by Kast³⁰ in a later investigation, in which he found that the reducing property of chloroform urine was destroyed by removal of the organic chloride compound. The carbohydrates were not increased, and the copper-reducing substance was in all probability a body analogous to urochloralic acid—trichlor. ethyl glycuronic acid—derived by oxidation from the chloroform and subsequent combination with the glycuronic acid. On the other hand, Vitali,³¹ as already stated, found no more organic chlorides in urine after chloroform than before, while Nachod³² attributes the reduction to an increase of kreatinin.

In this investigation the urine after chloroform narcosis was examined in seven of the experiments for substances giving osazone crystals, namely, Ureter Experiment 1 and Catheter Experiments 3, 4, 5, 7, 8, also in that quoted on p. 609, but not included in the table.

No osazone crystals were obtained from any of the normal samples. Crystals were present after chloroform in five of the experiments, and were wholly absent in two. In the majority of cases the crystals were unlike those of glucosazone in appearance, and gave melting points in impure condition, ranging about 130° C. In two there were undoubtedly glucosazone crystals present as well; the appearance was typical, and after fermentation with yeast they were no longer obtainable. Fermentation was also tried in other cases, where the first type of osazone crystal only was found. In one or two cases CO₂ gas was obtained, but only after a prolonged stay in the thermostat, during which time decomposition changes probably had occurred.

In one of the experiments examination with the polarimeter gave slight laevorotation. To obtain sufficient urine for the purpose the samples secreted during the anaesthetic and post-anaesthetic periods were added together and clarified by basic lead acetate. The mean of four readings in a 40 cm. tube gave -0.16. The examination was not quantitative.

The melting points and laevorotation indicate a glycuronic compound, similar to that suggested by Kast. It should be added that the reactions with orcin, phloroglucin, and hydrochloric acid, and also the reaction with P. bromphenyl hydrazine gave negative results both before and after boiling with dilute sulphuric acid. The quantity of urine available for the examinations was, however, very small, and much stress cannot be laid on the failure to obtain positive results in the latter tests. The investigation on these points is not yet completed.

SUMMARY OF RESULTS.

Chloroform.

1. The volume of urine secreted by the kidney is, as a rule, affected during chloroform narcosis in two ways. In the early stages, when the anaesthesia is light, the quantity is frequently increased. During full anaesthesia the secretion is always diminished, and may be suppressed.

2. The after-effect is invariably a great increase, which in certain periods may reach to four times the normal volume for the same period of time. The maximum outflow occurs about three hours after removal of the anaesthetic.

3. The total excretion of nitrogen is, as a rule, greatly reduced—more so than the quantity of urine. The averages taken from experiments with diminished urine volume show that during the anaesthetic period the excretion of nitrogen fell to 18 per cent. of the normal, whereas the quantity of urine in the same series fell only to 35 per cent. of that amount. In a minority of the experiments with increased urine volume the total nitrogen per period was also increased, but to a much less extent than the volume of urine in the same experiments.

4. The urine secreted during chloroform anaesthesia is almost invariably more dilute (contains less nitrogen per cent.) than the normal urine. This holds good even when the volume of urine is diminished, hence it is inferred that chloroform affects not only the blood flow through the glomerulus, but also the secretion of nitrogenous solids into the tubules and the latter even more than the former. The result, therefore, favours the theory of urinary secretion advanced by Bowman.

5. There is a general but not accurate correspondence between urine outflow, kidney volume, and blood pressure. The relationship between the first and second is closer than between the first and third. A state of almost com-

plete suppression may coexist with a comparatively high blood pressure.

6. In prolonged narcosis, with marked diminution of urine volume, there is a considerable exudation into the renal tubules of leucocytes, which subsequently escape with the urine. The condition is probably produced by more or less vascular stasis in the glomerular vessels.

7. The excretion of chlorides is much increased both during and after chloroform narcosis. In the fourth period after removal of the anaesthetic the amount may be ten times the normal quantity in the urine of the dog.

