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Boric Acid Poisoning

A Report of Fatal Adult Case from Cutaneous Use
A Critical Evaluation of the Use of This Drug in Dermatologic Practice

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Boric acid, in one preparation or another, has been used in medical practice since Lord Lister [1] first described its effects in 1875. Solutions of it have been used extensively for irrigating wounds and empyema cavities, and for bladder, rectal, and vaginal irrigations, etc. Because of its nonirritating properties, its lack of staining, its buffering qualities, and mild antiseptic values, this drug is one of the commonest used in dermatologic practice.[2] It is used in powders, lotions, wet dressings, ointments, and pastes. Most physicians, including dermatologists, regard boric acid as a substance of low toxicity and relatively harmless, and therefore use it indiscriminately. In our opinion, insufficient warning is given in standard dermatologic texts of the possibility of serious poisoning or death from the indiscriminate use of boric acid preparations on the skin.

The purpose of this presentation is to report a fatal case of boric acid poisoning from the indiscriminate use of this drug in the treatment of a skin condition, to discuss the toxicity of boric acid, to study the absorption of the drug from the skin when it is used in the treatment of various skin conditions, to consider the possibility of poisoning from such use, and to discuss the value of the drug in the treatment of skin conditions.

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Report of Case

A woman aged 35 was admitted to the Dermatologic Service of the Buffalo General Hospital at 11 a. m. on May 8, 1954. The following history was obtained from relatives.

The patient had had varicose veins for a number of years. A rash developed on the left ankle about the middle of March, 1954, for which her family physician prescribed a proprietary ointment containing ethyl aminobenzoate (benzocaine). Shortly after this ointment was used, the rash spread and about April 15, 1956, it became generalized. For this, continuous wet dressings of saturated solution of boric acid were prescribed on or about April 23. These were continued and used for a total of about 14 days. Except for the discomfort of the skin eruption, the patient was otherwise well and able to be up and about until May 4, 1954, when she became lethargic, chose to remain in bed, and, 24 hours before admission to the hospital, became comatose.

Physical Examination.—The patient was in deep coma. On the entire skin surface there was a generalized erythema with some scaling. There was a cyanotic flush to the face; the extremities exhibited pallor, cyanosis, and were cold to the touch. The pupils failed to react to light and accommodation; the tongue was dry and coated; the heart exhibited no murmurs; the blood pressure was unobtainable; the pulse was 120; respirations were 40; the chest was clear; the extremities spastic. To patient was obviously moribund. The following are the results of the laboratory examination done at the time of admission: Spinal fluid examination—fluid clear; pressure—120-140; spinal fluid protein—0.029 gm. per 100 cc.; spinal fluid Wassermann and colloidal gold tests—negative. Blood glucose—170 mg. per 100 cc.; blood urea nitrogen—26 mg. Blood Wassermann reaction—negative; red blood cell count—4,100,000; white blood cell count—34,000; myelocytes—1; juvenile forms—2; band forms—38; basophils—1; eosinophils—1; lymphocytes—1. Death occurred 14 hours after admission to the hospital, on May 9, 1954.

Postmortem examination (done by Dr. Kornel Terplan) showed the following positive findings:

The liver and lungs were hyperemic; microscopic examination of the kidneys showed the glomerular loops to be dilated and filled with blood. The tubules showed degeneration and necrosis. The bone marrow was hyperplastic, with predominance of the eosinophilic series. Analysis of various organs and fluids for boric acid showed the following per 100 gm.: liver—79 mg.; brain—69 mg.; urine—525 mg.; spinal fluid—95 mg.; blood —350 mg.

Review of the Literature

Numerous cases of serious poisoning or death from boric acid have been reported in the literature. Most of these have been from the accidental ingestion of boric acid.[3,4] Among this group, regrettably, were several hospitalized babies who died as a result of boric acid solution accidentally mixed in their formulas.[5-7] Severe poisoning or death has been reported from the use of boric acid as gastric lavages, rectal enemas,[3,4,8] bladder irrigations,[9] subcutaneous clyses,[10] vaginal packs,[4] intravenous administrations,[11] irrigation of empyema cavities [3]; from inhalation of boron hydrides used in industry [12]; the use in surgical wounds,[13] burns,[14] ulcers,[15] and skin eruptions.[4,8,16-18] Pfeiffer, Hallman, and Gersh [19] found that the minimal lethal oral dose for dogs was 2 gm. per kilogram and the subcutaneous minimal lethal dose was 1 gm. per kilogram. They found boric acid toxic for all laboratory animals which they studied. McNally and Rust [7] reported that six infants (average weight 7 lb.), fed 3 to 6 gm. of boric acid, died. McIntyre and Burke [11] reported that one patient given 15 gm. as a subcutaneous clysis developed only slight symptoms of poisoning, and Peyton and Green [10] reported that 18 gm. given subcutaneously produced severe poisoning with recovery. From the literature, Pfeiffer, Hallman, and Gersh [19] believe that the fatal dose in human adults is 15 to 20 gm., infants 5 to 6 gm. These authors also state that single large doses, as reported by McIntyre and Burke [11] and Peyton and Green,[10] are not so dangerous as repeated smaller doses. From the foregoing it is evident that boric acid is a potent poison when sufficient amounts of it are absorbed into the blood stream by one means or another.

