# Chapter 10: Serum Albumin and Serum Bicarbonate

## Summary


- The method of measurement of serum albumin has to be taken into account in interpreting the differences between centres and changes with time. Centres using bromocresol green (BCG) method have higher serum albumins compared to centres using bromocresol purple (BCP) method.

- For haemodialysis patients, the median serum albumin was 38 g/L (BCG) and 34 g/L (BCP). 79% (BCG) and 83% (BCP) of the patients had serum albumin above the lower limit recommended in the Standards document.

- Peritoneal dialysis patients had lower serum albumin compared with haemodialysis patients; the median serum albumin was 36 g/L (BCG) and 31 g/L (BCP). Approximately 60% of peritoneal dialysis patients had serum albumin above the lower limit recommended in the Standards document.

- Comparison of bicarbonate data is difficult due to different laboratory methodologies and non-clinical factors such as the time delay in transport to laboratories.

- For haemodialysis patients, the mean value for percentage of patients in a renal unit with pre-dialysis serum bicarbonate below 22 mmol/L was 15% (range 3–62%).

- For peritoneal dialysis, the mean value for percentage of patients in a renal unit with serum bicarbonate below 25 mmol/L was 24% (range 8–64%).


## Albumin

Previous reports from the UK Renal Registry and other publications[1,2,3] have recognised the difficulties in using serum albumin as an audit measure in patients with renal failure. Serum albumin concentration is influenced significantly by the dye used in the assay method. Bromocresol green (BCG) is the more commonly used method but tends to overestimate serum albumin when compared with antibody-based methods, especially at lower levels of serum albumin as are often seen in RRT patients. Bromocresol purple (BCP) may underestimate serum albumin in uraemia.[3] In addition, laboratories using the same methods often quote different normal ranges. For this report, centres have been separated by methodology of albumin measurements.

The Renal Association Standards document 3rd edition[4] recognises the importance of serum albumin as a marker of outcome, but does not recommend setting an audit standard for serum albumin. The Standards document continues to recommend collecting data for serum albumin, as serial measurements may be useful for monitoring individual patients. A careful search for causative factors (e.g. inflammation/infection, tissue ischaemia/necrosis, protein losses, volume overload) is recommended if serum albumin is <35g/L (BCG method) or <30g/L (BCP method).

### Haemodialysis

The median serum albumin ranged from 41 to 32g/L (Figure 10.1). As anticipated, centres using the BCP method generally had lower albumin concentrations (BCG median 38g/L v. BCP median 34g/L). Overall, 83% of patients had serum albumin above the lower limit recommended in the Standards

document for BCP method and 79% for BCG. However, this varied from 46 to 93% among units (Figure 10.2).

### *Peritoneal dialysis*

Serum albumin is generally lower in CAPD patients probably due to peritoneal protein losses. The median serum albumin ranged from 39 to 29g/L (Figure 10.3). The effect of using the BCP method was even more striking in PD patients. Ten out of 12 units using this method had median values below the lowest median for BCG. The E&W overall median concentration for the BCG method was 36g/L compared to 31g/L for BCP. The data indicate how difficult it is to keep serum albumin above the recommended minimum in patients treated by peritoneal dialysis. Approximately 40% of patients had serum albumin below the target concentration for either method: this varied from 21% to 65% among centres (Figure 10.4).

