oxygen flows when oxygen masks of the B.L.B. type are used. The importance of this point, which has been noted by others—for example, Card *et al.* (1940)—may not have been fully appreciated because most masks have been first tested at simulated altitudes in a decompression chamber (Boothby, Lovelace, and Bulbulian, 1938; Kent, 1946; Cotes, 1951; Burns and Hall, 1953) under conditions in which carbon dioxide accumulation is beneficial, or at ground level on normal subjects who are little affected by the increase of ventilation. But subjects with a severe limitation of ventilatory capacity may be made acutely uncomfortable by the increase of ventilation or carbon dioxide retention. These subjects may continue to wear the mask with a small gap at the edge of the facepiece, thus avoiding retention at the cost of inadequate oxygenation of the lungs (E. A. Pask, 1955, personal communication).

Increasing the oxygen flow (Boothby, Mayo, and Lovelace, 1940) is an unsatisfactory remedy, both where economy of oxygen is important, as in domiciliary treatment or with portable equipment, and where there is a risk of accentuating carbon dioxide retention on this account. To achieve oxygen economy a high efficiency mask operating on the oxygen reservoir principle is needed, flows of 2–4 l./min. usually being sufficient. Smaller flows are better for patients with acute exacerbations of chronic lung disease; for these patients 1–3 l./min. has been recommended, either by nasal catheter (Simpson, 1954) or by a mask of the B.L.B. type (Westlake, 1954), but the two methods differ in their efficiency (Fig. 2) and in their liability to carbon dioxide retention, and are therefore not really interchangeable. If a mask which permits rebreathing is to be used in these circumstances it should be modified by the fitting of a check valve into the neck of the bag and used at a reduced oxygen flow. Unmodified masks of this type should be reserved for conditions in which some carbon dioxide inhalation is also desirable.

Summary

The relative efficiency of different types of personal equipment for the therapeutic administration of oxygen is considered. The highest efficiency is achieved by the use of a mask with a reservoir bag for the storage of oxygen during expiration. In one type of mask rebreathing into the bag is permitted; in the other it is prevented by a non-return valve situated at the neck of the bag.

The effect of the design of the oxygen mask upon ventilation has been reassessed during the breathing of oxygen, using a mouthpiece assembly having volume and flow characteristics similar to those of these two types of oxygen mask.

It has been found that for an oxygen flow of 3 l./min. the mean resting ventilation in six normal subjects and in 14 patients with chronic chest disease increased by 52%, from 7.5 to 11.4 and 8.6 to 13.2 l./min. respectively, when the non-return valve at the top of the oxygen reservoir bag was removed. The increase in ventilation is attributable to the rebreathing of expired carbon dioxide, which may also explain the discomfort experienced by some patients when using this type of mask.

It is suggested that masks employing the rebreathing principle should not be used for the administration of oxygen to patients liable to develop acute carbon dioxide retention, or for those with very low maximum ventilatory capacities. Where efficient usage is desirable, masks fitted with a valve at the top of the oxygen reservoir bag to prevent rebreathing are recommended.

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URINE CONCENTRATION AFTER FLUID DEPRIVATION OR PITRESSIN TANNATE IN OIL

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It has been demonstrated (Miles *et al.*, 1954) that in convalescent patients with normal renal function the concentration of the urine following dehydration is greater than after an injection of "pitressin" tannate in oil. The present paper confirms that this difference is also present in young healthy subjects, and describes some experiments designed to determine its cause.

Methods.—The observations were made on 49 students, nurses, and doctors carrying out their normal duties both before and during the experimental period; there were 41 men and 8 women, of an average age of 24 years. In all experiments, observations were made on urines collected during the following three periods: (1) 8 a.m.–12 noon, (2) 12 noon–4 p.m., (3) 4 p.m.–8 p.m.; these have been named the morning, afternoon, and evening periods. Urine osmolality was calculated from the freezing point, which was determined with a thermometer incorporated in a bridge circuit (de Wardener and del Greco, 1955).

