BLOOD BORON LEVELS IN HUMAN INFANTS*

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Review of the literature reveals a number of reports of cases of alleged boric acid poisoning in which blood or tissue concentrations of boric acid are presented. These vary within extremely wide limits and evaluation of their significance demands knowledge of the variations of boron concentration in normal persons exposed to boric acid or boron only through dietary sources as well as in patients receiving therapy with boron compounds but who can be said safely to be free of any indications of boron toxicity. This study was devised in an effort to supply such data since it is not now available in the literature.

INVESTIGATIVE PROCEDURE

Arrangements were made with the Pediatrics Department of the Johns Hopkins Hospital and the Dermatology Clinic of the University Hospital of Baltimore to collect blood specimens from a number of infants and young children under treatment for various skin disorders. In each case, the clinical diagnosis was recorded and a history of whether there was exposure to boron-containing compounds was elicited from the parent of the patient. Blood samples were collected and analyzed by the method of Smith, Goudie and Sivertson[1] for boron content. The results are shown in Tables I and II.

The average concentration of boron in the 34 patients exposed only to dietary sources of boron was 0.25 microgram per milliliter of blood. The extremes in this group ranged from 0.00 to 1.25 micrograms of boron per milliliter of blood. In the other group of 37 patients, comprising those subjected to therapy with boron containing compounds, the average blood boron level was 0.20 microgram per milliliter with extremes ranging from 0.00 to 1.25 micrograms per milliliter.

In only five of these cases did the blood boron concentration exceed 1.0 microgram per milliliter and none exceeded 1.3. In one of these, there was a clearcut history of exposure to boric acid. The patient had been given baths in boric acid solution three times per day for a period of one week prior to the collection of the sample. We consider concentrations up to 1.3 micrograms per milliliter (equivalent to 0.75 mg. per cent as boric acid) to be within normal limits derivable from dietary sources of boron. These sources are: Principally the green vegetables and fruits which have been shown to contain in the case of currants, sultanas and raisins from various sources from 0.01–0.02% boric acid (1.8–3.9 mg. % boron). Seaweeds and edible products made from them may contain large amounts of boron; as much as 0.16% boric acid has been reported as present in agar-agar. Orange pulp contains from .35 to 1.4 mg. % boron equivalent to a maximum of 8 mg. of boric acid per 100 cc. It is interesting to note that the blood boron concentration in the seventeen cases with a history of use of borated

TABLE 1

Blood Boron and Infant Dermatitis

Age Group	No. of Patients	Average Boron* Concentration (γ/ml)	Range of Boron Concentrations (γ/ml)
Dietary Boron Exposure Only			
0–5 mos.	3	0.15	0.00–0.25
6–12 mos.	5	0.23	0.00–0.90
1–2 yrs.	6	0.20	0.00–1.02
2–4 yrs.	11	0.25	0.00–1.25
4–6 yrs.	3	0.10	0.00–0.23
Over 6 yrs.	6	0.15	0.00–0.67
Total	34	Average 0.25	0.00–1.25
Dietary & Boron Containing Medication†			
0–5 mos.	8	0.11	0.00–0.50
6–12 mos.	3	0.30	0.00–0.87
1–2 yrs.	9	0.10	0.00–0.55
2–4 yrs.	11	0.32	0.00–1.25
Over 6 yrs.	6	0.24	0.03–0.62

* To convert to milligrams Boric Acid/100 milliliters multiply by 0.572.

† Use of Boric Acid containing baby powder (5% Boric Acid in talc)—16 cases; Boric Acid solution baths—9; Boric Acid ointment U.S.P. 10% ointment for dermatitis—7; oral lavage with Boric Acid solution—4; laundry use of Boric Acid—1.

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Received for publication August 24, 1957.

TABLE 2

Blood Boron in Dermatitis

Impetigo	Eczema	Diaper Rash	Maculo-papular rash	Atopic Eczema	Miscel-laneous & undiag-nosed
Dietary Boron Exposure Only					
0.05	0.00	0.00	0.00	0.16	0.08
0.12	0.08	0.25	0.15	0.03	0.00
0.67	0.23	0.00	0.60	0.00	0.00
0.00	0.55	0.00		0.30	0.00
1.25	0.00	0.00			0.37
	0.00	1.25			0.25
	1.05	0.82			0.26
	0.64				0.20
					0.00
					1.02
					0.90
					0.00
					0.15
					0.03
					0.00
*Dietary & Boron Medication**					
0.09	0.05	0.03	0.20		0.05
0.00	0.00	0.15	0.00		0.00
0.00	0.75	0.00	0.03		0.00
0.15		0.55			0.88
0.09		0.50			0.10
0.00		0.00			0.10
0.00		0.20			0.05
0.00					0.00
1.25					0.87
0.10					0.00
					0.03
					0.08
					0.62
					0.53
					0.75

All results are expressed in micrograms/milliliter; to convert to milligram of boric acid/100 milliliter multiply by 0.572.

* For types of medication see Table 1.

talcum powder ranged from 0.00 to 0.75 microgram of boron per milliliter which is also well within normal limits. Thus, none of the cases of dermatitis listed shows any significant boron absorption.

In addition to the above study, we were fortunate in obtaining blood samples from two patients admitted to Baltimore City Hospitals for treatment after they had ingested boric acid solution. The patients were, respectively, a two year old white female and a three year old white female. The mother of the younger child had given both children a boric acid solution thinking it was water which was being saved during a temporary shutdown of plumbing facilities. The total amount of solution shared by the two children was 5 oz. containing 1½ teaspoonfuls of boric acid. Both children had gastric lavage at the hospital and were kept under observation for two days. At no time did either of them appear ill or develop any skin eruption. Blood samples taken on admission, showed the two year old to have 7.89 mg. per cent boric acid while the three year old had 7.44 mg. per cent boric acid. Both of these cases were followed and three weeks later the mothers reported that neither child had shown any skin rash or other manifestation of illness during the entire interval after the accidental administration of the chemical. This is of special significance since it indicates that such levels are non-toxic and strongly contradicts Ducey's[2] conclusion that 5 mg. per cent of boric acid is a fatal level. It is further in keeping with our experience that the blood boric acid level in fatal poisonings is of the magnitude of 50–100 mg. % or more.

SUMMARY AND CONCLUSIONS

(1) The average blood boron concentration observed in 34 patients exposed only to dietary boron was 0.25 microgram per milliliter. The highest level reached in this group was 1.25 micrograms per milliliter.

(2) 37 patients exposed to boron-containing medications as well as dietary boron showed an average blood boron concentration of 0.20 microgram per milliliter and a high of 1.25 micrograms per milliliter. These are not significantly different from the levels in the first group of patients described above.

(3) Two children who accidentally received a boric acid solution orally showed blood boric acid levels of 7.89 milligrams per cent and 7.44 milligrams per cent respectively. Neither of these patients exhibited any signs of boric acid toxicity at any time during their stay in the hospital despite the fact that these levels are above those previously reported as fatal.

REFERENCES

1. Ducey, J. and Williams, D. B.: Transcutaneous absorption of boric acid. J. Pediat., **43:** 644–652, 1953.
2. Smith, W. E., Jr., Goudie, A. J. and Sivertson, J. N.: Colorimetric determination of trace quantities of boric acid in biological materials. Analytical Chem., **27:** 295–297, 1955.