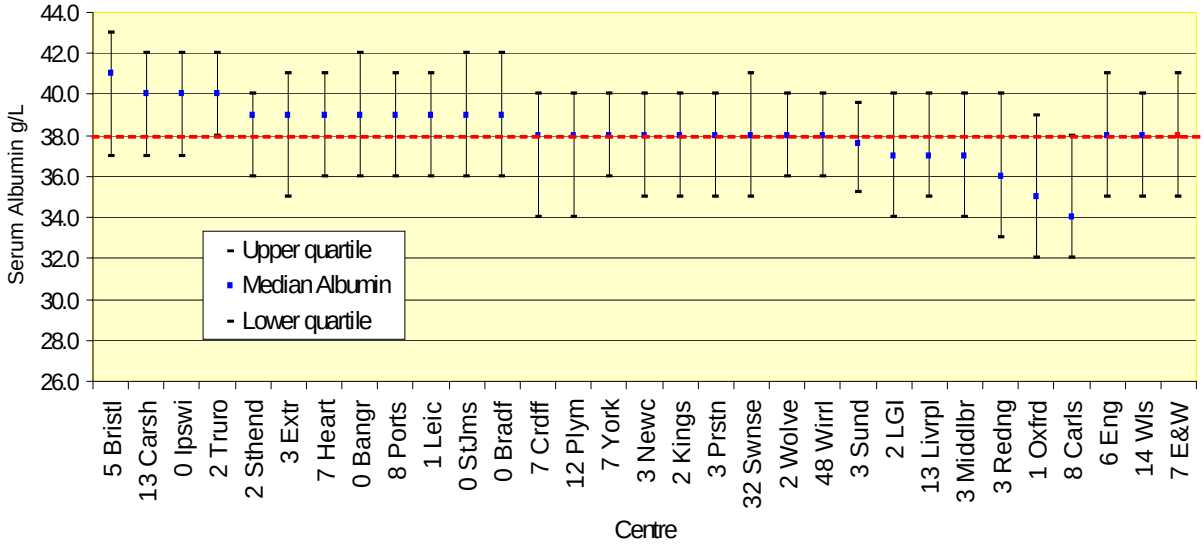


**Figure 10.1a. Median serum albumin in HD patients (BCG)**

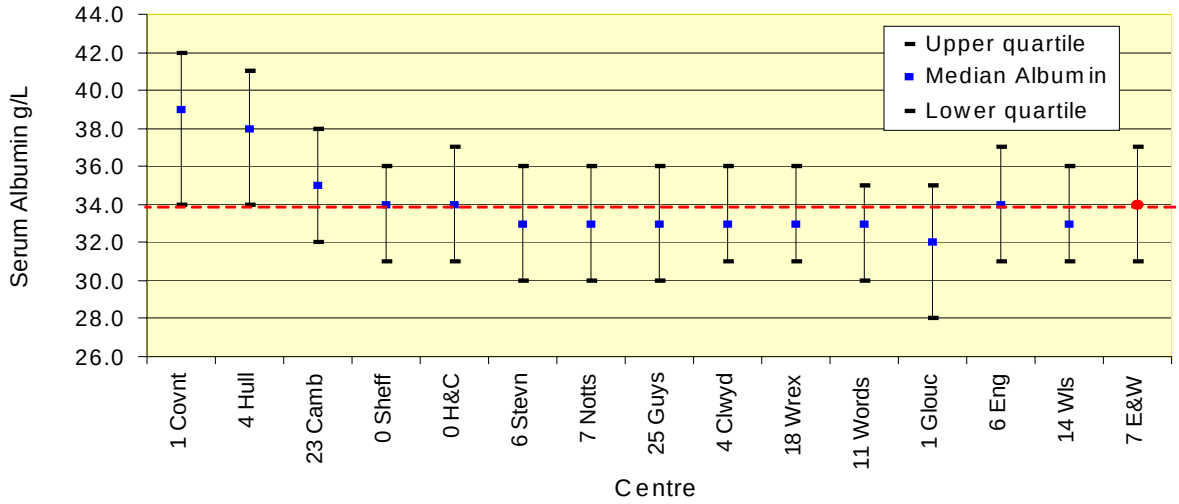


**Figure 10.1b. Median serum albumin in HD patients (BCP)**

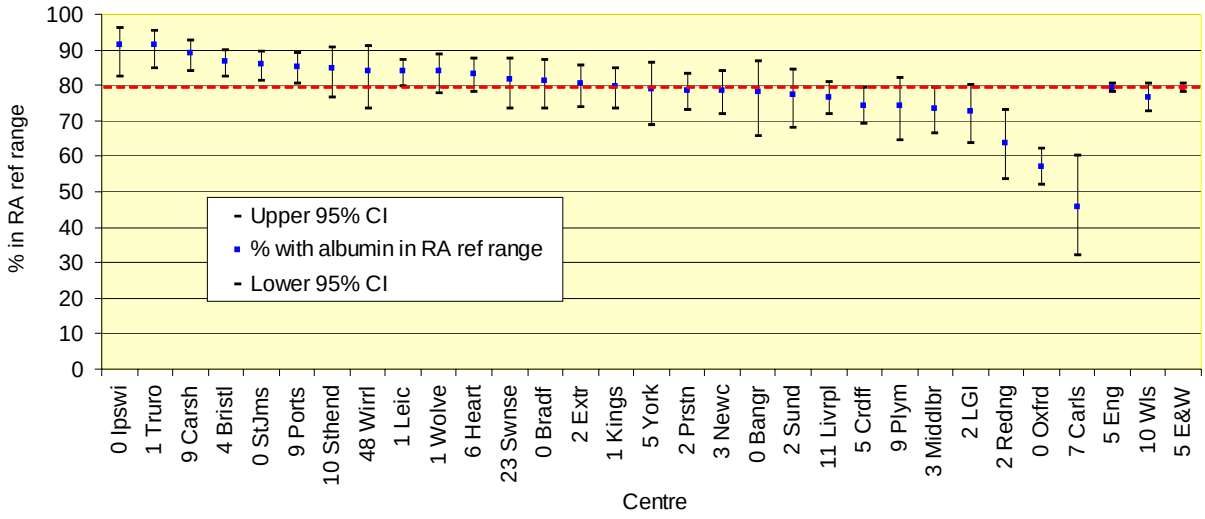


