DISCUSSION

Serum sodium in relation to surgical procedure and fluid administration.

Serum sodium constitutes the main cation in extracellular fluid which maintains the osmolality of extracellular fluid. The serum sodium level normally represents the degree of dilution or concentration of extracellular body fluid both in health and disease. Retention of sodium, reduction in urinary sodium and reduction of free water excretion are the classic responses to surgical trauma. The surgical trauma causes a sudden rise in aldosterone & cortisol level. The cortisol & aldosterone both are responsible for sodium retention and reduction in urinary sodium in post operative period (Japson R.P., 1956; K.M.Chadon 1951).

Following surgery, important mechanism for aldosterone secretion appears to be through A.C.T.H. The stimulatory effect of A.C.T.H. on aldosterone production is short lived. As a result of this short lived potency A.C.T.H. probably has a minor role in chronic states where angiotension II appears to be the main stimulatory hormone, which in addition also has a stimulatory role even in the early phase of injury. Other factors that may alter the aldosterone secretion by adrenal cortex are
1. Increased $\text{pK}^+$ (Plasma potassium)

2. Decreased $\text{pNa}^+$ (Plasma sodium)

Increased potassium level is a good stimulus for aldosterone secretion but does not regulate the sodium level, while increased aldosterone seen with decreased plasma sodium represents an appropriate response for maintaining sodium balance. However, the effect of plasma sodium on aldosterone secretion is of minor importance in regulation of sodium excretion.

1. Decrease in plasma sodium has a relatively weak stimulatory effect on aldosterone secretion.

2. Changes in sodium intake have minimal effect on plasma sodium i.e. on increased sodium intake, sodium is added to the extracellular fluid & produces transient increases in plasma sodium, the plasma osmolality also increases stimulating osmomo receptors. It leads to stimulation of thirst and A.D.H. release, leading to expansion of plasma volume and dilution of ingested sodium. Thus over all changes in plasma sodium is small. Since plasma sodium level is not the main regulating force for aldosterone secretion, the changes in aldosterone secretion that accompany changes in sodium level must be primarily mediated through angiotensin II.
The decreased renal excretion of sodium is well documented feature of postoperative period. Hardey J.P. (I.S. Ravider 1952). In addition to aldosterone the functional extracellular fluid volume has recently been shown to be another major determinant of renal sodium excretion through the former in the normal individual (Spstein F.H., 1957). The decrease in functional extracellular fluid volume during the per operative period itself is a strong stimulus for aldosterone secretion, which causes sodium retention in the post operative period. Conversely a fall in plasma sodium concentration often to hyponatremic levels is also known to occur after trauma and surgical procedures (Flear C.T.G., Bhattacharya, S.C., Singh C.M. (1971) & Chan S., Redcliffe A. Johnson A. 1980) in spite of a raised aldosterone level. It is widely believed that fall in plasma sodium after an complicated surgery results from endogenous dilution. In patient who are severely ill it is after operation profound fall in plasma sodium may occur and osmolar gaps seen (Tindell S.F., Clark R.E., 1976, Flear C.T.G. Singh C.M., 1963). Part of this hyponatremia can be explained on the basis of an obligatory antidiuresis due to raised antidiuretic hormone level lasting for 24-36 hours (Lequesne & Lewis 1952 Chan et al, 1980)
post surgery. Thus the hyponatremia in post
operative period is provoked by an even greater
Another basis of post operative hyponatremia was
hypothesized by Saires et al (1961) to be due to
a significant loss of fluid within the third space.

Another determinant of serum
sodium level is the type of fluid infused in the
post operative period. If a large volume of solute
free fluid is given to the patient during operation
or post operative period the most common electrolyte
abnormality seen, following surgery is hyponatremia.
The raised aldosterone and cortisol level after
surgery was the basis of present concept of giving
salt free fluid in early post operative periods.
But during fluid planning what had not been consi-
dered, was the raised level of A.D.H., decreased
real excretion of sodium and loss of extracellular
fluid volume due to losses in the third space &
dilutional hyponatremia post surgically. It is the
balance between sodium retaining and sodium dilutional
factors which ultimately determines the serum level
in the post operative period.
Our study clearly shows the importance of type of fluid administration on serum sodium level other factors being identical except the amount of sodium administration in the post operative period. There was a significant fall in serum sodium level, persisting upon to 48 hours post operatively in patients receiving 3 lit. 5% dextrose and 2 lit. of dextrose 5% + 1 lit. of isotonic saline, while there was significant rise in patients receiving 2 lit. of isotonic saline + 1 lit. of 5% dextrose The fall in serum sodium level in patient receiving 3 lit. dextrose 5%/day was significant enough to be classified as hyponatremic (pNa+ \( < 135 \text{ meq/lit.} \)).