Experiment 1

A comparison of the effect of 48 hours' dehydration and 5 units of pitressin tannate in oil on urine osmolality, urine flow, and solute output.

This comparison was made on 17 subjects. Fluid deprivation was for 48 hours, beginning at 8 p.m.; during this time all fluids, including soups, ice creams, and fruit, were avoided, but the meals were otherwise normal. Urine was collected during the last twelve hours of this period.

One to two weeks later each subject was given a subcutaneous injection of pitressin tannate in oil at 7 a.m.,

followed by a litre of water by mouth at 8 a.m. This was found necessary, for some of the subjects (particularly women) habitually consumed so little fluid that the concentration of the urine on a control day might be the same as after 48 hours' dehydration (Table I); unless water was given to all subjects, therefore, results attributed to pitressin

TABLE I.—*Similarity, in Two Women, Between the Urine Concentration at the End of 48 Hours' Dehydration and When Normally Hydrated During Control Conditions. Results Obtained on Urine Collected from 12 noon to 8 p.m.*

Subject No.	Urine Osmolarity (m.Osm./l.)	Urine Flow (ml./min.)	Solute Output (μ.Osm./min.)
7 { After 48 hours' dehydration	1,025	0.39	399
{ Normally hydrated ..	1,030	0.38	393
8 { After 48 hours' dehydration	1,015	0.421	436
{ Normally hydrated ..	1,092	0.568	621

might in fact be caused by dehydration. During the next twelve hours meals and fluids were taken according to the subject's natural inclinations.

The urines which have been compared were collected during the last eight hours of dehydration—that is, from 12 noon to 8 p.m.—and during the corresponding period on the day on which the pitressin was given.

The results are shown in Table II. The urine osmolarity was significantly greater after dehydration than after pitressin, while the urine flow and solute output were significantly

TABLE II.—*Experiment 1. Comparison of the Effect of 48 Hours' Dehydration and 5 Units of Pitressin Tannate in Oil on the Urine Osmolarity, Urine Flow, and Solute Output. Results Obtained on Urine Collected from 12 noon to 8 p.m.*

Subject No.	Osmolarity (m.Osm./l.)		Urine Flow (ml./min.)		Solute Output (μ.Osm./min.)	
	After 48 Hours' Dehydration	After 5 Units Pitressin	After 48 Hours' Dehydration	After 5 Units Pitressin	After 48 Hours' Dehydration	After 5 Units Pitressin
1	1,168	1,008	0.393	0.656	459	657
2	1,122	882	0.482	0.603	540	531
3	1,082	971	0.557	0.607	603	597
4	1,079	1,026	0.321	0.502	348	516
5	1,194	993	0.442	0.811	528	804
6	1,020	813	0.457	0.820	465	636
7	1,025	998	0.389	0.655	399	651
8	1,015	1,092	0.421	0.431	436	471
9	1,063	863	0.507	1.004	537	867
10	1,247	1,096	0.478	0.562	594	603
11	1,301	1,008	0.485	0.832	582	840
12	1,009	922	0.647	0.925	621	846
13	1,216	1,135	0.468	0.631	570	711
14	1,220	916	0.478	0.891	582	786
15	1,070	846	0.397	0.514	426	450
16	1,110	1,022	0.475	0.621	525	633
17	1,067	937	0.477	0.700	528	639
Mean ..	1,118	972	0.463	0.692	514	661
Difference of means	146 ± 31		0.229 ± 0.043		147 ± 37	
t ..	4.688		5.316		3.96	
P ..	< 0.001		< 0.001		< 0.001	

less. The correlation coefficient between urine osmolarity and solute output calculated from the combined results during dehydration and following pitressin was $r=0.2965$, which is not significant at the 5% level.

Experiment 2

Comparison of the rate of solute output during control conditions and following 5 units of pitressin tannate in oil.

In 14 subjects the urine excreted from 12 noon to 8 p.m. on a normal control day was collected, and the rate of solute output compared with that obtained following an injection of 5 units of pitressin tannate in oil. The results are shown in Table III. The solute output during control conditions was significantly greater than after pitressin.

