# REVIEW

## The Appropriate Use of Diagnostic Services (ii)

# The Case for Fewer Measurements of the Plasma Sodium Concentration : Costs and Gains

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**BIOGRAPHICAL NOTE**

D Brian Morgan qualified at the Welsh National School of Medicine in 1959 and after Lectureships in Clinical Investigation at Leeds, Pathophysiology in Berne and Physiology at Nottingham, returned to Leeds in 1972 as Senior Lecturer in Chemical Pathology. He was appointed to the Chair of Chemical Pathology in October 1977.

Many clinicians and chemical pathologists would, at least in informal discussion outside the political and professional arena, agree that some (if not most) of the measurements of plasma sodium concentration made in hospital laboratories are a waste of effort and money. Yet the number of these measurements is increasing (Figure 1), a fact which many of us are tempted to use as evidence of an increasing contribution of chemical pathology to clinical medicine. There is therefore the paradox of an increasing number of what might be largely useless measurements.

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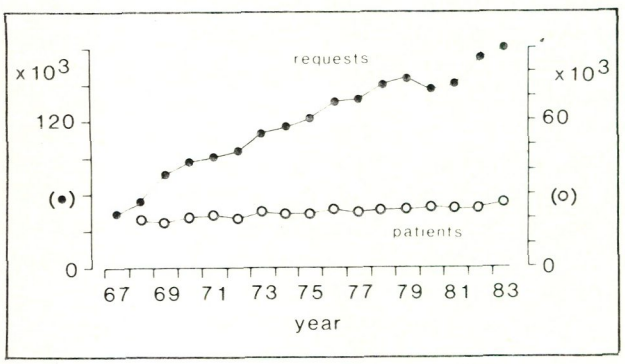


**Figure 1:** *In-patient numbers and chemical pathology requests, Leeds General Infirmary 1967 – 1983. (The number of requests for plasma sodium concentration has a relatively constant proportion of total requests through this period.)*

The reasons for this paradox are complex; however it is likely that clinicians continue to ask for the measurements because they are easy to get, thought to be cheap and unlikely to be misleading; they are a part of a houseman's routine. On the other hand, laboratories continue to provide the measurements largely without question 24 hours a day every day of the year because they are equipped and staffed to do so and indeed their size, expensive equipment and expansion are the result of meeting this demand.

A brief review of the historical sequence which created this paradox is necessary as a background to a discussion of the feasibility and costs of reducing the demand for these measurements.

## HISTORICAL BACKGROUND

The plasma sodium concentration was one of the earliest measurements available in chemical pathology. Improvements in technique changed the production rate from one result in several hours (by hand) to 60 an hour by automatic analysis. At the same time the plasma sodium concentration became part of a set of measurements, the 'urea and electrolytes', which have achieved a hallowed place in medicine akin to body temperature. As it is the set which is requested in practice, it is difficult to discuss the need for plasma sodium alone. More recently multichannel analysers which measure 11 - 20 variables (including the 'urea and electrolytes') have become a feature of most large chemical pathology laboratories.

Much of the increase in workload over the last 30 years has been attributed to the availability of increasingly sophisticated analytical machines. However, the increase in the number of sodium analyses is an order of magnitude too large to be explained by an increase in those specific clinical conditions where the need for plasma sodium measurement is undisputed.

Indeed it is doubtful if these specific needs account for more than a small minority of all requests. Yet it was these needs which made the measurements available and they deserve some discussion before moving on to the other less clearly justifiable reasons for the requests (Table 1).

**TABLE 1**

**The reasons for Laboratory requests**

1. Specific clinical questions; diagnosis or response to treatment.
2. Screening (no specific indication in the individual but the individual comes from a high risk group).
3. Baseline measurements for patients at subsequent risk.
4. 'Routine' measurements (like body temperature).
5. Efficiency (in organisational terms; that is admission profiles).
6. Prognosis indicator.

### (1) SPECIFIC CLINICAL QUESTIONS

There is a widespread view that the plasma sodium concentration is a measure of the body sodium and a guide to the need for and adequacy of sodium replacement. This is not the case[1]. Changes in the plasma sodium concentration are determined by changes in the relative body content of water; an excess of water causes a fall in the concentration of sodium and a lack of water leads to a rise in the concentration of sodium. The clinical effects of excess and lack of water come not from the changes in the sodium concentration but from changes in the cell content of water. In the brain these changes in water content lead to the symptoms which range from headache to convulsions to coma to death. The specific need for plasma sodium measurements could be largely met if patients who had symptoms which might be due to water lack or water excess had their plasma sodium concentration measured.

It could be argued that plasma sodium measurements would be justified in detecting water lack and water excess before they became clinically obvious. However, for complex reasons changes in the plasma sodium concentration are often ignored in patients without the appropriate symptoms.

### (2) SCREENING

In screening, measurements are made not because of the symptoms and signs of the individual patient, but because the patient is in a group at risk. An example is the measurement of urea and electrolytes before and after surgical operations; these are a substantial part of a laboratory's workload. The preoperative assessment arises because of the view that operation is a high risk situation and because many anaesthetists like to minimize their chances of missing an abnormality, something which might be important. However, not all unsuspected conditions are detected by measuring urea and electrolytes.[2] Furthermore, the frequency of clinically and suspected significant abnormality in the urea and electrolytes is very small.[3]

There are changes in the urea and electrolyte values after operation which are largely predictable on the basis of the intravenous fluids which have been given. Post-operation measurements are done to detect the unusual, but there is no clear evidence that unexpected change is detected earlier chemically than it is clinically and furthermore the chemical changes in some unusually sick patients after operation do not include excessive change in the plasma sodium concentration.[2]

### (3) ADMISSION PROFILES

When the large multichannel analysers became available it was argued that it was more efficient to make a set of measurements on each patient on admission than to wait and make only the specifically requested analyses. It is doubtful if there is any hospital in the UK where this aim is a major determinant of the pattern of requesting. Admission measurements are in practice screening rather than economy or efficiency measures.

