EPISODES of syncope varying from mild shock to rapid collapse and death frequently follow the administration of enemata in patients with congenital megacolon, particularly when the solution used is water, and when one of the parasympathomimetic drugs is given coincidentally. Such reactions have been previously described by one of the authors (R. B. H.) and were found to occur in approximately 60% of a series of 42 cases.1

A review of the literature on congenital megacolon for the past 10 years discloses little information on the subject, and no reports or warnings are to be found in the pediatric literature or textbooks. The striking improvement in the prognosis of this disease which has followed advances in surgical treatment makes general knowledge of this complication imperative in order that these tragic accidents may be prevented. For this reason a review of the subject and some illustrative case reports are presented.

REVIEW OF THE LITERATURE

Wesley2 stated that children with achalasia of the lower bowel occasionally suffer from collapse while attempting to defecate, but gave no opinion concerning the frequency or mechanism of this phenomenon. Moncrieff and Crichlow3 reported a case of congenital megacolon (Hirschsprung's disease) in a patient who died suddenly after one week of increasing abdominal distension, during which time enemas had been productive of "poor results." Postmortem examination revealed semifluid feces in the entire colon, but no cause of death was discovered. Whitehouse and Kernohan4 in an excellent review of the microscopic pathology of the colon in this disease reported 11 postmortem examinations. Most of the deaths were operative or postoperative fatalities, but three children are of interest as possible examples of sudden death of the type under discussion. One of these "... died suddenly within a few hours of the first signs of an unknown toxicity." Another, admitted to a hospital for relief of fecal impaction, failed to respond during three days of medical management and died, presumably of weakness and debility. The third died suddenly with elevated pulse and temperature after five days of hospitalization, and autopsy failed to reveal the cause of death.

Burnard5 discussed the outcome of congenital megacolon in infancy. Twenty-three patients were studied, and of these 18 had died at the time of writing. One patient died suddenly at 4 years of age, autopsy revealing the characteristic lesion of the colon, but not the cause of death. In two other cases the author stated "death was sudden and for no obvious cause." Four other patients died at home soon after hospital discharge, one of these "during an attack of bronchitis." It is conceivable that some of these deaths were due to reactions to enemata.
Jolleye® has recently reported the death of a 4 year old child following the administration of 2.3 l. of a barium solution (suspending agent not stated), and 850 cc. of a soapsuds solution given subsequently in an attempt to recover the retained barium enema. This child on return to the ward was cold, perspiring, and in shock, and vomited dark-colored fluid. Seven hours later coma, cyanosis, convulsions and polyuria (sp. gr. 1.001) were noted. Death occurred in a convulsion 20 hours after instillation of the barium solution. Autopsy was not performed. The barium mixture was analyzed, and no soluble barium salt was found. The author concluded that the cause of death was "water intoxication," and advised treatment of such reactions with intravenous injection of hypertonic sodium chloride solution.

The following typical cases are reported to illustrate the nature and emphasize the danger of this complication. All were known cases of congenital megacolon verified by roentgen examination or subsequent surgery.

**Case Reports**

Case 1. V. D., a girl 4 yr. of age, was admitted to hospital in 1948. Hers was the first severe reaction encountered. On 1st 2 hospital days she received 2 large colonic lavages of unstated composition and a soapsuds enema. Early in morning of 3rd hospital day she was found convulsing and unconscious. There was no response to calcium gluconate or phenobarbital therapy. Because of extreme abdominal distension 7.7 l. of tap water were given by colonic lavage, with return of brown fecal material. One hour later she was cyanotic, and 2 hr. later frothy bloody material was noted to be exuding from mouth; she died 10 min. later. From outset she convulsed continuously.

Postmortem examination revealed following findings: brain—congestion of leptomeninges, flattened convolutions and narrowed sulci, and symmetric reduction in size of lateral ventricles. Lungs—extreme pulmonary edema. Colon—3.2 l. of fluid present, typical congenital megacolon.

