FLUID - ELECTROLYTE AND ACID - BASE DISTURBANCES IN GASTRO - INTESTINAL DISEASES .

THESIS

SUBMITTED FOR PARTIAL FULLFILIMENT OF M.S. DEGREE IN GENERAL SURGERY

BY

ISMAIL ABDEL HAKIM RADWAN

SUPERVISED BY ,

* PROFFESSOR DR. MAHMOUD A. NAGUIB ,
PROFFESSOR OF SURGERY ,
AIN SHAMS UNIVERSITY .

* DR. IMAM FAKHR ,
LECTURER IN GENERAL SURGERY .

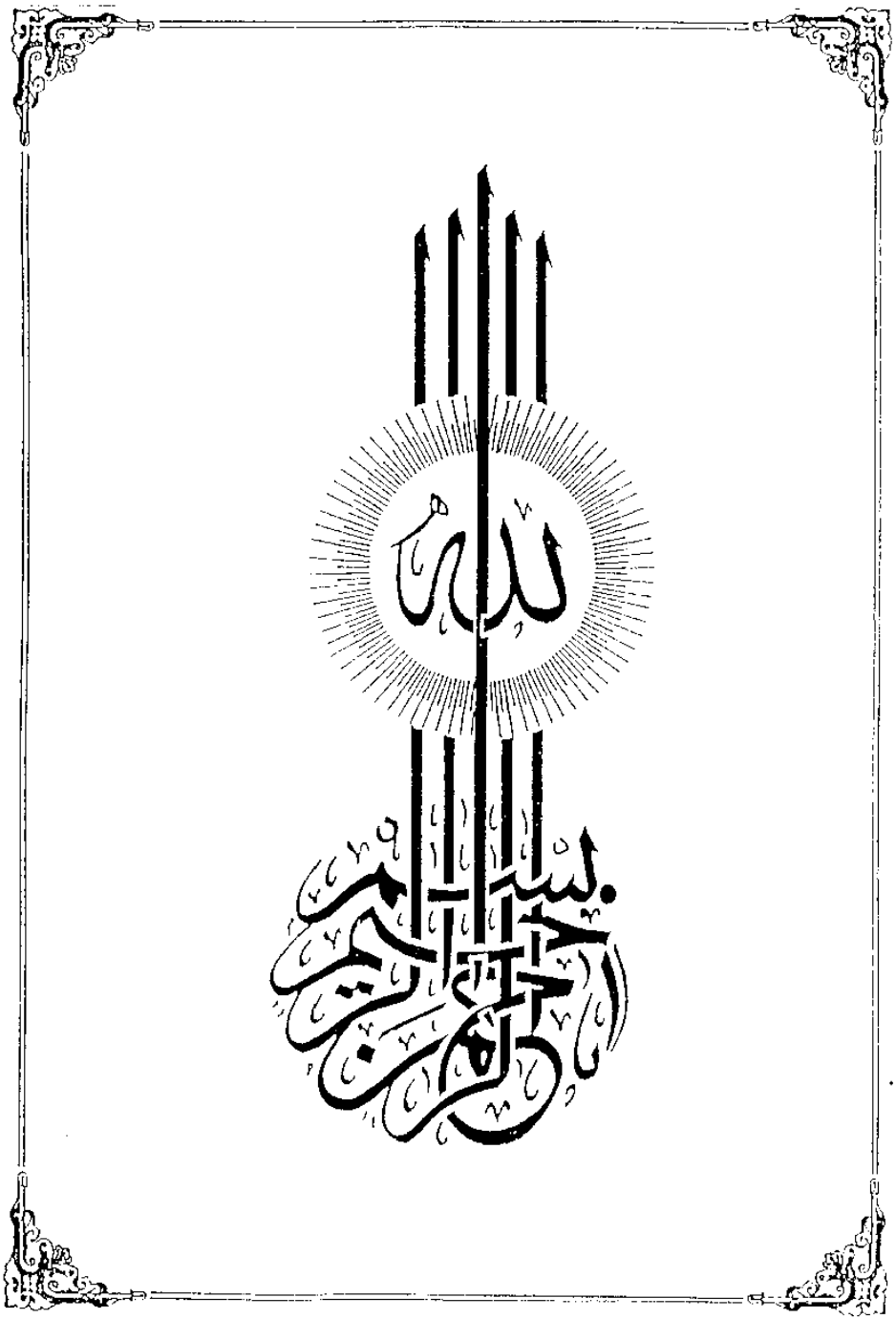
" ACKNOWLEDGEMENT "

In a trial to be truthful to that who offered me the best chances to work , to study and to advance straight forward , I just put a few words of gratitude for our Professor Dr. MAHMOUD MAGUIB , the headmaster of our section who tries to train us not only as good surgeons but more important his trial to make from every one a responsible man of good behaviour , attitude , and high principle .

