Gastric Hypothermia: *

A Critical Evaluation of Its Use in Massive Upper Gastrointestinal Bleeding

J. Beall Rodgers,** M.D., Thomas M. Older,*** M.D.,
E. Vernon Stabler,† M.D.

From the Department of Surgery, The Roosevelt Hospital, New York City, New York

Use of gastric hypothermia was first reported in 1954 by Khalil and MacKeith.[4] While doing experiments on general hypothermia, they found that cooling and rewarming by use of an intragastric balloon was quicker and safer than application of blankets. They reported successful use of an intragastric cooling balloon in the treatment of a hyperpyrexic child. Bernard [1] in 1956 and Holt, Benvenuto and Lewis [3] in 1958 confirmed the usefulness of this method in producing general body hypothermia. These workers also reported that intragastric cooling could be employed for long periods at low temperatures (3° C.) without damage to gastric mucosa.

In 1958 Wagensteen [6] and associates introduced local gastric hypothemia for control of massive upper gastrointestinal hemorrhage. They reported [8] that marked reductions in gastric blood flow, acid secretion and digestive activity occur when the stomach temperature is lowered to between 10° and 14°C. Further work [2, 5, 9] showed this form of therapy to be useful in control of selected cases of upper gastrointestinal hemorrhage.

Massive hematemesis and shock continue to be difficult problems. At times etiology is not certain and the site of bleeding is unknown. Furthermore acute hemorrhage may be complicated in a poor-risk patient with low blood volume and underlying medical diseases. Emergency operation for upper gastrointestinal bleeding involves high mortality. At The Roosevelt Hospital this rate is 22.4 per cent. To defer emergency operation during this initial critical stage, gastric hypothermia has been employed. In a limited number of patients vital signs have stabilized and the general condition of the patient improved considerably before operative intervention.

Gastric hypothermia was used in a restricted group of patients since January 1961 and it may have been helpful in controlling massive hemorrhage in some instances. Some difficulties and complication encountered with this method have been reported by others.[5, 7, 9] Our experience leads us to believe that re-evaluation of complications associated with the method would prove beneficial.

Technic

Nonoperative methods to control hemorrhage are instituted at first. Concurrently, the general condition of the patient is evaluated and a tentative diagnosis is made. Supportive measures include replacement of blood volume deficit and current loss, gastric aspiration and gastric lavage. Vital signs and continued blood loss are accurately monitored.

When the decision to use gastric hypothermia is made the stomach is evacuated

* Submitted for publication March 3, 1965.

** Associate Attending in Surgery, The Roosevelt Hospital and Assistant Clinical Professor of Surgery, College of Physicians and Surgeons, Columbia University.

*** Senior Resident in Surgery, The Roosevelt Hospital.

† Senior Resident in Surgery, The Roosevelt Hospital.

TABLE 1. *Results of Gastric Hypothermia According to Source of Hemorrhage in 33 Patients*

		Bleeding Uncontrolled*		Bleeding Ceased			
	Cases	No.	Deaths	No.	Recurrence	Deaths	Deaths
Varices	9	3	3	6	1	4	7
Duodenal ulcer	10	3	2	7	2	1	3
Gastric lesions	10	5	2	5	1	3	5
Hemorrhage after gastric operation	4	1	0	3	1	2	2
Totals	33	12	7	21	5	9	17**

* Survivors in this group underwent emergency operation.
** Overall mortality 52%.