Case 2.* L. V., a boy 3 yr. of age, was discharged from hospital, after confirmation of clinical diagnosis of congenital megacolon by RG, on a medical regime consisting of prostigmine (0.5 gm. b.d.) and enemata as required. Response was good initially, but constipation recurred after 1 mo. A soapsuds enema was given and was retained. Then a dose of prostigmine was administered. About 1 hr. later, while the patient was straining to defecate, he frothed at mouth, rapidly lapsed into coma, and was rushed to a local physician’s office, where he was found to be dead on arrival. Autopsy was not performed.

Case 3. K. F., a 6 yr. of age with megacolon, suddenly complained of pain in throat following hypodermic injection of prostigmine 0.045 gm. and administration of a soapsuds enema of unstated quantity in hospital. He then began to vomit and said that he could not see. Physical examination revealed a pale retching child with cold extremities and colicky abdominal pain. Blood pressure was 60/20 mm.Hg and 5 min. later, after hypodermic injection of atropine sulfate 0.0001 gm., had risen to 90/60 mm.Hg. He was quieter at this time, and gradually recovered spontaneously.

Case 4. R. K., a boy 15 mo. of age, was being treated at home on a medical regime consisting of prostigmine and enemas as needed. During a colonic irrigation (solution unstated) he became irritable, cyanotic and pulseless, coughing unproductively and gagging repeatedly. In course of next 2 days colonic irrigations were given without event. On 3rd day, during an irrigation, the patient cried out hoarsely, started to "choke up," became weak, pale and pulseless. Irrigation was stopped, whereupon spontaneous recovery occurred. The following day, local physician attended the irrigation; he later stated that during it patient suffered an episode of pulmonary edema, manifested by moist rales and cyanosis. Parents discontinued both prostigmine and irrigations temporarily, but several days later, because of increasing abdominal distension, patient was given 2 doses of prostigmine and another irrigation, whereupon he had another episode of shock. On suspicion that he was suffering from prostigmine toxicity, an injection of atropine sulfate was given; this was thought to improve his condition.

Case 5. P. F., a boy 2 yr. of age, was being treated at home with enemata and a combination of prostigmine and syntropan®. Following an enema consisting of 350 cc. of a sodium bicarbonate

* Case report obtained through courtesy of Dr. Sidney Robin, Chicago.
UNTOWARD EFFECTS OF ENEMATA

solution, mild shock occurred, which responded rapidly to home treatment. About 2 mo. later a 400 cc. soapsuds enema was given 3 hr. after usual administration of prostigmine and syntropan®; 15 min. later cyanosis was noted, and within 30 min. patient lost consciousness. He was taken to a neighborhood hospital, where he responded within 3 hr. to an intravenous infusion of plasma and other fluids.

While this patient was being prepared for surgery in hospital, serial determinations of plasma electrolyte concentrations were made after the instillation of a tap water enema (400 cc.), as previously described. One hour and 20 min. after the enema, serum Na had fallen from 137.5 mEq./l. to 127.5 mEq./l.; plasma protein from 8.06 gm./100 cc. to 7.09 gm./100 cc.; and plasma specific gravity from 1.0286 to 1.0261. No clinical reaction accompanied these chemical alterations, and the solution of hypertonic sodium chloride solution which had been held in readiness was not needed.

Case 6. G. F., a boy 4 yr. of age, was given in course of home treatment an enema consisting of a solution of borax in water, total volume thought to be less than 1 qt. A few minutes later he became nauseated and vomited several times, and after about 30 min. was found to be cold and clammy. He was seen by a local physician at a hospital some hours later, who stated that he had suffered a sudden episode of prostration which responded to treatment with plasma, external heat and intravenous infusion of glucose and saline solutions.

Case 7. D. C., a girl 6 yr. of age, received a tap water enema of unstated amount after which she evacuated a small amount of liquid fecal material. Three hours later her abdomen was noted to be hard, and she began to urinate frequently and in large quantities. Four and one-half hours after 1st enema, another enema consisting of cane sugar 60 gm. and NaHCO₃ 60 gm. dissolved in tap water 200 cc. was given, with production of a large amount of gray-black, formed stool. Patient then vomited and complained of headache, and skin became cold and clammy. Irritability and weakness developed, and about 10 min. after 2nd enema she lapsed into coma and displayed signs of a tonic convulsion (teeth clenched, eyes externally rotated). Blood pressure was 120/45 mm Hg. PR 140/min. at this time. She remained in a restless coma for about 2½ hr., during which time there was a practically continuous flow of gray fecal material and liquid from anus. She then recovered spontaneously, complained of thirst, and took fluids eagerly during following 12 hr.