If I'm allowed to ask for something , I only ask my God to keep long our Professor Dr. MAHMOUD MAGUIB for his sons who are the residents of his section , the assistant lecturers and the lecturers , as he usually calls .

May God help us all and thank you .

Ismail A. Radwan .



" INTRODUCTION "

In this thesis I am just putting a trail to simplify the difficult subject of fluid - electrolyte and acid - base disturbances . This trail , I hope , will through the light on the points of surgical importance as our job needs .

Thank you .

Ismail A. Radwan .

May 1982 .

CONTENTS :-

* * * * *

A. " BODY FLUID COMPARTMENTS "

There are two main compartments for body fluids which are :-

* intracellular compartment .
* extracellular compartment .

The extracellular compartment is distributed in two main sites :-

* the blood plasma .
* the interstitial fluid .

The average adult male weighing 70 Kg has got :- 18 % of body wt protein , 7 % minerals and 15 % fat . The remaing 60 % of body weight is water distributed in these previous spaces . Of these 60 % body weight , 40 % is intracellular water and 20 % is extracellular water . Of the 20 % , 5 % is plasma and 15 % is interstitial fluid . The interstitial fluids include also , but a separate group , transcellular fluids .

Transcellular Fluids :-

These include the aqueous humour , Synovia , lymph , endolymph in the ear and CSF . These are considered as a separate group and affected but little by changes in body water .

Determination Of Body Fluid Volumes :-

The dilution principle is the one mostly used for measurement . A substance that mixes evenly and thoroughly in the body fluids , not metabolized or excreted rapidly and does not affect the distribution of water is injected . After mixing has occurred a sample is withdrown and the concentration of

the substance measured and we can conclude the volume of dilution which is the volume of the required space . For measuring the plasma volume , Evans blue or Iodine tagged albumin is used , and for measuring the extracellular space volume inulin is the one mostly used . To measure the intracellular fluid space is a big problem but we can deduce it . We measure the total body water using Deuterium oxide (heavy water) or tritium oxide , then we substract from it the extracellular space volume , the remaining is the intracellular space volume .

It is the extracellular space water which is depleted in dehydration and consequently water is withdrown from the cells leading to intracellular dehydration .

Thus dehydration begins extracellular but ends intracellular.

The relation of extracellular space volume to intracellular space volume is an important factor in dehydration . The larger the ratio as it is in infants and children the more rapidly dehydration occurs and consequently more dangerous .

Normal water Exchange :-

In an average adult male in temprate climates ; water is gained by :-

- 500 - 1700 ml from drinks .
- 800 - 1000 ml in solid food .
- 200 - 300 ml from oxidation of food staffs in the body

Thus daily need is 1500 - 3000 ml / day . The water is lost from the body in :-

- urine 600 - 1600 ml

- stool 50 - 200 ml
- skin and lungs in prespiration 800 - 1200 ml

The total loss is 1500 - 3000 ml / day .

Water Metabolism :-

Three main facters influence water metabolism ; namely ; glomerular filteration , ADH and adrenal steroids .

1) Glomerular Filteration Rate :-

Normally 180 L. of plasma are filtered from glomeruli but only 1½ L. of urine is produced. This is due to the fact that in the proximal tubule Na and K with corresponding anions and other solutes are readily absorbed by active process or passive diffusion . Water follows the solute passively and is absorbed . This accounts for $^{7}/_{8}$ of water absorption which is not influenced by hormones but by reabsorption of solute.

The remaining $^{1}/_{8}$ of filtered water is subjected to be influenced by other factor e.g. hormonal.

2) A . D . H . :-

This hormone is a neuro-secretion produced by the supra-optic nuclei then migrates in hypothalamohypophyseal tracts to be stored in posterior pituitary to be released in response to increased plasma osmolality .

This hormone acts selectively on the collecting ducts to increase their permeability to water , and the surrounding hypertonic renal interstitum will imbibe water from them pouring it in the vasa recta then to the general circulation again .

Defeciency of this hormone will cause the excretion of a big amount of dilute hypotonic urine in a disease called diabetes insipidus .

The half life of this hormone is about 18 minutes and it is mainly inactivated mainly in the liver . It is released from the posterior pituitary in response to osmotic and volume stimuli .