of blood and clots by induced vomiting and rapid irrigation with large quantities of saline through a nasogastric tube. The hypothermia machine * is essentially a refrigeration unit and pump that circulates 40 per cent ethyl alcohol at a controlled temperature and volume through a double lumen 18F. plastic tube attached to a latex balloon. Prior to insertion the balloon is is inflated to determine the desired volume, to check for leaks, and to shape it with the hands so that it will conform to the configuration of the stomach or esophagus in which it is to rest. The balloon is then deflated, passed through the nose into the stomach and reinflated with alcohol to a volume between 600 and 1,000 cc. When used for esophageal bleeding, tension is placed on the tubing to pull the balloon into the esophagus. Tension is maintained by taping a piece of foam rubber around the tube at the patient's nose. An 18 to 20F. nasogastric tube is left in the other nostril to gauge the amount of bleeding from the stomach and to keep the stomach free of clots by irrigations. Inflow temperature is maintained between 4° and 10° C. Heating blankets envelop the patient to prevent general body hypothermia. Body temperature is checked every half hour by an indwelling rectal thermocouple. Vital signs, hemoglobin and hematocrit are monitored closely. The danger of tracheal aspiration is lessened by elevating the head of the bed.

When periodic gastric irrigations indicate that bleeding has ceased, the degree of hypothermia is reduced to 10° C. and 100 cc. of alcohol are removed from the balloon every hour. At this point milk is dripped through the nasogastric tube to counteract rebound secretion of acid as the stomach is warmed. If bleeding does not recur the balloon is deflated and removed. When gastric hypothermia is being used as a means of temporizing prior to operation, the balloon is removed when the patient is taken to the operating room.

Results

During the 3-year period, 1961–1963, 368 patients were admitted to The Roosevelt Hospital with active upper gastrointestinal bleeding, and 192 were classified as massive bleeders. Thirty-three were treated with gastric hypothermia; all but six were considered poor surgical risks. In addition to hemorrhage, these patients had such diseases as hepatic failure, blood dyscrasia, congestive heart failure, nephrotic syndrome and pulmonary decompensation. Patients treated with gastric hypothermia were divided into four groups according to the source of hemorrhage (Tables 1, 2).

Esophageal Varices. Nine patients with esophageal varices were treated. Hemorrhage ceased in six and was uncontrolled in three. Hematocrits on admission ranged

* OEM Gastric Hypothermia Machine with air monitor: OEM Corp., Shampagne Industries.

from 18 to 35 per cent with a mean of 27 per cent and the patients received an average of 14 units of blood. Seven of nine patients were in hepatic failure prior to initiation of treatment.

Despite significant control of bleeding, seven patients died. Hepatic failure was the primary cause of death in three patients, and complications resulting from the procedure were thought to contribute significantly to the death of the four remaining patients.

Duodenal Ulcers. In ten patients the source of hemorrhage was duodenal ulcer. These patients received an average of seven units of blood each before cooling, and ultimately 13 units of blood each.

Bleeding ceased in seven patients and was uncontrolled in three. Two patients in whom bleeding ceased had recurrence of hemorrhage. These two, plus three in whom bleeding was uncontrolled, underwent emergency operation. Two of the latter three patients died. An additional patient undergoing elective operation after successful control of his hemorrhage died from postoperative pulmonary embolus.

Gastric Lesions. Ten patients had massive bleeding from gastric lesions. Bleeding stopped in five and was uncontrolled in five, and in one bleeding recurred. All patients were in clinical shock and had an average hemoglobin of 7 Gm./100 ml. and hematocrit of 26 per cent. Each patient received an average of seven units of blood before gastric cooling and an average of 20 units of blood during hospitalization.

The site of hemorrhage in five patients was benign *gastric ulcer.* Bleeding stopped in two and was uncontrolled in three. There was one recurrence of bleeding. This recurrent bleeder, and the three patients in whom the bleeding was uncontrolled, had emergency operation. There were two deaths in this group.

Two other patients, one with *stress ulcer* and one with *steroid ulcer,* were successfully treated with gastric hypothermia. However, one later died of renal failure and septicemia.