Case 8. N. R., a girl 6 yr. of age, while in hospital was given an enema consisting of soapsuds solution 700 cc. after which she expelled a large amount of feces and fluid. Shortly thereafter she became cold and clammy, and appeared to be in shock. Blood pressure was 84/34 mm Hg and slowness of response to stimuli was noted. Abdomen was rigid and tender, but roentgen films of abdomen did not show presence of free air. Spontaneous recovery occurred.

Case 9. R. B., a boy 4 yr. of age, was hospitalized for operation. At time of admission mother volunteered information that patient had fainted occasionally after enemas with soapy water, but that since she had been using oil enemas no reactions had occurred.

DISCUSSION

The clinical picture demonstrated by most of these patients, characterized initially by weakness, headache, vomiting and cough, and eventually by pallor, perspiration, polyuria, coldness of the skin, syncope, and sometimes death in coma and convulsions, is best explained by the syndrome of water intoxication. Case 1 is similar in all respects to the classical description of the first fatal human case by Helwig et al. The pathophysiology is apparently altered function of essential structures, particularly the central nervous system, caused by a sudden increase in intracellular water content.

This pathogenesis is supported by the fact that in all the cases reported here where the enema composition was known, water or aqueous solutions having low osmotic pressure (e.g., soapsuds solutions) were the inciting agents. Further corroboration is offered by the postmortem findings in Case 1 and by the chemical determinations in Case 5. The sudden and unexpected nature of the reactions described accounts for the lack of

* Case report through courtesy of Children's Memorial Hospital, Chicago.
laboratory documentation. One is more concerned with promoting recovery of the
patient in syncope than with experimental studies of water balance, and no animal prepa-
ration simulating the conditions of congenital megacolon is available for experimental
work.

Although water intoxication appears to explain the majority of the reactions described,
there is reason to suspect that additional etiologic factors were operative in some of the
cases. The most important of these is prostigmine intoxication, of which Cases 3 and 4 are
probably examples. The symptoms of overdosage with this drug are similar to those of
water intoxication, except for the presence of pin-point pupils, blurring of vision and
dyspnea, and the absence of coma except as a terminal event. Absorption of this drug
from the alimentary tract, though normally poor, could conceivably be greatly enhanced
by the combination of stasis of intestinal contents and hypertrophy of the colonic mucous
membrane. In addition to the direct toxicity of large doses of prostigmine, doses in the
physiologic range probably facilitate absorption of hypotonic enema solutions by produc-
ing peristaltic contractions of the colon and increased hydrostatic pressure within the
lumen.

Other factors which may have played a role in these reactions were the use of
alkaline solutions (Cases 6 and 7), the potential toxicity of sodium borate if absorbed
(Case 6), and the direct irritative effect of the strongly hypertonic solution used in
Case 7. This patient developed signs of water intoxication (abdominal rigidity and
marked polyuria) from the hypotonic enema given prior to the administration of the
hypertonic alkaline enema; it is possible that the latter solution created an osmotic
gradient which drew the excess extracellular fluid back into the colon, thereby bringing
about a state of dehydration. This speculation cannot be proved, but is supported by the
presence of thirst and polydipsia in the recovery phase.

Further evidence favoring the increased absorptive powers of the mucosa in congenital
megacolon is provided by the report8 of a fatality with clinical and laboratory findings of
magnesium intoxication following the administration of a small magnesium sulfate
enema in a patient with this disease. Although such enemas have been given without
mishap in many patients with megacolon, the authors stress the increased permeability
of the diseased gastrointestinal membrane, and state that magnesium sulfate enemas are
contraindicated in patients with primary megacolon. In contrast to this report, routine
use of magnesium sulfate retention enemas has been recently advocated,9 although rare
instances of shock following administration of such an enema and the evacuation of a
large amount of fecal material are stated to occur.