It is concluded that the difference in the rate of solute output between that found in the dehydrated state and that following pitressin (Experiment 1) is not due to the pitressin increasing the solute output above control values.

TABLE III.—*Experiment 2. Comparison of the Solute Output During Control Conditions and Following 5 Units of Pitressin Tannate in Oil. Results Obtained on Urine Collected from 12 noon to 8 p.m.*

Subject No.	Solute Output (μ.Osm./min.)	
	Control	After 5 Units Pitressin
1	1,116	657
2	921	531
4	564	516
5	867	804
6	681	636
7	390	651
8	663	471
9	699	864
10	795	603
11	972	840
12	855	846
13	1,017	711
14	807	786
18	612	432

$$t=2.198. \quad P = < 0.05.$$

Experiment 3

A comparison of the effect of 48 hours' dehydration and 5 units of pitressin tannate in oil on the urine osmolarity, urine flow, and solute output during standardized food intake.

The experiment was performed in two subjects. Dehydration, and pitressin administration were the same as in Experiment 1, except that the food intake was made identical for three days on each occasion. Deprivation of fluid took place during the last 48 hours of the first three-day period of controlled food intake, and pitressin was administered on the third day of the second period. The urines which have been compared were collected in the same way as in Experiment 1.

The results are shown in Table IV. The urine osmolarity was substantially greater and the urine flow smaller in both subjects during dehydration, though in each the solute out-

TABLE IV.—*Experiment 3. Comparison of the Effect of 48 Hours' Dehydration and 5 Units of Pitressin Tannate in Oil on Urine Osmolarity, Urine Flow, and Solute Output During Standardized Food Intake. Results Obtained on Urine Collected from 12 noon to 8 p.m.*

Subject No.	Urine Osmolarity (m.Osm./l.)	Urine Flow (ml./min.)	Solute Output (μ.Osm./min.)
1 { After 48 hours' dehydration	1,207	0.503	605
{ Pitressin	1,040	0.540	562
2 { After 48 hours' dehydration	1,155	0.564	652
{ Pitressin	973	0.66	642

put was almost the same, being slightly greater during dehydration. The urea excretion rate in both subjects was also higher, following pitressin, being respectively 27 and 23 μ.Osm./min. greater than with dehydration.

It is concluded from these results and from those obtained in Experiment 1 that the difference in urine osmolarity between that found after dehydration and that following pitressin is unlikely to be due to a difference in the rate of solute output.

Experiment 4

Comparison of the effect of varying doses of pitressin tannate in oil on urine osmolarity, urine flow, and solute output.

These observations were made on nine subjects on three separate occasions, at weekly intervals. On each occasion an injection of pitressin tannate in oil was given at 7 a.m. and a litre of water at 8 a.m. In five subjects the first dose of pitressin was 2.5 units; this was increased to 5 units and then 10 units in the next two experiments, while in the other four subjects the order of the pitressin dosage was reversed. Meals and fluids were according to the subjects' inclinations. The urines which have been compared were collected during the eight-hour period from 12 noon to 8 p.m.

The results are shown in Table V. There was no significant difference between the results obtained with 2.5, 5, and 10 units of pitressin.

TABLE V.—Experiment 4. Comparison of the Effect on Urine Osmolarity, Urine Flow, and Solute Output of Varying Doses of Pitressin Tannate in Oil. Results Obtained on Urine Collected from 12 noon to 8 p.m.