TABLE 2. *Cause of Death in 17 of 33 Patients with Hemorrhage Treated by Gastric Hypothermia*

Cause of Bleeding	Cause of Death	No.
Varices	Hepatic failure	3
	Ventricular fibrillation*	1
	Mechanical defects of gastric hypothermia**	3
Duodenal ulcer	Hemorrhage	2
	Pulmonary embolus	1
Gastric lesions	Hemorrhage	3
	Septicemia and renal failure*	1
	Renal failure*	1
Hemorrhage after gastric operation	Pneumonia and congestive heart failure*	1
	Pneumonia and septicemia*	1

* Complications of hypothermia contributing cause.
** Rupture of stomach 2, rupture of balloon 1.

Another, a 26-year-old man with massive *hematemesis,* was treated with gastric hypothermia for 10 hours without response. At operation a cardio-esophageal tear (Mallory-Weiss Syndrome) was found. He recovered.

Two elderly patients with massive upper gastrointestinal hemorrhage had large *hiatal hernias* and no other demonstrable lesions. Both were treated with gastric hypothermia. One died from massive hemorrhage despite 5 hours of gastric hypothermia. The other stopped bleeding after 48 hours, but developed generalized hypothermia to 27.2° C. and later succumbed to renal failure.

Hemorrhage after Gastric Operations. Four patients had massive postoperative bleeding from 6 to 14 days after operations on the stomach and were considered too ill to tolerate reoperation. All were treated with gastric hypothermia. Hemorrhage stopped in three and was uncontrolled in one. Bleeding recurred in one patient but stopped spontaneously without further treatment. The patient in whom bleeding

TABLE 3. *Complications Associated with Gastric Hypothermia in 27 of 33 Patients*

Complication	No.	%
Pneumonia	21	64
Septicemia	2	6
Thermal damage	14	39
Generalized body hypothermia (35° C. or below)	8	24
Paralytic ileus	9	27
Mechanical difficulties	3	9

was not controlled was operated upon and survived a complicated postoperative course. Two patients died from pulmonary complications even though bleeding had stopped.

Complications

Complications associated with local gastric hypothermia in our experience have been alarming. Twenty-seven of 33 patients (81%) had one or more complications (Table 3). Seventeen patients died, a mortality rate of 52 per cent. Three deaths were directly attributed to mechanical defects of gastric hypothermia; in five, hypothermia was a contributing factor (Table 2).

Pneumonia. This complication occurred in 21 patients (64%). The lesion was confined to the lower lobes of the lung and was accompanied by pleural effusion in ten patients.

All patients with pre-existing pulmonary disease such as asthma, chronic bronchitis, emphysema and congestive heart failure developed pneumonia with the hypothermia. When pneumonia existed prior to gastric hypothermia it was greatly aggravated by treatment. Every patient undergoing the combination of operation and hypothermia developed pneumonia.

Treatment with gastric hypothermia requires sedation and immobilization as well as two large bore tubes in the esophagus. This sets the stage for tracheal aspiration. Wangensteen[7] found that during gastric hypothermia Congo Red solution could be aspirated from the oropharynx, 20 minutes after it had been placed in the stomach through the nasogastric tube. Tracheostomy was performed in only four patients but we now believe it is indicated in all patients with pulmonary disease and in others in whom spontaneous coughing does not clear secretions.

TABLE 4. *Thermal Damage in 14 of 33 Patients after Gastric Hypothermia*

Pathologic Findings	No. Cases	Average Hr. Cooled
None	3	34
Edema of wall of stomach and duodenum*	3	8
Superficial erosion of gastric mucosa	3	39
Areas of mucosal necrosis and chronic inflammation of stomach and lower esophagus	5	42
Areas of partial necrosis of lower esophagus and cardia of stomach with localized peritonitis and hemorrhagic pancreatitis	3	125

* One patient had gastroesophageal tear.

We were unable to correlate development of pneumonia with balloon temperatures, balloon volumes or total hours of cooling.

Septicemia. Two patients developed septicemia and died. Evidences of septicemia were masked by prolonged cooling and general body hypothermia which delayed diagnosis and proper therapy.