Prophylaxis

1. Water Intoxication: As early as 1941, Soper10 recommended the use of 10% sodium sulfate as an enema solution, because it would stimulate contractions without being absorbed by the mucosa. The present authors' experience indicates that enemas consisting of isotonic sodium chloride solution can be given in large amounts with impunity in the absence of renal or cardiac lesions, since the absorption which occurs only results in an increase in extracellular fluid without serious dislocation of the electro-
lyte pattern, and is readily compensated by normal kidneys. However, an isotonic solu-
tion of an inert substance, such as gelatin (7%), would probably be preferable for
routine use because of its safety, and should certainly be employed when renal or cardiac
disease is present to prevent pulmonary edema.
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Barium salts used in enemas for diagnostic purposes in suspected cases of this disease should be suspended in isotonic sodium chloride solution rather than in water.

Rational therapy of an established attack would seem to be the immediate intravenous injection of hypertonic (2%) sodium chloride solution.

2. Prostigmine Intoxication: Dosage of this drug in patients with congenital megacolon should be smaller than that usually recommended. Such a reduction would probably be wise in the case of any potentially toxic drug which is given orally in many times its parenteral dose in anticipation of poor absorption from the gastrointestinal tract.

3. Potentially toxic substances such as magnesium sulfate or borax used in enema solutions are contraindicated in patients with congenital megacolon.

**SUMMARY**

The problem of untoward reactions to enemata in cases of congenital megacolon has been discussed, and nine cases of such reactions presented. The evidence, although admittedly incomplete, seems to favor water intoxication as the basis of most of these reactions. Other possible etiologic factors are discussed.

A routine for the prevention of syncope by the use of isotonic enema solutions in cases of congenital megacolon is advocated. The use of tap water or soapsuds enemas or of solutions containing potentially toxic substances such as magnesium sulfate is contraindicated in congenital megacolon.

**REFERENCES**


**SPANISH ABSTRACT**

Reacciones Desagradables con el Empleo de Enemas en el Megacolon Congénito

Con mucha frecuencia la administración de enemas a pacientes con megacolon congénito se acompaña de síntomas, variable de shock ligero a colapso o muerte, en particular cuando la solución es acuosa y el enfermo está recibiendo una de las substancias parasimpático-miméticas. Pocos informes se tienen al respecto en los últimos diez años; el pronóstico de este padecimiento, tan favorable con el tratamiento quirúrgico, hace obligatoria la difusión de estas complicaciones para evitar accidentes trágicos.

Los autores presentan nueve casos de niños en quienes se presentaron diversos cuadros clínicos tras el uso de enemas; se iniciaban generalmente por debilidad, cefalea, vómitos y tos, seguidos más tarde de palidez, sudoración profusa, poliuria, piel fría, síncopa y en ocasiones muerte en coma y...
convulsiones; el cuadro era el del síndrome de intoxicación por agua. Suponen que la fisiopatología radica aparentemente en alteraciones funcionales de estructuras esenciales, particularmente en el sistema nervioso central, provocadas por el aumento brusco del contenido acuoso intracelular. Otros factores que deben tomarse en cuenta son: la intoxicación por prostigmina, cuya absorción generalmente escasa en el tracto digestivo, podría acentuarse tanto por la estasis del contenido intestinal como por la hipertrofia de la membrana mucosa del colon; el empleo de enemas con soluciones alcalinas, la toxicidad potencial del borato de sodio y por último el efecto directo irritativo de las soluciones altamente hipertónicas.

La profilaxis de estas reacciones tan desagradables debe dirigirse hacia la prevención de la intoxicación por agua y por la prostigmina así como la proscripción del empleo de enemas de substancias potencialmente tóxicas como el sulfato de magnesio y borato de sodio, en soluciones hipertónicas, substituyéndolas por soluciones isotónicas.

630 West 168th Street
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MARY R. RICHARDS and ROBERT B. HIATT

Pediatrics 1953;12:253

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