Pitressin units:	Osmolarity (m.Osm./l.)			Urine Flow (ml./min.)			Solute Output (μ.Osm./min.)		
	2.5	5	10	2.5	5	10	2.5	5	10
Subject No.									
2	923	882	966	0.713	0.603	0.676	657	531	651
3	1,085	971	900	0.369	0.617	0.766	517	591	690
4	1,069	1,026	1,065	0.533	0.502	0.577	570	516	615
5	888	993	902	0.845	0.811	0.773	741	804	699
10	1,190	1,096	1,138	0.667	0.562	0.744	795	602	834
11	1,150	1,008	1,135	0.602	0.832	0.660	693	840	741
12	910	922	865	0.708	0.925	0.770	645	846	663
13	1,067	1,135	1,150	0.860	0.631	0.628	912	711	723
14	960	916	1,022	0.611	0.891	0.952	576	786	966
Analysis of variance test									
F ..	0.2334			0.6089			0.5642		
P ..	>0.05			>0.05			>0.05		

It is concluded that the lower concentration of the urine following 5 units of pitressin tannate in oil compared with that achieved during dehydration is not due to this dose being either inadequate or excessive.

Experiment 5

The effect of 5 units of pitressin tannate in oil on the urine osmolarity, urine flow, and solute output during dehydration.

The effect of pitressin during dehydration has been compared with the effect of dehydration alone. The observations were made in 20 subjects dehydrated for 36 hours beginning at 8 a.m.; the conditions of dehydration were the same as those in Experiment 1. Urine was collected at four-hourly intervals during the last twelve hours of dehydration—that is, from 8 a.m. to 8 p.m. In 10 of the subjects an injection of 5 units of pitressin tannate in oil was given subcutaneously at 12 noon of the day on which the urine was being collected.

TABLE VI.—Experiment 5. Effect of 5 Units of Pitressin Tannate in Oil on Urine Osmolarity, Urine Flow, and Solute Output During the last Twelve Hours of a 36-Hour Period of Dehydration, Compared with the Effect of Dehydration Alone. The Differences Between the Evening (4 p.m. to 8 p.m.) and Morning (8 a.m. to 12 noon) Urine in Each Group are Compared

Subject No.	Difference between Evening and Morning Urines (p.m.—a.m.)		
	Osmolarity (m.Osm./l.)	Urine Flow (ml./min.)	Solute Output (μ.Osm./min.)
During 36-Hr. Dehydration			
19	+65	-0.133	-84
20	+45	+0.150	+168
21	+70	+0.125	+174
22	+100	-0.163	-144
23	-28	+0.435	+465
24	+100	-0.212	-165
25	+165	-0.027	+57
26	+85	-0.123	-87
27	+130	-0.222	-135
28	+200	-0.078	+81
During 36-Hr. Dehydration + Pitressin at Noon			
29	+167	-0.165	-18
30	+187	-0.181	+48
31	+45	+0.025	+51
32	+80	-0.013	+18
33	-44	+0.223	+195
34	-34	+0.319	+384
35	+110	-0.009	+27
36	-140	+0.304	+267
37	+165	-0.264	-318
38	-2	+0.192	+204

t test on the difference between the differences in the two groups:
 Osmolarity .. t=1.0048; P>0.05
 Urine flow .. t=1.7320; P>0.05
 Solute output .. t=0.6041; P>0.05

To avoid any emotional effect of the pitressin injection, and in order to allow time for the pitressin to be absorbed, the urine collected in the morning (8 a.m. to 12 noon) has been compared with that obtained in the evening (4 p.m. to 8 p.m.) in all 20 subjects. The effect of the pitressin has been estimated by comparing the differences between the morning and evening urines in the two groups.

The results are shown in Table VI. The changes in urine flow, osmolarity, and solute output between the morning and evening periods in the control dehydrated group were not significantly different from the changes which occurred between the same periods in the group who were similarly dehydrated but given pitressin at noon.

It is concluded that the lower concentration of the urine following 5 units of pitressin tannate in oil, compared with that achieved during dehydration, is not due to some property of pitressin (as opposed to endogenous antidiuretic hormone) which prevents the kidney from concentrating to its maximal extent.

Experiment 6

The effect in a dehydrated subject, who has been given pitressin, of a large drink of water on urine osmolarity, urine flow, and solute output.

The effect of water ingestion in a dehydrated subject who has also been given pitressin has been compared with the effect of dehydration alone.