### (4) ROUTINE; ILLNESS MARKER

The widespread use and easy availability of these measurements has resulted in the view that 'urea and electrolytes' measurements are as basic and routine as body temperature measurements; they are requested as a routine in ill patients and it is in this sense that I suggest they are often being used as illness markers as well as to exclude renal fluid and electrolyte problems. One view of the way requesting demand is determined is that the houseman goes round the ward (in his mind) with a threshold of illness and complexity which determines whether or not he will request urea and electrolytes in each patient. This threshold will vary with the degree of experience and confidence of the houseman which probably explains the remarkable variation in workload during the 6 months of each 'house' (at least in our hospital).

### (5) PROGNOSTIC INDEX

Within a group of patients with a particular and known condition there may be a relationship between the plasma sodium concentration and the outcome of the patients. The plasma sodium concentration is lower in people who are ill than in people who are well,[4] (it is low in patients after heart attack but particularly in those who do badly[5]) and a low plasma sodium concentration is associated with a poor outlook in patients with heart failure. However, this information is not usually precise enough to be useful in the individual patient and it is probably an unusual reason for requesting measurements of the plasma sodium concentration.

### Which measurements of sodium concentration can be justified ?

The vast majority of measurements of plasma sodium concentration are difficult to justify. They continue to be done either because the useful situations cannot be distinguished from the useless or because the measurements are thought to be cheap and harmless (non-confusing) so that even the occasional unexpected help from them justifies their cost.

#### a. Can the useful occasions be defined ?

The directly diagnostic situations are few. The other reasons for the measurements, such as screening and monitoring, have to be carefully assessed for their cost effectiveness that is the cost of detecting the occasional unexpected abnormality in relation to the real gain to the patient from the detection of that abnormality. What information we have suggests that these uses are probably not cost effective.

#### b. The cost of the measurements

The costs directly attributable to sodium measurements are difficult to define. Automation was led by the demand for the plasma sodium (and potassium) and most requests for 'multichannel analysis' are requests for urea and electrolytes. Even in emergency situations the sodium and potassium are measured together (because of machine design and not because of need). It can therefore be argued that even if the plasma sodium concentration was stopped as a routine measurement, other measurements (such as potassium and urea) would be necessary. There are two counter-arguments. Firstly, the cases for the continuation of potassium and urea measurement in the numbers we do them are little stronger than the case for sodium measurement. Secondly, the argument is not just about sodium or potassium or urea but about the case for multichannel analysers as such. An extreme view would be that most of the costs of multichannel analysers can be put down to the demand for urea and electrolytes. The costs of these measurements are then very substantial, not only in money terms but also in the changes in skills required in the laboratories from those of chemical analysis to those of organisation, machine care, data input and computerisation. The shift has almost destroyed the classical analytical skills of chemical pathology in those laboratories.

It is doubtful if those who already have multichannel analysers in their laboratories can achieve any significant change in demand. In any case the reduction in demand would have to be very large before a substantial reduction in running costs was achieved because the marginal cost of a single test is small. The argument about how many measurements we should make is therefore really an argument about what type of service we should offer and thus what type of apparatus we require when our present apparatus needs to be replaced.

### A PERSONAL VIEW

1. All chemical pathology measurements are expensive (in total or unit cost).

2. We must identify those which are useful.
3. Plasma sodium (and indeed urea and electrolyte) measurements should not be regarded as a 'routine' like body temperature. Consultants should agree not to chastise their housemen for failing to make the measurements in the absence of an adequate reason.
4. The plasma urea and electrolytes should not be regarded as a useful, non-specific indicator of illness. Many of the changes which are observed are predictable responses to illness and trauma; unnecessary repetition adds no information of value to the management of the majority of patients.
5. There are few situations where measurement of plasma sodium is specifically indicated.
6. The measurement of plasma sodium cannot be justified as part of screening, if screening is the detection of the occasional unsuspected abnormality in ill patients (and not electively admitted patients). What might be justified is the analysis of potassium, urea and calcium in the search for gross unsuspected abnormalities in all ill patients.
7. The general use of admission profiles and routine admission, pre-operative and post-operative sodium analyses cannot be justified.

## SUMMARY AND CONCLUSIONS

The measurement of large numbers of plasma sodium concentrations given the measurement a semblance of authority and implies usefulness and necessity; these effects in themselves perpetuate and even increase the requests for the measurement. The same arguments apply to other measurements in the set called 'urea and electrolytes'.

We are on a treadmill and the question is how do we get off ? It is clear that to do so will require a change in the clinician's perception of the contribution of the plasma urea and electrolytes to patient diagnosis and management, a change in the chemical pathologist's perception of his role and his contribution and a change in the health service administrator's measure of the contribution of chemical pathology.

The time has come to stop the production of largely useless information; in large laboratories with large capacity multichannel equipment the reduction in workload will have to include several tests other than sodium if substantial reductions in running costs are to be achieved. The clinicians and the chemical pathologists should then agree the best uses for the available extra money and laboratory talent.

## REFERENCES

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