Study also includes the percentage of patient which becomes hyponatremic or shows decreased serum sodium level (\( < 135 \text{ mmol/lit.} \)) in post operative period. It was compared with the study of A.J. Guy, J.A. Michaels and C.T.G. Fleurr (1967) which showed that about 27.5% patients who underwent various types
of surgical procedure became hyponatremic on first post operative day while our study showed an incidence of 60% patients with 3 lit. of 5% dextrose, 37.5% receiving 2 lit. dextrose + 1 lit. isotonic saline became hyponatremic. On pre operative day in this study 20% of patient receiving 3 lit. of 5% dextrose & 12.5% of patient receiving 2 lit. 5% dextrose & 1 lit. isotonic saline are hyponatremic. While hyponatremia on first post operative day in patient receiving 3 lit. of 5% dextrose increases to 60% & patient receiving 2 lit. of 5% dextrose + 1 lit. of isotonic saline to 37.5%. On second post operative day 73.33% of group I & 43.75% of group II patient are hyponatremic.

In the third group where 33 patient received 2 lit. isotonic saline + 1 lit. dextrose 5%, 9% of patient were hyponatremic pre operatively & post operatively. Thus the percentage of patients remained constant in this group. No patient showed any clinical sign of hypernatremia namely pulmonary or peripheral edema. It can be stated that infusion of balanced salt solution to the patients undergoing surgical procedure prevents hyponatremia and quick recovery of these patients (A.J. Guy et al, 1967).
Serum potassium in relation to surgical procedure and fluid administration.

Serum potassium is usually found elevated after surgical procedures and elevation is usually dependent upon the severity of trauma or surgical procedure. In cases of major surgery, elevation is more than with minor surgical procedures.

This study shows an elevation of serum potassium on first and second post operative day. This elevation of serum potassium level is independent of nature of post operative fluid infusion (i.e. 5% dextrose) normal saline. Our study differs from study of A.J.Guy et al (1967). They study showed a fall in serum potassium level in post operative periods. But nature of fluid administration did not affect the serum potassium level. The reason for the elevated serum potassium level.

1. Cell damage & liberation of potassium from the cells.

2. Change in membrane potential so potassium passes into the extracellular fluid.

3. Acidosis

Serum osmolality in relation to surgical procedure & fluid administration.

The serum osmolality measures the total concentration of all osmotically active entities
in the plasma. Sodium is the principal cation of extracellular fluid. Increase or decrease in serum osmolality is as a consequence of increase or decrease of sodium or concentration of other osmotically active substances. The serum osmolality decreases where there is retention of fluid as a results of excess A.D.H. activity which is feature of body response to trauma causing dilutional hyponatremia and also if there is post operative infusion of salt free fluids.

It is widely believed that fall in plasma sodium after uncomplicated surgery results from endogenous dilution. In patient severely ill after operation profound fall in plasma sodium may occur and osmolar gaps seen (Tindell S.F., Clark R.C., 1976 & Fleer C.T.G., Singh C.M. 1963). The lowering of plasma sodium may be abrupt or slow and sustained. An abrupt fall in sodium plasma are often accompanied by a reduced osmolality. The sick cell concept attributes osmolar gaps to isotonic redistribution of solutes, from cells to extracellular fluid, caused by an abrupt increase in cell membrane permeability and the sustained dilution with no osmolar gaps to wide spread impaired capability of cells to maintain their normal content of non diffusible solute (Fleer C.T.G., 1970, Fleer C.T.G., Singh C.M. 1972, 1973).
Present study suggests a significant fall of serum osmolality in patients receiving 3 lit. of 5% dextrose while insignificant fall of serum osmolality in patient receiving 2 lit. of 5% dextrose + 1 lit. of isotonic saline post operatively. There was a slight or insignificant rise of serum osmolality in patient receiving 1 lit. of 5% dextrose + 2 lit. of isotonic saline. The above findings are because of dilutional hyponatraemia & our findings corresponds with the study of T.T. Irwin C.J. et al (1977). They also observed a significant fall in serum osmolality in patients who were kept on salt free fluid or dextrose saline solution.