TABLE VII.—Experiment 6. Effect of 1.5 l. of Water by Mouth in Dehydrated Subjects Who Have Been Given 5 Units of Pitressin Tannate in Oil, Compared with the Effect of Dehydration Alone. The Differences Between the Afternoon (12 noon to 4 p.m.) and the Morning (8 a.m. to 12 noon) Urine in Each Group are Compared

Subject No.	Difference between Afternoon and Morning Urines (p.m.—a.m.)		
	Osmolarity (m.Osm./l.)	Urine Flow (ml./min.)	Solute Output (μ.Osm./min.)
During 36-Hr. Dehydration			
19	+60	-0.100	-81
20	-75	+0.325	+342
21	-20	+0.140	+138
22	+80	-0.167	-155
23	+30	+0.130	+165
24	-30	+0.076	+51
25	+25	+0.193	+198
26	+70	-0.101	-69
27	+165	-0.362	-366
28	+110	-0.109	-15
During 36-Hr. Dehydration + Pitressin at 7 a.m. + 1.5 l. H ₂ O at Noon			
4	+205	-0.820	+72
11	-50	+0.112	+339
15	+68	-0.100	-78
39	+40	-0.045	-18
40	-45	+0.085	+75
41	-121	+0.312	+258
42	+147	-0.345	-282
43	+120	+0.060	+123
44	+100	-0.005	+51
45	0	+0.212	+222
46	-22	+0.200	+189

t test on the difference between the differences in the two groups:
 Osmolarity .. t=0.03495; P>0.05
 Urine flow .. t=0.4068; P>0.05
 Solute output .. t=0.7988; P>0.05

The control data used were those obtained from the control group in Experiment 5. The experimental data were obtained from a group of 11 subjects who were dehydrated for 28 hours, beginning at 8 a.m.; after 23 hours' dehydration—that is, at 7 a.m.—they were given an injection of 5 units of pitressin tannate in oil, and at the end of the 28th hour of dehydration—that is, at 12 noon—they drank 1.5 litres of water over a period of an hour. The effect of this water load has been estimated by comparing the differences between the morning (8 a.m. to 12 noon) and afternoon (12 noon to 4 p.m.) urine in the two groups. It was previously ascertained in three other subjects that drinking 1.5 litres of water during the 29th hour of a period of dehydration induces a substantial diuresis.

The results are shown in Table VII. The changes in urine osmolarity, urine flow, and solute output between the morning and afternoon periods in the control dehydrated group were not significantly different from the changes which occurred in the group who were dehydrated, given pitressin, and then drank 1.5 litres of water at midday.

It is concluded that in dehydration there is some factor, other than the level of circulating antidiuretic hormone (A.D.H.), which causes the urine of subjects who have been dehydrated to be more concentrated than that of subjects who have been given pitressin when hydrated. It is also evident that this factor does not disappear within two to three hours of drinking a quantity of fluid sufficient to produce a diuresis in a dehydrated subject not given pitressin.

Discussion

The finding that in normal subjects the urine concentration following dehydration is greater than after a subcutaneous injection of 5 units of pitressin tannate in oil confirms the observation made in convalescent subjects (Miles *et al.*, 1954). This difference does not appear to be dependent on the rate of solute output, for, though dehydration was accompanied by a lower solute output, the correlation between osmolarity and solute output is not significant, and in two subjects given identical meals during dehydration and during administration of pitressin the concentration of the urine was greater after dehydration, though the solute outputs were the same in both experiments. The same lack of correlation is apparent from inspection of the illustrations of West *et al.* (1955), which are derived from the results of similar experiments to those reported here.* Neither is the lower concentration obtained with pitressin due to an inadequate or excessive quantity of pitressin, for the results were the same after 2.5, 5, and 10 units; nor for the following reason does it appear to be due to any qualitative difference that may exist between circulating A.D.H. and pitressin. The administration of 1.5 litres of water to dehydrated subjects who had been given pitressin was without effect on the concentration of the urine, but if given to dehydrated subjects who had *not* been given pitressin there was a prompt and substantial diuresis with a fall in urine osmolarity. This diuresis was due presumably to a decrease in the level of circulating A.D.H., a decrease which must have occurred in both groups, but as there was no fall in urine concentration in those who were given pitressin it is deduced that, following dehydration, pitressin is as effective as A.D.H. in producing a concentrated urine.