**Figure 10.2a. Percentage of HD patients by unit with serum albumin >35g/L (BCG)**

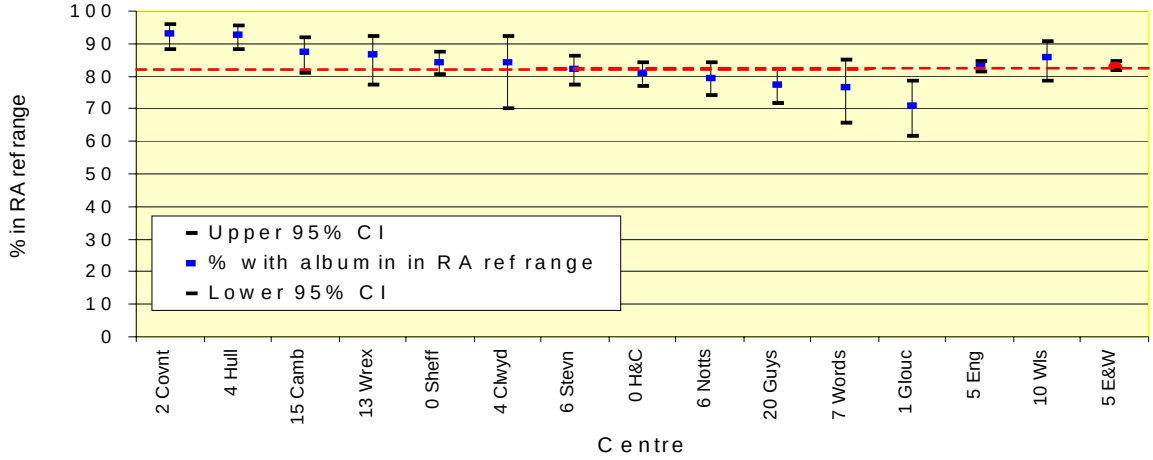


**Figure 10.2b. Percentage of HD patients by unit with serum albumin >30g/L (BCP)**