Thermal Damage. Tissues of the upper gastrointestinal tract were studied in 17 patients by either operative inspection or pathologic examination. Changes attributed to hypothermia were found in 14; Table 4 indicates the type of damage found and correlates the degree of injury with the number of hours that hypothermia was in use. The time interval between hypothermia and tissue examination ranged from 2 hours to 12 days.

One patient underwent vagotomy, gastroenterostomy and suture of a bleeding duodenal ulcer which had been partially controlled by gastric hypothermia. At operation only edema of the wall of the stomach

and duodenum was found. The patient died of pulmonary embolus on the ninth postoperative day, and at autopsy there were partial sloughing of mucosa and chronic inflammation of the walls of the distal esophagus and upper stomach. One would suspect from this experience that tissue damage resulting from hypothermia may not be apparent at an early stage.

We were unable to correlate balloon volume and balloon temperature with tissue damage. In general, however, extensive tissue damage usually was associated with longer periods of cooling.

Generalized Hypothermia. In eight patients rectal temperature fell to 35° C. or below and six of these died. In three death could be related to general body hypothermia. Ventricular fibrillation occurred in one patient during the rewarming period and renal failure occurred in two patients, one of whom also had septicemia. Significant periods of hypotension were sustained also by the patients who had renal failure.

In our early experience only a posterior warming blanket was used and during this time generalized hypothermia occurred. Complete encasement in a warming blanket was necessary to prevent this complication. If body temperature reaches 35° C., balloon temperature is raised 10° C. or higher until the body temperature is considered to be within a safe range. With these precautions no fatalities related to generalized hypothermia occurred.

Paralytic Ileus. Nine instances of paralytic ileus were associated with local gastric hypothermia. Diagnosis was by clinical and radiologic findings and ileus lasted from 3 to 8 days. This complication presented no problem in management, except in cirrhotic patients in whom ileus aggravated the difficulties of clearing the gut of ammonia-producing blood.

Mechanical Difficulties. Three deaths were related to operational difficulties with the hypothermia apparatus. In two patients the stomach was ruptured. In one the stomach was ovredistended as a result of a mechanical defect in the hypothermia machine. In the other overdistension was secondary to large clots which were retained despite nasogastric irrigation.

A third patient was disoriented and pulled on the tubing hard enough to break it at its point of attachment to the balloon. 800 cc. of 40 per cent ethyl alcohol were released into the gastric lumen and only partially recovered by irrigation. This patient died within 24 hours.

Discussion

As shown by Wangensteen, gastric hypothermia has been beneficial in the treatment of upper gastrointestinal hemorrhage in a university hospital setting, under strict management of a team of individuals enthusiastic about laboratory and clinical aspects of the method. When applied in a general metropolitan hospital, it has been of some benefit in controlling hemorrhage in poor-risk patients. However, the method has produced its own complications and contributed significantly to death.

As shown in Table 1, of 33 patients treated with gastric hypothermia, bleeding ceased in 21 and was uncontrolled in 12. Thus, control of massive gastrointestinal hemorrhage was achieved in 63 per cent, although five patients developed recurrence of hemorrhage. Mortality was 52 per cent, or 30 per cent if those with esophageal varices are excluded.

The large number of complications encountered emphasize the pitfalls and hazards associated with gastric hypothermia. Many can be prevented by a team which is thoroughly familiar with gastric hypothermia and which is available at all times. Every case should be managed by members of such a team. The apparatus should be in perfect condition and must have a monitoring device to detect air leak. Nursing care is important, and in our hospital all patients are treated in the Intensive Care Unit.

The incidence of pneumonia, 64 per cent in this series, can be reduced by intensive nursing care that includes frequent suction of pharyngeal and tracheal secretions, changes in position and encouragement of coughing. Since all patients with pulmonary disease developed pneumonia, we believe that tracheostomy should be performed in these patients to facilitate suction of the secretions.