It follows that dehydration is associated with some factor which, when combined with either A.D.H. or pitressin, causes the urine to be more concentrated than when pitressin is given in the hydrated state. The existence of such a factor is also implicit from the results of Shannon's (1942) experiments on dogs with diabetes insipidus, in which it is reasonable to suppose there was little or no capacity to produce A.D.H. He found that if the animals were normally hydrated the administration of pitressin did not lower the urine flow, or raise the creatinine U.P. ratio to the same level as if it were given after a period of dehydration, when the values were comparable to those obtained in normal dogs following a period of severe dehydration. Similar results have been obtained in human diabetes insipidus (Leaf *et al.*, 1952).

It is concluded that the urine following dehydration is more concentrated than after pitressin because of a mechanism which allows a greater proportion of tubular water to be reabsorbed independently of the rate of solute output, and which works equally well in the presence of either A.D.H. or pitressin.

*Since the completion of the experiments described here West *et al.* (1955) have reported their findings in a similar investigation, and some of their results have been referred to above. The procedures they used, however, and the number of experiments they performed differ so widely from those reported here that it is difficult to make many justifiable comparisons, but in general the data from both investigations are in agreement.

Summary

The urine osmolarity, urine flow, and solute output after 48 hours' dehydration are compared with the values obtained after a subcutaneous injection of 5 units of pitressin tannate in oil.

The urine osmolarity is greater, and the urine flow and solute output are less, after dehydration.

The difference in osmolarity does not appear to be dependent on the rate of solute output or on the quantity or quality of the pitressin administered.

It is concluded that during dehydration there is a factor, other than the antidiuretic hormone or the rate of solute output, which is concerned with concentrating the urine.

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BENIGN ASCITES

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Most cases of ascites are probably due to cardiac failure, cirrhosis of the liver, or malignant disease involving the peritoneum or obstructing the portal vein. Other causes are states associated with depletion of the blood proteins, such as the nephrotic syndrome and starvation, grave anaemia, tuberculous peritonitis, the syndrome of "polyserositis," ruptured ovarian cyst, and thrombosis of the portal vein. The last-named is described as occurring as a complication of cirrhosis of the liver and of malignant disease.

According to the textbooks none of these causes of ascites is benign, and only when the condition is due to grave anaemia, starvation, tuberculous peritonitis, and the nephrotic syndrome is there said to be hope of complete recovery. I have been unable to discover in the literature any reference to ascites appearing in otherwise apparently healthy patients and later clearing up completely. The following case reports indicate that such ascites can occur.

Case 1

A married woman aged 22, referred by Dr. R. Woollett, was admitted to the Farnham Hospital in June, 1949, with the history that for two weeks she had had increasing enlargement of the abdomen. She denied having any symptoms, apart from some effort dyspnoea and nausea, and there was nothing relevant in her previous history. On examination the abdomen was greatly distended with fluid; otherwise she appeared healthy and no signs could be found. Twelve pints (6.8 litres) of yellow fluid was drained off. She ran an irregular temperature up to 100° F. (37.8° C.) for the first week, but had no fever subsequently.

Investigations.—Peritoneal fluid: slightly cloudy and yellow; R.B.C., 2,000 per c.mm.; W.B.C., 100 per c.mm. (mainly lymphocytes); protein, 2,200 mg. per 100 ml.; no acid-fast or other organisms seen; no growth on culture. E.S.R. 30 mm. after one hour (Westergren). Blood count: Hb, 75% (11.1 g. per 100 ml.); R.B.C., 4,400,000 per c.mm.; W.B.C., 4,000 per c.mm. (3,400 polymorphs, 520 lympho-