of a similar finding in other reported cases of α - β -lipoproteinaemia remains unexplained.

Summary

A 15-year-old Arab boy born to a first-cousin marriage and suffering from α - β -lipoproteinaemia is described. In addition to steathorrhoea, ataxia, skeletal deformities, and night blindness he had defective blue-yellow colour-vision, a finding not described in previous reports on α - β -lipoproteinaemia.

Supported in part by a grant from the Lebanese Council for Scientific Research.

REFERENCES

- Duke-Elder, S. (1967). Diseases of the Retina. *System of Ophthalmology*, Vol. 10, p. 588. Kimpton, London.
- Forsyth, C. C., Lloyd, J. K., and Fosbrooke, A. S. (1965). α - β -lipoproteinaemia. *Archives of Disease in Childhood*, **40**, 47.
- Haddad, N. A. (1970). *UM/AUB Joint Vision Study*, Vol. 2. Willow Run Laboratories, Institute of Science and Technology, University of Michigan Press, Ann Arbor.
- Heck, A. F. (1963). Presumptive X-linked intermediate transmission of retinal degenerations. *Archives of Ophthalmology*, **70**, 143.
- Kahlke, W. (1967). α - β -lipoproteinaemia. In *Lipids and Lipidoses*, p. 382. Ed. by G. Schettler. Springer, Berlin and New York.
- Kalmus, H. (1955). The familial distribution of congenital tritanopia, with some remarks on some similar conditions. *Annals of Human Genetics*, **20**, 39.
- Kornzweig, A. L. (1970). Bassen-Kornzweig syndrome: present status. *Journal of Medical Genetics*, **7**, 271.
- Omarzu, C. A. (1970). *UM/AUB Joint Vision Study*, Vol. 1. Willow Run Laboratories, Institute of Science and Technology, University of Michigan Press, Ann Arbor.

A. K. KHACHADURIAN,* R. FREYHA, M. M. SHAMMA'A, and S. A. BAGHDASSARIAN

Departments of Biochemistry, Internal Medicine, and Ophthalmology, American University of Beirut School of Medicine, Beirut, Lebanon.

*Present address: Director, Clinical Research Center, Children's Memorial Hospital, 2300 Children's Plaza, Chicago, Ill. 60614, U.S.A.

Copper Poppers: A Benign Cause of Blue Diapers*

The blue diaper syndrome has been described in one family by Drummond *et al.* (1964). The syndrome was apparently caused by a gastrointestinal transport defect in the absorption of tryptophan so that unabsorbed tryptophan in the gut was converted to indoles by intestinal bacteria.

*This work was supported in part by grants from the National Foundation—March of Dimes and the Collins Foundation of Oregon.

The indoles were then absorbed and converted in the liver into indican which was then excreted in the urine. Conjugation of two molecules of indican in the urine produced the water insoluble dye indigotin, which was responsible for the blue discoloration of the diapers.

This note describes a new cause for blue diapers which is not due to an inborn error of metabolism, but to a chemical interaction, under certain circumstances, between normal urine and the metal snaps which are sometimes used for securing infant napkins.

This condition was brought to our attention when a female infant was seen for a routine post-natal clinic checkup at the age of 3 months. At that time, the patient appeared to be perfectly healthy, but the mother complained that the napkins were sometimes turning blue after the child had urinated. The child was admitted to hospital and a number of investigations, including tryptophan tolerance tests, were undertaken. These were all normal. At that time, the mother declared that the blue coloration was particularly obvious around the metal poppers which were used for securing the napkin. This observation led us to postulate that a chemical interaction was occurring between a constituent of the urine and the metal in the poppers. This led to a number of investigations.

Results

(1) Following an oral L-tryptophan tolerance test (100 mg/kg) the urine was tested for indican by Jaffe's method (Hawk and Bergeim, 1931). No excess indican was present and the tryptophan metabolite pattern was normal on paper chromatography.

(2) Examination of a napkin from the baby showed that the colour occurred in patches which were most marked around the metal poppers. Attempts were made to elute the colour from a blue stained napkin with acetone, benzene, and chloroform. The blue material was insoluble in these solvents but was readily soluble in 1 N ammonium hydroxide. On the addition of 1 N hydrochloric acid to the solution, the blue colour disappeared but returned again when it was realkalinized with sodium hydroxide. The colour also disappeared on the addition of aqueous sodium cyanide (Curtman, 1938).

(3) Dry, powdered di-ethyl di-thio carbamate was added to the blue eluate from a stained napkin. A yellow colour was produced indicating the presence of copper in the solution.

(4) A cleaned popper from the child's napkin was soaked in 1 N ammonium hydroxide and a strong

blue colour was rapidly produced. A popper from a new napkin was treated similarly but no colour resulted. However, when the new popper had been filed to remove some of the nickel plating, a strong blue colour was produced with ease.

(5) Some normal urine was alkalized to pH 8 with either ammonium hydroxide or sodium hydroxide. Portions of a clean napkin possessing a worn popper were then dipped in these solutions and set aside. After three days, both napkins smelled strongly of ammonia and both had turned blue.

(6) Similar tests using stainless steel safety pins in place of the worn poppers produced no colour.

Discussion

The above findings can be explained by the production of a cuprammonium complex, the ammonia being produced by bacterial degradation of urinary urea and the copper coming from the brass of the poppers from which the nickel plating has worn away. The colour is produced with any normal urine to which sufficient ammonium hydroxide has been added or which is kept at room temperature until the smell of ammonia is obvious.

In the New World, 'nappy' pins for securing infant napkins (diapers) have been partly replaced by poppers (snaps), which are often found on the sides of reusable cloth napkins. Nappy pins are made of steel, whereas most poppers are made of brass covered with nickel or plastic. If ammoniacal urine were to come in contact with any copper-containing alloy, a similar colour should be produced.

This condition should be differentiated from indicanuria in which urinary indican and minute (though critical) amounts of residual bleach in the napkin may conspire to produce the blue dye

indigotin. Excess urinary indican may be excreted in a number of conditions including the 'blue diaper syndrome' which is apparently a dangerous condition since two of the original cases died.

Over the past four years, we have studied four patients who presented with blue discoloration of the napkin. Three of these children were healthy and showed no disturbance of tryptophan metabolism. Our finding of another cause for the production of blue napkins in at least one of these patients may prevent similar expensive and traumatic evaluations of healthy children, whose only problem is that they are wearing 'hand-me-downs'.

Summary

A benign cause for blue discoloration of infant napkins (diapers) is described. The colour is produced by a cuprammonium complex caused by contact of ammoniacal urine with the copper of napkin 'poppers' from which the nickel plating has worn away. The colour should be distinguished from other possibly serious causes for blue urine.

The authors are grateful to Dr. R. Blair and Dr. J. Schulte for referring their patients for study.

REFERENCES

- Curtman, L. J. (1938). *Quantitative Chemical Analysis*, 2nd ed. p. 276. Macmillan, New York and London.
- Drummond, K. N., Michael, A. F., Ulstrom, R. A., and Good, R. A. (1964). The blue diaper syndrome: familial hypercalcaemia with nephrocalcinosis and indicanuria. *American Journal of Medicine*, **37**, 928.
- Hawk, P. B., and Bergeim, O. (1931). *Practical Physiological Chemistry*, 10th ed., **28**, p. 723. Blakiston, Philadelphia.

N. R. M. BUIST, D. A. RAMBERG, J. J. STRANDHOLM, and P. C. FERRY

University of Oregon Medical School, 3181 S.W. Sam Jackson Park Road, Portland, Oregon 97201, U.S.A.