8. Albumen appears in a small proportion of experiments after chloroform inhalation.

9. Reducing substances other than glucose are almost invariably increased. The nature of the reducing substance has not been definitely determined.

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(To be continued.)

SOME EXPERIMENTS IN DENSIMETRY

WITH A VIEW TO ASCERTAINING THE PERCENTAGES OF CHLOROFORM SUPPLIED BY JUNKER'S INHALER.

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THE great convenience afforded by Junker's inhaler in midwifery cases makes it desirable to ascertain, as far as possible, whether its use is safe within certain limits.

The bottle, which is graduated up to 8 drachms, can be suspended to the bed. If, in the later stages of labour, some intermittent anaesthesia is considered to be desirable, the patient can be entrusted with the mask, which is of no use without the propulsion bulb. To work the latter requires voluntary muscular movement. The patient may be allowed to seize the mask and to grope for the propulsion bulb at the onset of a pain; this takes some time, and since muscular movement ceases when the senses are dulled, the supply of chloroform ceases with the cessation of muscular movement. Such consolatory anaesthesia is safe enough as far as it goes, and a doctor alone in the country, needing both his hands and all his attention, may find it of great help to him, notwithstanding much upbraiding on the part of the patient. He may even, if no other assistance is available, for the purpose of turning or the like, be tempted to entrust the bulb and mask to a nurse. For these and other uses to which Junker's inhaler may be put its convenience should not be the sole justification; we should also have some knowledge of the percentage of chloroform which is being supplied to the patient.

Two forms of mask or facepiece are supplied with this inhaler. Happily the simplest and safest is also the cheapest and most durable, and can be more easily cleaned after use. This is the rigid vulcanite facepiece without a cushion at the rim. There are certain difficulties to be met with in experimenting with any form of Junker's apparatus. An endeavour has been made in these experiments to obtain for examination as far as possible a portion of the vapour which is actually presented to the patient by simulating the conditions when the mask, in this instance of vulcanite, is closely but not absolutely adapted to the irregularities of the face.

If the mask is in complete adaptation to the face, or the whole face aperture is closed by a diaphragm, the mask

forms a box into which a mixture of chloroform and air is pumped by means of a bulb compressed in the hand. The box thus formed has a small exit valve, opening by + and closing by - interior pressure. Two other openings are provided at the base of the box near the point where the tube from the chloroform bottle enters the mask. These two apertures are provided in order to supply contributory air so as to dilute the incoming vapour. They also serve the purpose of relieving the internal pressure

Explanation of diagram: A, 250 c.cm. glass flask, attachable at *a* and *a'*; B, suction bulb connected with the interior of the mask *D* by means of a tube piercing the indiarubber sheeting attached round the mask at *G*; C, propulsion bulb; E, expiratory valve; F, (near) revolving cap, by means of which the contributory air-inlet apertures are opened or closed.

within the mask. Both are closed by one rotatory movement of the cap placed where the tube enters. When these contributory inlets are closed, and the hand is working the bulb, a + pressure occurs inside the box, as the exit aperture, though only closed by a light indiarubber flap forming a valve, is too small to permit a free escape of vapour. When the bulb is worked, the percentage of chloroform vapour within the mask continues to rise, and finally approximates to what is obtained directly from the tube leading from the chloroform bottle before it enters the mask. For example:

(1) Percentage of chloroform vapour obtained directly from tube leading from bottle	12.7
(2) From exit valve of mask, all other apertures being closed	8.2

It appears, therefore, that if the mask is in close adaptation to the face by means of an air cushion at the rim, and the contributory air inlets are closed, the use of the apparatus is excessively dangerous. In all these experiments the percentage of chloroform vapour was estimated by densimetry, as suggested by Dr. Waller.

A 250 c.cm. glass flask is accurately weighed; it is then filled with a specimen of the vapour supplied, and is weighed again. Each c.cm. of chloroform vapour weighs 4 mg. more than a c.cm. of air. When there are 2.5 c.cm. of chloroform vapour in a 250 c.cm. bulb, there is 1 per cent. of chloroform vapour, and a 250 c.cm. flask containing 2.5 c.cm. of chloroform vapour will weigh 2.5×4 mg. more than the same flask filled with air—that is, 10 mg. more. So also 1.5 per cent. will weigh 15 mg. more, and 2.1 per cent. will weigh 21 mg. more. The percentages can be thus easily read in all cases.

