THE MEDICAL JOURNAL OF MALAYA,
Vol. XV, No. 2, December, 1960.

MILLI-EQUIVALENTS AND TRANSFUSION SOLUTIONS

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Over the past ten years there has been a growing tendency to express the formula of intravenous solutions in terms of "Milli-equivalents" as opposed to expressing the strength in terms of a "Percentage Weight/Volume Solution". The change of terminology is largely due to the development of the flame photometer by which the quantitative analysis of Sodium and Potassium in body fluids can now be rapidly and accurately determined. The results of such analysis are expressed in Milli-equivalents. Therefore it is obviously of benefit to the physician or surgeon to express the composition of intravenous or replacement fluids in similar terms whereby the accurate chemical composition of the fluid concerned can be immediately assessed.

It will be remembered that the definition of "Equivalent Weight" is defined as the weight of an atom or radical divided by its valency. A Milli-equivalent is one thousandth part of the equivalent weight, and this amount when dissolved in one litre forms a milli-equivalent solution. Normal Saline contains 0.9% w/v of Sodium Chloride, i.e. 9,000 mgm per litre. As the molecular weight of Sodium Chloride is 58.5 (Na = 23, Ci = 35.5) therefore normal saline contains $\frac{9000 \times 23}{58.5}$ = 3,540 mgm of Na per litre balanced by (9000 — 3540), i.e. 5460 mgm Cl per litre. There is no obvious relation between these two figures. However, a clearer picture is obtained when expressed in terms of Milli-equivalents. A Milli-equivalent of Na contains 23 mgm per litre. Therefore the number of mEq/L of Na in Normal Saline is $\frac{3540}{23}$ = 154 mEq/Litre and the number of mEq/L of Cl. is expressed by $\frac{5460}{35.5}$ = 154 mEq/L Cl, which immediately clarifies the balance between the acidic and basic Ions.

The following rule can be formulated:

$$\text{mEq/L} = \frac{\text{Mgm/Litre} \times \text{Valency}}{\text{Atomic Weight}}$$

or conversely:

$$\text{Mgm} = \frac{\text{Milli-equivalents} \times \text{Molecular Weight}}{\text{Valency}}$$

The advantage of adopting the milli-equivalent system can be further illustrated by comparing the average ionic composition of blood plasma of an adult person in health when represented in the milli-equivalent and mgm per cent systems.

BASE			ACID		
mEq/L		Mgm/cent	mEq/L		Mgm/cent
Na	142	330	HCO_3'	27	3.5
K′	5	15	CL′	103	360
Ca″	5	10	HPO_4''	2	3.5
Mg	3	2.5	SO_4''	1	—
			ORG.AC	6	—
	155		PROTEIN	16	—
				155	

DIAGRAM 1

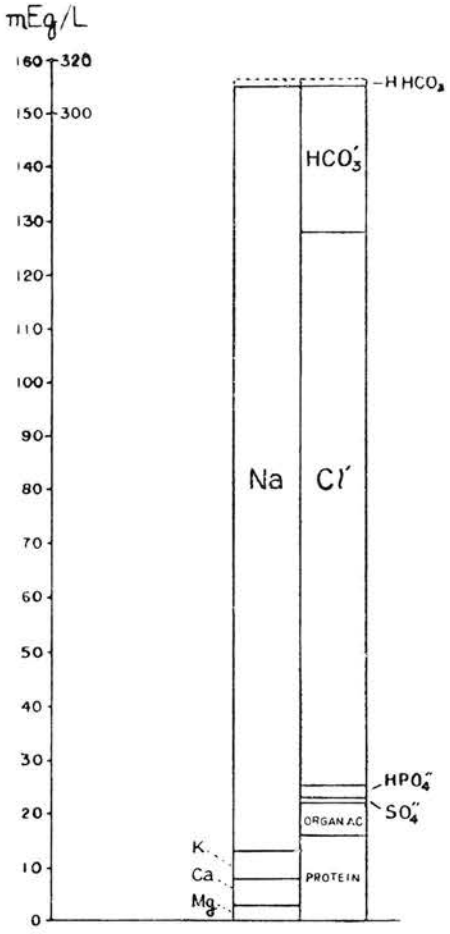
Diagram 1 is constructed by superimposing the individual values for the cations in the left hand column and those for the anions in the right hand column. From this diagram it is clearly observed that nearly all of the base (91 per cent) is Sodium and that Chloride is the largest component of the total acid value. The next largest item of structure is the concentration of the Bicarbonate ion (HCO_3) which, together with the base that it covers, constitutes the plasma bicarbonate. The value for the sum of organic anions in the plasma is taken as the difference between the sum of the other ions and the total base. The line down the centre demonstrates that in assessing the constituents of blood plasma, separately controlled quantities of individual ions have to be considered and not salts.

The Milli-equivalent strengths of some of the solutions used for the treatment of electrolyte imbalance are given in the following table:

INTRAVENOUS FLUID	IONIC CONCENTRATION IN mEq/L								
	Na^+	K^+	Ca^{++}	Mg^{++}	NH_4^+	Cl^-	HCO_3 equiv.	PO_4^-	Lactate$^-$
Isotonic Saline (0.9%)	154					154			
Ringers Solution	147	4	6			157			
Ringers Lactate (Hartmann's)	130	4	4			111	27		22
M/6 Sodium Lactate	167						167		
Darrows Solution	121	35				103	53		
M/6 Ammonium Chloride					167	167			
Potassium Chloride 0.2% in 5% Dextrose		27				27			
Ammonium Chloride 0.9%					170	170			
Nabarro's Repair Solution	20	30		5		45		10	
Dextrose in 0.33% Saline	51					51			
Dextrose in 0.45% Saline	77					77			
Children's Balanced Solution	25	20		3		22		3	23
Adults' Balanced Solution	40	35				40		15	20
Saline — Potassium Mixture in 2.5% Dextrose (Isotonic)	40	40				80			
Potassium Chloride 0.3%		40				40			

By the implementation of the milli-equivalent system in transfusion solutions the physician or surgeon having the results of accurate quantitative assessment of the biochemical derangement when fluid and electrolyte losses have occurred can build his prescription for corrective therapy.

ACID-BASE COMPOSITION OF BLOOD PLASMA



ACKNOWLEDGMENTS

I wish to thank the Director of Medical Services of the Federation of Malaya for permission to publish this article and also to Dr. J. L. Gamble for the reproduction of Chart 4 from his Chemical Anatomy, Physiology and Pathology of Extracellular Fluid published by the Harvard University Press.