Serum osmolality also depends upon blood urea & blood sugar. In our study there was no change in blood sugar level but slight fall in blood urea level but which was insignificant.

**Urinary volume in relation to surgical procedure and fluid administration.**

The present study shows an apparent increase in urine volume post operatively. The reason for increase in urine measured was because of irrigation of urinary bladder by isotonic saline in patient who underwent Freyer's modified prostatectomy.
If these patients were excluded there was fall of urine output in first day in all three groups. On the IIInd & subsequent post operative days there was a significant rise of urine output. Thus there is retention of water within 24-36 hours post operatively. The low urine output was seen on the day of operation in all groups i.e. patients receiving 3 lit. 5% dextrose, 2 lit. 5% dextrose + 1 lit. isotonic saline and 1 lit. 5% dextrose + 2 lit. of isotonic saline respectively. The patients receiving 3 lit. of 5% dextrose per day showed a higher urine output in comparison to patient receiving isotonic saline, urine output almost becomes similar on 3rd or 4th post operative day.

The present study shows similar results as shown by study of S.F. Tindell, R.G. Clark (1981) J.H. Thomas, D.B.Morgan (1979) and J.H. Thomas et al (1979). They observed that on the day of operation the vasopressin or antidiuretic hormone level increases to the extent that they were much higher than those achieved by simple water depletion and much higher than would be expected from alterations in plasma sodium concentration. Thus rise of serum arginine vasopressin level remains for 24 - 35 hours thereby
leading to increased water reabsorption & decreased urine formation. This initial increase in arginine vasopressin in either group was a part of stress response (Moran et al, 1964).

Moran et al (1964) have identified four phases of vasopressin secretion following surgery

I. Phase I. Normal pre-operative control period, in which plasma vasopressin concentration is within normal range.

Phase II - elevation of A.D.H. level due to overnight fast.

Phase III- It results from cutaneous and visceral stimuli and lasts from skin incision to closure.

Phase IV - Post operative phase in which there is an early increase in plasma vasopressin concentration which comes to normal upto 5th post operative day.

Moran et al (1964) hypothesized that there are four afferent reflexes controlling this vasopressin release.

They are

- Osmoreceptor
- Baroreceptor and
- Left atrial stretch receptor.

All of the above three receptor are negative feedback receptors.
Fourth reflex is mediated by painful stimuli which is not a feed back reflex. Therefore in presence of pain vasopressin secretion can occur even in phases of hyposmolar hyponatremic condition. This explains a persistant secretion of vasopressin and also explains low urine output in the post operative periods.

**Urinary sodium in relation to surgical procedure and fluid administration.**

Our study showed a significant fall in urinary sodium in patient group receiving 3 lit. of 5% dextrose /day and 2 lit. 5% dextrose + 1 lit. of isotonic saline, while there was no significant change in the urinary sodium on the first post operative day in patients receiving 2 lit. of isotonic saline + 1 lit. of 5% dextrose. But a significant rise in urine sodium on the IInd & IIIrd post operative days. Result of our study for urinary sodium is similar to the findings of Tom Shires, Jack William M.B. & Frank Brown D. (1961) and T.T.Irvin,et al.

We have calculated for our patients the minimum requirement, to maintain water balance & to prevent fall in plasma sodium. It was seen that patients who have been infused with 5% dextrose only were hyponatremic. They had no osmotic drive for
vasopressin secretion (I.H. Thomas and D.B. Morgan, 1979). The fall in plasma sodium occurred on the first post operative day in patients receiving 3 lit. of 5% dextrose. At least 130 mmol/lit. of sodium chloride is to be given to prevent hyponatremic Thomas and Morgan (1979) concluded from their studies that normal saline alone should be given during the early post operative period to avoid the development of hyponatremic. The present study shows that patient receiving 1 lit. of 5% dextrose + 2 lit. of isotonic saline results in maintenance of plasma sodium at pre operative level. When planning a fluid regimen it should not be forgotten that third space losses are not true losses, as the fluid is reabsorbed unless they are lost through wound drainage.