In these experiments devices were made to simulate as far as possible the conditions obtaining in actual practice, both when the contributory inlet apertures are opened and when they are closed. On the assumption that a high + pressure within the mask is not likely to be met with, the lowest + pressure necessary to open the expiratory exit valve was used.

At first the large facial opening of the mask was closed by a rigid obturator of cardboard. In this a hole was made, fitted with an indiarubber tube attached to an elastic suction bulb. This suction bulb was relaxed at the same time that the propulsion bulb was compressed. By this means the vapour would be drawn through the

mask without unduly increasing the pressure within it. An improvement was made upon this by abandoning the cardboard obturator and substituting a covering of thin indiarubber sheeting, so that + pressure within the mask could be at once recognized. The 250 c.cm. glass flask was at first connected by tubing to the suction bulb. Very variable results were obtained, owing to the difficulty of preventing air being sucked back into the glass flask when the suction bulb was relaxed. Finally, fairly constant results were obtained by retaining the suction bulb so as to obtain a minimum + pressure within the mask, but attaching the glass flask by tubing to the exit aperture leading from the side of the mask, the slight + pressure needed to open the valve being so small as to be almost negligible.

Altogether ninety-four separate estimations were made under varying conditions. In every regular series of experiments the amount of liquid chloroform in the graduated bottle was constantly maintained at 8 drachms. Variations in the vapour percentages readily arise from small causes. There is a fall as the height of the column of liquid chloroform through which air is blown diminishes. The temperature of the chloroform bottle leads to variations, thus a percentage of 5.8 obtained when the bottle is standing on the table may be converted into a percentage of 6.5 when the bottle is placed inside the waistcoat. The possible errors are many, so that it cannot be claimed that the figures show with absolute accuracy the percentage of chloroform vapour supplied to the lungs of a patient. The experiments were, however, made with much care, and the results were sufficiently constant to be of practical use; for example:

On October 22nd ten successive experiments showed the following results:

Contributory Inlets Closed.			
Experi- ment.	Per- centage.	Experi- ment.	Per- centage.
1	5.2	6	5.4
2	4.8	7	4.9
3	5.7	8	5.2
4	5.0	9	5.5
5	5.4	10	5.0
Average percentage		5.2	

On November 12th:

Contributory Inlets Open.			
Experi- ment.	Per- centage.	Experi- ment.	Per- centage.
1	3.0	6	1.7
2	1.9	7	2.5
3	2.9	8	2.1
4	2.2	9	3.1
5	2.8	10	2.2
Average percentage		2.44	

These figures are eloquent enough, and seem to call for the permanent patency of the contributory air inlets, indeed, it seems to be desirable that the mechanism by which these inlets can be closed should be discarded, and that these instruments should issue from the maker's shop with permanent and uncloseable contributory inlets. A percentage of 5 per cent. is unsafe, and in a popular instrument should not be possible of attainment.

If the propulsion bulb is energetically worked a spray of liquid chloroform is easily propelled into or condensed upon the inner surface of the mask; it should always be noted throughout a series of experiments that everything is clean and dry.

CONCLUSIONS.

1. The plain vulcanite mask is safer than the more expensive form with rubber rim cushion.
2. The compression bulb must be worked gently and steadily.
3. The air inlet apertures should never be closed, and ought to be uncloseable.
4. It would be better to maintain the level of liquid chloroform in the graduated bottle at 5 drachms rather than at 8 drachms.
5. Owing to the variability of the percentages of chloroform vapour supplied the apparatus is not suitable for prolonged operations.
6. When all precautions are observed the use of the apparatus with the mask is fairly safe in careful hands for short periods of anaesthesia.

THE German Public Health Association will hold its thirty-first annual meeting this year at Augsburg from September 11th to 15th.