volume ≥ 25 ml	Patients with *p*H ≤ 2.5 and Volume ≥ 25 ml
1. Bicitra® 15 ml, po, N = 25	3.20 ± 0.21	45.4 ± 3.5	8 (32%)	32.4 ± 5.5	14 (56%)	3 (12%)
2. Bicitra® 30 ml, po, N = 25	3.72 ± 0.17	45.6 ± 3.5	4 (16%)	58.4 ± 8.9	21 (84%)	3 (12%)
3. Cimetidine* 300 mg, po, N = 25	5.04 ± 0.44	146.2 ± 9.9	4 (16%)	13.0 ± 2.4	3 (12%)	1 (4%)
4. Ranitidine† 150 mg, po, N = 20	6.40 ± 0.44	153.9 ± 13.4	2 (10%)	9.6 ± 2.0	2 (10%)	1 (5%)
5. Bicitra® 15 ml, po + metoclopramide 10 mg, iv, N = 25	3.40 ± 0.29	50.0 ± 3.5	9 (36%)	21.8 ± 4.1	7 (28%)	1 (4%)
6. Bicitra® 30 ml, po + metoclopramide 10 mg, iv, N = 25	3.71 ± 0.30	50.4 ± 3.6	7 (28%)	26.0 ± 5.5	9 (36%)	2 (8%)
Direction and signficance of values	1 > 3 4 > 1 = 2 = 5 = 6 3 > 1 = 2 = 5 = 6	3 = 4 > 1 = 2 = 5 = 6	No significant difference	2 > 1 = 5 = 6 2 > 3 = 4 = 5 = 6 1 > 3 = 4	1 > 3 = 4 2 > 3 = 4 = 5 = 6 1 = 2 1 = 5 = 6	No significant difference

* Data from Manchikanti and Roush.[5]

† Data from Manchikanti *et al.*[6]

Discussion

Pulmonary aspiration has been considered a potential risk if patients have 25 ml or more of gastric contents at a *p*H below 2.5.[1-3] While it is generally agreed that a highly acidic *p*H, namely 1.0–1.5, in small volume is capable of producing severe pulmonary injury and death in animals, the critical life-threatening *p*H and volume in humans is not agreed upon. Most investigators believe that a liquid with a *p*H of 2.5 or above does not produce significant pulmonary damage in the event of aspiration. Recent data from aspirates with various combinations of *p*H and volume in rats demonstrated that the volume of 0.4 ml/kg, considered as potential risk, may well be beyond the critical value if associated with a *p*H of <1.4.[26] Conversely, aspirates with higher *p*H of ≥1.8 were associated with far fewer deaths even at volumes of 1–2 ml/kg.[26]

Antacid prophylaxis is a well-established practice in obstetric anesthesia. However, its beneficial effects have not been proven. As particulate antacids have been shown to cause pneumonitis,[10,11] nonparticulate antacid preparations sodium citrate and Bicitra® have been suggested to replace particulate antacids as these preparations have been shown to raise gastric *p*H significantly and to be essentially harmless when aspirated.[11-23]

Similar to previous reports, our data from this study again demonstrate the existence of the potential risk of acid aspiration in untreated outpatients undergoing elective surgery as 88% of them presented with gastric *p*H ≤ 2.5 and 36% of them had a combination of *p*H ≤ 2.5 and volume ≥ 25 ml. Bicitra®, independently and in combination with metoclopramide, significantly reduced the risk factors. Bicitra®, 15 ml and 30 ml, po, increased mean gastric *p*H and decreased the proportion of patients with gastric *p*H ≤ 2.5 to 32% and 16%, respectively, in contrast to 88% in the control group. However, Bicitra® 15 ml and 30 ml increased the proportion of patients with gastric volume ≥ 25 ml to 56 and 84%, respectively, in contrast to 36% in the control group. The addition of metoclopramide 10 mg, iv, to both groups had no beneficial effect in terms of alteration of gastric *p*H, but reduced the proportion of patients with gastric volume ≥ 25 ml and *p*H ≤ 2.5 significantly in Groups 5 and 6 (table 4). Metoclopramide independently (Group 4) reduced mean gastric volume (15.6 ml *vs.* 32.7 ml) and the proportion of patients with gastric volume ≥ 25 ml (20% *vs.* 36%) with no effect on gastric acidity.