Wangensteen[10] states that control of hemorrhage usually can be achieved within 2 hours after intragastric cooling. In our experience, control was achieved after longer periods in a few instances. Recovery of coffee ground aspirate is frequent for several hours after apparent clinical control of hemorrhage. Despite early control, hypothermia should be continued for a minimum of 24 hours. In patients bleeding from esophageal varices it has been employed for longer than 72 hours.

In the poor-risk patient, gastric hypothermia may be an alternative to operation. However, in some depleted individuals the method can be a double-edged sword, particularly in those with pulmonary disease. It should be used cautiously in the aged and promptly discontinued if deterioration begins. In general, gastric hypothermia is an ancillary form of therapy and established principles of treating massive upper gastrointestinal hemorrhage should not be altered. Criteria for operative intervention still prevail though preparation and evaluation of some patients may be facilitated during the "breathing period" afforded by gastric hypothermia.

Summary

Gastric hypothermia is evaluated an ancillary aid in management of massive hemorrhage from the esophagus, stomach and duodenum.

Thirty-three patients were treated, 27 of whom were poor surgical risks.

Hemorrhage ceased in 63 per cent of the patients; bleeding recurred in 15 per cent. The overall mortality was 52 per cent, or 30 per cent if those with esophageal varices are excluded.

Complications were frequent and contributed to 8 of 17 deaths.

Pneumonia developed in 64 per cent of the patients. Every patient with pre-existing pumonary disease experienced this complication. Gastric hypothermia is, therefore, to be used with caution in patients who have underlying diseases. If circumstances make this treatment mandatory, tracheostomy should be done.

Septicemia may be masked by prolonged hypothermia.

Generalized hypothermia, which contributed to the mortality, should be prevented.

Gastric hypothermia should be conducted by a team of doctors and nurses who are familiar with the technic and its inherent complications.

References

1. Barnard, C. N.: Hypothermia: A Method of Intragastric Cooling. Brit. J. Surg., **44**:296, 1956.
2. Griffen, W. O., Salmon, P. A., Costaneda, A., Nicoloff, D. and Wangensteen, O. H.: Local Gastric Hypothermia in the Treatment of Massive Upper Gastrointestinal Hemorrhage. Minnesota Med., **43**:299, 1960.
3. Holt, M. H., Bevenuto, R. and Lewis, J. F.: General Hypothermia with Intragastric Cooling. Surg. Gynec. Obstet., **107**:251, 1958.
4. Khalil, H. H. and MacKeith, R. C.: A Simple Method of Raising and Lowering Body Temperature. Brit. J. Med., **2**:734, 1954.
5. Miller, R. E., Moscarella, A. A. and Fitzpatrick, H. F.: Local Gastric Hypothermia. Arch. Surg., **86**:272, 1963.
6. Wangensteen, O. H., Root, H. D., Jenson, C. D., Imamoglu, K., and Salmon, P. A.: Depression of Gastric Secretion and Digestion by Gastric Hypothermia: Its Clinical Use in Massive Hematemesis. Surgery, **44**: 265, 1958.
7. Wangensteen, O. H., Root, H. D., Salmon, P. A. and Griffen, W. O.: Depressant Action of Local Gastric Hypothermia on Gastric Digestion. J.A.M.A., **169**:1601, 1959.
8. Wangensteen, O. H., Salmon, P. A., Griffen, W. O., Patterson, J. R. S. and Fattah, F.: Studies of Local Gastric Cooling as Related to Peptic Ulcer. Ann. Surg., **150**:346, 1959.
9. Wangensteen, S. L.: Intragastric Cooling for Upper Gastrointestinal Hemorrhage. Surg. Clin. N. Amer., **42**:1171, 1962.
10. Wangensteen, S. L. and Smith, R. S. III: Intragastric Cooling for Upper Gastrointestinal Bleeding. Ann. N. Y. Acad. Sci., **115**: 328, 1964.