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Research Article

INORGANIC SULPHATES IN HUMAN BLOOD

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INTRODUCTION

In recent years, many of the electrolytes of the blood have been intensively studied under normal and pathological conditions in human beings. The inorganic sulphate ion has not participated in this general interest, as has been pointed out by Denis (1), because of the minute amounts normally present and because of its apparent lack of importance from a physiological standpoint.

Denis, in 1921, reported a large number of SO_4 determinations, made nephelometrically, on human blood in normal individuals and in various diseases. In view of the fact that this is the only comprehensive study of this subject in addition to those of White (2) and Kahn (3), it seems justifiable to report a similar series of observations made some years ago by a *gravimetric* method even though the results merely confirm those of Denis.

METHOD

One drop of caprylic alcohol and 10 cc. of serum are placed in a 50 cc. volumetric flask. To this are added 10 cc. of water and 30 cc. of saturated aqueous picric acid solution. After thorough mixing, the contents are *rapidly* centrifuged (to avoid evaporation) and the supernatant fluid is filtered. A 30 cc. aliquot is placed in a 50 cc. beaker and 5 cc. of one per cent $BaCl_2$ solution are slowly added. The precipitation is allowed to go on for at least 6 hours and then the solution is filtered through a 7 cm. ash free filter paper (sometimes two to four filtrations are necessary) and the precipitate is washed 5 times with 4 cc. of water acidulated with HCl. The filter is ignited slowly in a weighed platinum crucible with the lid only slightly open until charring has occurred. Later, the lid is kept about half open to prevent excessive reduction of $BaSO_4$. Care must be taken not to allow the filter to burst into flame. Ignition should take about 25 minutes. The crucible should be weighed as soon as it is cool. A certain amount of reduction of

TABLE 1

Addition and recovery of SO_4 from serum

SO_4 added	SO_4 recovered	Calculated as SO_4 per 100 cc. serum	
		Found	Theoretical
mgm.	*mgm.*	*mgm. per 100 cc.*	*mgm. per 100 cc.*
2.00	1.92	26.0	26.8
2.00	1.85	21.2	22.7
2.00	1.89	24.7*	25.8
2.00	1.89	25.6*	25.8
2.00	2.05	27.4†	26.9
2.00	2.19	28.8†	26.9
1.00	0.89	15.1	16.1
1.00	1.30	17.8	14.8

N.B.: Determinations marked (*) and (†) are duplicates.

TABLE 2

Normals

Number	$BaSO_4$ weighed	Expressed as SO_4 in serum		Urea N	Non-protein N
	mgm.	*mgm. per 100 cc.*	*mEq. per L.*	*mgm. per 100 cc.*	*mgm. per 100 cc.*
Lo	0.4	2.7	0.6	13.3	28.3
Lo	0.5	3.4	0.7	12.2	35.4
Zi	0.6	4.1	0.9		
Re	0.7	4.8	1.0		
Se	0.3	2.1	0.4		
We	0.5	3.4	0.7		
Be	0.5	3.4	0.7		
Ru	0.5	3.4	0.7		
La	0.6	4.1	0.9	17.3	
So	0.6	4.1	0.9		
Ti	0.2*	2.4	0.5		
Ho	0.4*	3.4	0.7	12.5	24.0
At	0.4	2.7	0.6		32.9
Average normal.....		3.4	0.7		
Highest normal.....		4.8	1.0		
Lowest normal.....		2.1	0.4		

* Seven cubic centimeters of serum and a 35 cc. aliquot were used instead of the customary 10 cc. of serum and a 30 cc. aliquot.

$BaSO_4$ appears to take place but the errors resulting therefrom are not significant. While the amounts weighed are very small and while there are several sources of possible error, the results obtained with the method have been fairly constant.

TABLE 3

Cardiac and renal disease

Name	Diagnosis	$BaSO_4$	Expressed as SO_4 in serum		Urea N	Non-protein N
		mgm.	*mgm. per 100 cc.*	*mEq. per L.*	*mgm. per 100 cc.*	*mgm. per 100 cc.*
Gray	Toxemia of pregnancy	0.8	5.5	1.1		
Gray	Toxemia of pregnancy	0.5*	4.2	0.9	14.7	30.0
Di Leonardo	Mitral disease	0.9	6.2	1.3		
Schuhmacher	Acute nephritis	1.2*	10.0	2.1	48.3	75.0
Garntyuk (duplicate)	Chronic nephritis	1.4	9.6	2.0		68.0
		1.3	8.8	1.8		
Garntyuk	Chronic nephritis	1.3	8.9	1.9		49.2
Gordon	Hypertension	0.6	4.1	0.9	9.3	
Wilkins	Hypertension	0.9*	7.5	1.6	18.7	37.8
Snufsky	Uremia	7.5	51.4	10.7	158.0	214.0
Snufsky	Uremia	5.7	39.0	8.1	138.0	200.0
Mason	Hypertension	0.8	5.5	1.1	9.0	22.0
Andrews	Chronic nephritis	0.9	6.2	1.3	15.4	33.8
Putney	Cardiac decompensation	1.5	10.3†	2.2		38.0
Williamson	Hypertension	1.0	6.9	1.4		55.0
Galloway	Hypertension	0.7*	5.9	1.2		40.0
Brown	Hypertension	0.9	6.2	1.3		46.1
Geo. Smith	Hypertension	1.0	6.9	1.4	19.9	36.5
Sava	Chronic nephritis	5.4	37.0	7.7		160.0
Taylor	Chronic nephritis	2.1	14.4	3.0		111.0

* Seven cubic centimeters of serum and a 35 cc. aliquot were used instead of the customary 10 cc. of serum and a 30 cc. aliquot.

† Following $Mg \cdot SO_4$ administration.

TABLE 4

Miscellaneous cases

Name	Diagnosis	$BaSO_4$ weighed	Expressed as SO_4 in serum		Urea N	Non-protein N
		mgm.	*mgm. per 100 cc.*	*mEq. per L.*	*mgm. per 100 cc.*	*mgm. per 100 cc.*
1	Rheumatic fever	0.4	2.7	0.6		
2	C.N.S. lues	1.0	6.8	1.4		
	Acute glaucoma	0.7	4.8	1.0		
3	Pneumonia	0.9*	7.5	1.6	14.3	28.7
4	Pernicious anemia	0.7	4.8	1.0		
5	Portal cirrhosis	0.5	3.4	0.7		41.6
6	Diabetes mellitus	0.8	5.5	1.1		

* Seven cubic centimeters of serum and a 35 cc. aliquot were used instead of the customary 10 cc. of serum and a 30 cc. aliquot.

RESULTS

From table 1 it may be seen that addition and recovery determinations of sulphate added to serum are quite satisfactory. Table 2 shows that the sulphate content of normal serum is approximately the same as that obtained by Denis. Table 3 shows that the concentration of SO_4 in the blood of patients suffering from cardiac and renal disorders is at times markedly increased and that it nearly parallels the retention of nitrogen. Table 4 shows that there is little deviation from the normal SO_4 values in certain other pathological conditions.

CONCLUSIONS

1. The normal SO_4 content of serum varies between 0.40 and 1.00 milli-equivalent per liter when determined by the *gravimetric* method described above and the results are in close agreement with the findings of Denis.

2. In nephritis with nitrogen retention the SO_4 ion is retained in the blood and roughly parallels the non-protein nitrogen as Denis has shown. The concentration of SO_4 in serum may reach 10 milli-equivalents per liter.

3. Inorganic SO_4 plays a relatively important rôle in the partition of the acid radicals in the blood in nitrogen retention nephritis.

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