We may be criticized in this study, as we did not attempt to rotate the patients for adequate mixing of the antacid with gastric contents. However, antacid was administered in the outpatient surgery department before the patients entered the operating room and the patients moved from their hospital bed to the stretcher and from the stretcher to the operating table. Hence, it seems reasonable to presume that the movement would provide adequate mixing of antacids with gastric contents. Another criticism may be directed toward the fact that the gastric volumes in this study do not represent total volume of gastric contents, because emptying of the stomach with a nasogastric tube has been shown not to ensure absolute emptying of gastric contents.[4] Hence, it is likely that larger volumes were present. Nevertheless, gastric volumes in all six

groups indicate the risk trend and most likely underestimate the volume as well as the risk.

Bicitra® is a commercial preparation in a clear liquid form containing nonparticulate antacid sodium citrate and citric acid in a sugar-free base with a *p*H of 4.3, in contrast to sodium citrate prepared in the laboratory, which results in a solution with *p*H > 7.0. Sodium citrate is a safe drug. However, administration of large volumes of sodium citrate may cause gastrointestinal side effects such as nausea, vomiting, and diarrhea. Metoclopramide, a dopamine antagonist, characteristically increases resting gastric tone and phasic contractile activity of gastrointestinal smooth muscle and also has antiemetic properties.[8,28] Its capacity to increase gastric motility and lower esophageal sphincter tone and its central antiemetic properties are considered to be useful in the perioperative period.[8,28]

Our data indicate that Bicitra® 15 ml or 30 ml with or without metoclopramide administered 30–90 min before induction of anesthesia increased gastric *p*H > 2.5 in 64–84% of patients. An increase in gastric volume was present in all the groups receiving Bicitra®, with modification achieved in terms of a reduction in volume with intravenous metoclopramide. These results are in agreement with some previous investigations, while they are in contrast with others using sodium citrate.[12–23] Most investigators reported a reliable increase in gastric *p*H ⩾ 2.5 in most patients following sodium citrate.[12–23] In some investigations, the increase in gastric *p*H may be attributed partly to the preoperative administration of anticholinergics with sodium citrate, as anticholinergics alone may increase gastric *p*H or potentiate the antacid effect.[27] Variability in results also may be attributed partly to variability in the constituents and *p*H of commercial preparation compared with solutions prepared in the laboratory. The combined administration of metoclopramide (20 mg im) and sodium citrate (50 ml) was evaluated in elective surgical patients and was found to have no effect on gastric volume in healthy women premedicated with either meperidine or diazepam.[21] In this study, metoclopramide reduced the volume of gastric contents by one-half in terms of mean volume as well as the proportion of patients with gastric contents ⩾ 25 ml when administered with Bicitra®. However, the neutralization effect of Bicitra® was not seen in a number of patients who had low gastric content volumes (<25 ml). This finding is consistent with results reported by Schmidt and Jorgensen.[21] The neutralizing effect of the antacid is presumably countered by the rapid exit of the antacid with hastened gastric emptying.

Comparison of the results in this study with our previous studies demonstrates that cimetidine and ranitidine were superior to Bicitra® alone or in combination with metoclopramide. Even though Bicitra 30 ml provided protection similar to that provided by cimetidine and ranitidine with respect to the proportion of patients with a gastric *p*H ⩽ 2.5, it significantly increased both mean gastric content volume and the proportion of patients with volume ⩾ 25 ml and 50 ml. The addition of metoclopramide altered gastric volume significantly but failed to reduce it to the same level as cimetidine and ranitidine.

In conclusion, a high proportion of prepared patients undergoing elective surgery have high volumes of acidic gastric contents. Eighty-eight per cent of patients had gastric *p*H ⩽ 2.5 and 56% of patients had *p*H ⩽ 1.8, while 35% of patients had *p*H ⩽ 1.5. Bicitra® increased gastric *p*H to safe levels in 68–84% of patients with or without metoclopramide. However, it also increased gastric content volume in most patients. Thirty milliliters of Bicitra® effectively raised gastric *p*H > 2.5 in 84% of the patients, while 15 ml was effective in only 68% of the patients. Hence, in our opinion, Bicitra® is not a satisfactory prophylactic agent against acid aspiration syndrome, except in situations where adequate time is not available for other drugs to be administered. Cimetidine and ranitidine administered the night before surgery followed by a second dose on the day of surgery or as a single dose administered 1–4 h before induction of anesthesia with or without metoclopramide will provide better protection, and potential untoward effects are minimal with one or two doses of cimetidine and ranitidine.[5,6,8,9,28]

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