Poisoning from Cutaneous Application.—Rothman [20] and others [21] have outlined the principles of percutaneous absorption. In general, water-soluble, lipoid-soluble nonelectrolytes penetrate the unbroken skin best. Since boric is both water-soluble and lipoid-soluble and is not an electrolyte, it falls into the group of substances that theoretically are best absorbed.

Kahlenberg,[22] in 1924, was able to demonstrate that boric acid, but not its salts, could pass through the normal skin and appear in the urine in limited quantity. Pfeiffer and his co-workers [19] and Goldbloom and Goldbloom [4] were unable to demonstrate that boric acid passed through the normal skin under the experimental conditions set up by them. Vignec and Ellis [23] were unable to demonstrate any amount of boric acid in the urine of infants who had had 5% boric acid powder used in the diaper area. No serious cases of poisoning have been reported, to our knowledge, from the use of boric acid preparations on normal skin.

It has been pointed out that the epidermis is a principal barrier to the passage of chemicals through the skin. When the continuity of this structure is broken by trauma or disease, substances which may have passed through the unbroken skin only in limited quantities, may be readily absorbed and pass into the bloodstream with ease. We, as dermatologists, are principally interested in the possibility of poisoning from the use of boric acid preparations on the skin which has been altered by disease or trauma. In considering this, it is important to point out the work of Pfeiffer and his coworkers,[19] who in laboratory experiments, found repeated nonlethal subcutaneous injections of boric acid produced cumulative effects. In their animals it took 14 days for a mean plateau to appear in the urine. This finding is of importance in the considera-

tion of the use of this drug in the treatment of skin conditions, since repeated applications are commonly used, and thus the possibility of cumulative effects must be considered.

There are a number of reports in the literature of serious poisoning or death from the use of boric acid preparations on wounds, ulcers, burns, and miscellaneous skin conditions which are of interest to us as dermatologists.

The first case of serious poisoning was that reported by Brose [15] in 1883, who recorded the death of a 31-year-old man from the use of boric acid powder for five days on a chronic leg ulcer. This was followed by a report from Best [13] in 1903 of a patient who died from the use of 6 oz. (180 gm.) of boric acid powder used in a surgical wound. In 1905, Dopfer [24] attributed the death of a child to the use of a 10% boric acid ointment on a 3 by 12 cm. skin burn. The preparation was used over a period of four days. Savariaud [25] reported the death of an 8-year-old child from the use of boric acid powder on a burn. Maguire [26] reported the death of a 23-year-old woman from the use of boric acid fomentation on a traumatic leg wound. Gissel [14] recorded the death of a 4-year-old child from the use of 30 gm. of boric acid powder on a burn. Abramson [16] recorded the death of an infant from the use of boric acid powder and ointment on an excoriated eruption in the diaper area. Brooke and Boggs [8] likewise reported the death of an infant from the sprinkling of boric acid powder on a diaper dermatitis. Ducey and Williams [18] reported poisoning in three infants, one from borated talc used on a diaper rash for seven days, one from the use of boric acid solution and crystals on a diaper rash. This resulted in death. The third infant suffered poisoning without death from a similar application.

Watson [17] reported a case which he believed developed boric acid poisoning from the use of boric acid ointment and the saturated solution of the drug on severe infantile eczema. The child died. Postmortem examination showed the immediate cause of death was pneumonia and purulent meningitis. Goldbloom and Goldbloom [4] reported four alleged cases of boric acid intoxication from the use of borated talc in the diaper area. One of the authors later retracted this and stated the criteria used were erroneous.[27]

Since the Goldbloom and Goldbloom [4] report, Vignec and Ellis [23] have done careful investigations on the possibility of poisoning from the prolonged use of 5% boric acid powder in talc on buttocks of normal infants and infants with diaper dermatitis. They found no significant boric acid absorption.

Fisher, Freimuth, and O'Connor [28] did a similar, carefully controlled, study and likewise found no significant absorption of boron from the use of borated powder. These authors offered the statement that of alkaline talc combined with the boric acid to form an inabsorbable salt.