3) Adrenocortical Steriods :-

These hormones are present excessively either Cushing's Syndrome or more commonly iatrogenic . These hormones affect mainly salts causing their retension and secondary water retension takes place . The primary effect is on soduium causing its absorption in all its forms as Na cl or in exchange for K^+ and H^+ .

B. " ELECTROLYTES "

In general terms , an electrolyte is a salt ; i.e it is salt of an organic acid with a metal . It can thus be seen that an electrolyte is two fractions ; an anion and a cation . The anion is negatively charged , but the cation is positivily charged . The medically important cations are Na^+ , K^+ , Ca^{++} , Mg^{++} and the medically important anions are Cl^- , HCO_3^- , $H_2PO_4^-$ and HPO_4^{--} .

When these electrolytes are in solution , they are soluble and the solubility is influenced by pH which affects their movement across cell membranes .

" SODIUM BALANCE "

It is the main cation of extracellular fluid and accounts for 90 % of plasma osmolality .

Na is present in two pools mainly :-

- Exchangeable Na .
- Non exchangeable Na which is present in bone and fixed in it as fixed salt .

The exchangeable pool is the one subjected to variations due to physiologic and pathologic factors .

Factors affecting serum sodium :-

This is influenced by two main factors :-

- the intake .
- the output .

As regards the intake ; the intravenous infusions are of importance . This iatrogenic problem should be put in mind in post-operative care for surgical patients .

The output is governed mainly by Aldosterone , a suprarenal cortical hormone .

This hormone is not released in cases of increased plasma osmolality to wash sodium out of body via renal excretion .

A point to be put in mind here is the correlation between Na^+ K^+ , H^+ excretion .

Na is excreted in exchange for K^+ and H^+ at a renal tubular level . The K^+ and H^+ will compete for exchange with sodium , thus acid base balance will correlate well with electrolyte balance.

The daily Na need is 80 - 100 m Eq of Na Cl which is supplied in 5 gm salt or 750 ml of 0.9 % saline solution .

Channels for Na^+ loss :-

Three main roots account for this :-

(1) Skin losses :-

The sodium content in sweat is 50 m Eq / L , Cl 45 m Eq / L . The insensible water loss ranges to about 800 ml/ day and is influenced by temprature and humidity . The amount is markedly increased in hot dry climate as in baker workers who stand for long hours in front of oven radiating heat causing sweating and marked salt loss .

Away from sweat extensive skin lesions as chronic dermatologic conditions e.g Eczema ,the loss of sodium in the exudation may be marked to the point of hyponatraemia .

An important surgical emergency is skin burns in which plasma with its contained cations is lost from the body . The larger the burn and more superficial , the more likely hyponatraemia to develop .

(2) Gastro - intestinal losses :-

This is the most important rout for Na loss . Let' us see the sodium content in different gasterointestinal secretions ;

- Saliva : 10 m Eq / L Na^+ 1.5 L saliva per day .
- Gastric juice : 60 m Eq / L Na^+ , 1.5 L / day juice .
- Bile : 150 m Eq / L Na , 50 - 1000 ml / day .
- Pancreatic juice : 140 m Eq / L Na , 100 - 800 ml / day juice .
- Small bowel juice : 110 m Eq / L Na , 1 - 9 L / day of juice .

It is thus seen , the most important is small bowel juice due to large volume and nearly as plasma conc. of sodium in the juice next is bile and pancreatic juice .

Losses of these gastrointestinal secretions by vomiting , suction , fistula , diarrhoea or any other condition will contribute much not only to fluid but also to electrolyte balance .

(3) The third main rout for loss is Renal :-

The kidneys are the main channel for Na^+ excretion The daily excretion of Na^+ is about 50 m Eq / L , and the urine is

is about 1.5 L . Thus the normal daily daily excretion is about 75 m Eq / day . In salt losing nephritis , sodium is excreted in increasing amounts so many folds as the normal leading to hyponatraemia . The main regulator hormone for Na^+ excretion is aldosterone , thus in addisson ' s disease , socium is lost due to lack of the conserving hormone .

In the diuretic phase of acute renal failure sodium is also washed in big amounts causing hyponatraemia .

These are the main channels by which sodium may be excreted and lost but in fluids of the serous cavities as hydrothorax and ascitis sodium is lost in these drained fluid replacement shoul be instituted .

The normal serum sodium is 137 - 147 mEq / L which is not only influenced by the intake and ouput but also affected by the volume of ECF , which when increased as in water intoxication will cause dilutional hyponatraemia .