Experimental Studies

No adequate studies have been done on the absorption of boric acid from its dermatologic use in various skin conditions. Cope [29] considered the absorption of 10% boric acid ointment and saturated solution of boric acid as an irrigant on skin burns. He found that up to 2 gm. of boric acid appeared in the urine in 24 hours after the application of 10% boric acid ointment, and when saturated solution of boric acid was used as an irrigant up to 2.5 gm. appeared per day. He stated that the prompt excretion of the drug prevented toxic blood levels.

To study the possibility of boron poisoning from the absorption of boric acid preparations used in various dermatologic conditions, a group of 22 hospitalized patients were employed. Boric acid was used in the form of 5% ointment in white petrolatum, as a saturated solution of boric acid, and in the form of pure boric acid

Summary of Study of Twenty-Two Patients for Boric Acid Absorption

Patient	Age Yr.	Sex	Diagnosis	% Body Surface	Form of Application	Duration of Application	Blood Boron Level Mg. per 100 cc.
1	63	M	Exfoliative dermatitis (dermatitis venenata)	99+	5% in petrolatum	3 weeks	Trace (2nd wk.)
2	75	F	Dermatitis venenata (dermatitis hypostatica)	13	5% in petrolatum	3 weeks	<0.5
3	51	M	Dermatitis venenata	27	5% in petrolatum saturated solution	2 weeks	Trace (2nd wk)
4	61	F	Pemphigus vulgaris	15	5% in petrolatum	8 weeks	<0.5
5	27	F	Dermatitis venenata	11	5% in petrolatum	1 week	<0.5
6	69	M	Dermatitis venenata	27	5% in petrolatum	10 days	Trace (10 days)
7	13	M	Dermatitis venenata	12	5% in petrolatum saturated solution	1 week	<0.5
8	67	M	Dermatitis venenata	8	5% in petrolatum	2 weeks	<0.5
9	66	F	Dermatitis venenata (psoriasis)	12	5% in petrolatum	4 weeks	<0.5
10	66	M	Dermatitis venenata (dermatitis hypostatica)	15	5% in petrolatum	4 weeks	<0.5
11	67	M	Dermatitis venenata	53	5% in petrolatum	2 weeks	<0.5
12	44	M	Dermatitis venenata	40	5% in petrolatum saturated solution	3 weeks	0.5 (second)
13	31	F	Dermatitis venenata	17	5% in petrolatum saturated solution	2 weeks	<0.5
14	46	F	Dermatitis venenata	20	5% in petrolatum	4 weeks	<0.5
15	61	F	Dermatitis venenata (dermatitis hypostatica)	40	5% in petrolatum saturated solution	3 weeks	Trace (2nd wk.)
16	56	M	Dermatitis venenata	18	5% in petrolatum	3 weeks	<0.5
17	71	M	Mycosis fungoides (fungating)	99 plus	5% in petrolatum	3 weeks	<0.5
18	52	M	Ecthyma (pediculosis corporis)	11	5% in petrolatum	2 weeks	<0.5
19	66	M	Stasis ulcers	1	5% in petrolatum	4 weeks	<0.5
20	50	M	Stasis ulcers	2	Crystals	3 weeks	<0.5
21	60	F	Stasis ulcers	1	Crystals	2 weeks	<0.5
22	48	F	Dermatitis venenata	36	5% in petrolatum	2 weeks	<0.5

crystals. It was applied to such conditions as exfoliative dermatitis, dermatitis venenata, leg ulcers, mycosis fungoides, and extensive ecthyma. The areas of the body over which the applications were applied varied from 1% of the total body skin surface to 99% of the total skin surface. Blood boric acid levels were determined at at least weekly intervals. The volumetric method outlined by Kolmer[30] was employed. In no instance was there a rise in blood boric acid levels that could be considered significant.

The accompanying table gives the pertinent data on the 22 patients studied. In interpreting our results, it must be remembered that small amounts of boron (0.04 to 1 mg. per 100cc.) of blood may be a normal level and that fatal levels are usually 100 mg. or more per 100cc. In view of our inability to produce significant boric acid levels in the bloodstreams of our patients from the topical application of boric acid preparations, it is difficult to explain some of the severe poisonings and deaths reported in the literature, including our own case from the application of this drug to the skin. Some of the cases reported may not have been authentic instances of boric acid poisoning and others may have resulted from the accidental, unknown ingestion of the drug. It was noted among our patients in most instances that rapid healing of the skin took place under treatment with the drug. Such healing would tend to prevent further absorption. In the fatal case reported the skin condition, instead of improving, grew continuously worse. This would enhance the absorption of boric acid. Other factors may be involved. It is possible in some individuals more storage takes place than in others. In these patients elimination of the drug may be slower than normal. Since the drug is principally eliminated by the kidney, impaired renal function may account for the high blood levels observed in some patients. There was no evidence of renal disease in our patients. Our findings agree with those of Cope,[29] who believed that among his burn cases, rapid excretion prevented toxic cumulative levels.

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