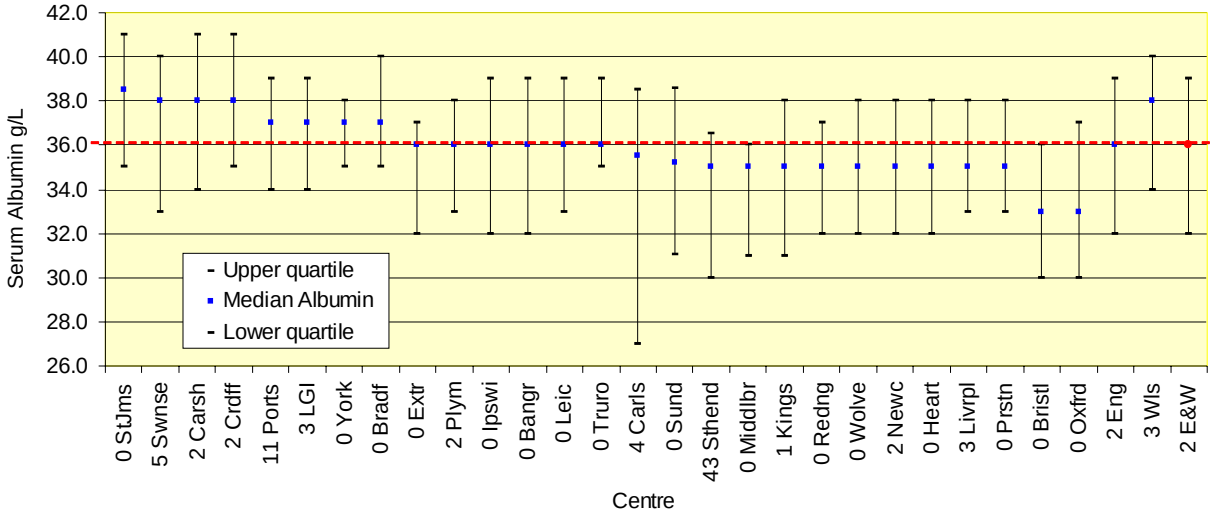


**Figure 10.3a. Median serum albumin in peritoneal dialysis patients (BCG)**

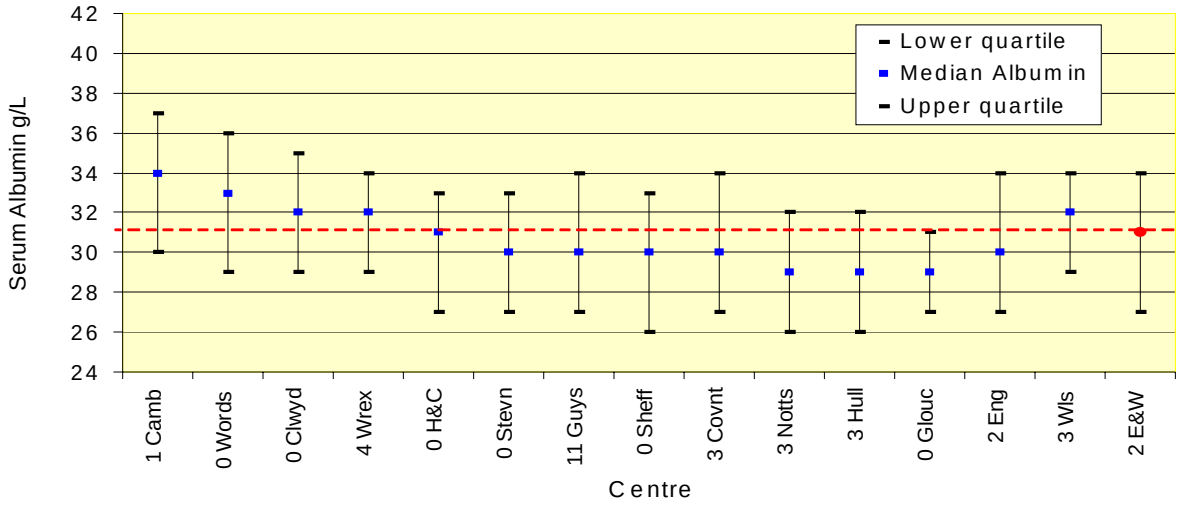


**Figure 10.3b. Median serum albumin in peritoneal dialysis patients (BCP)**

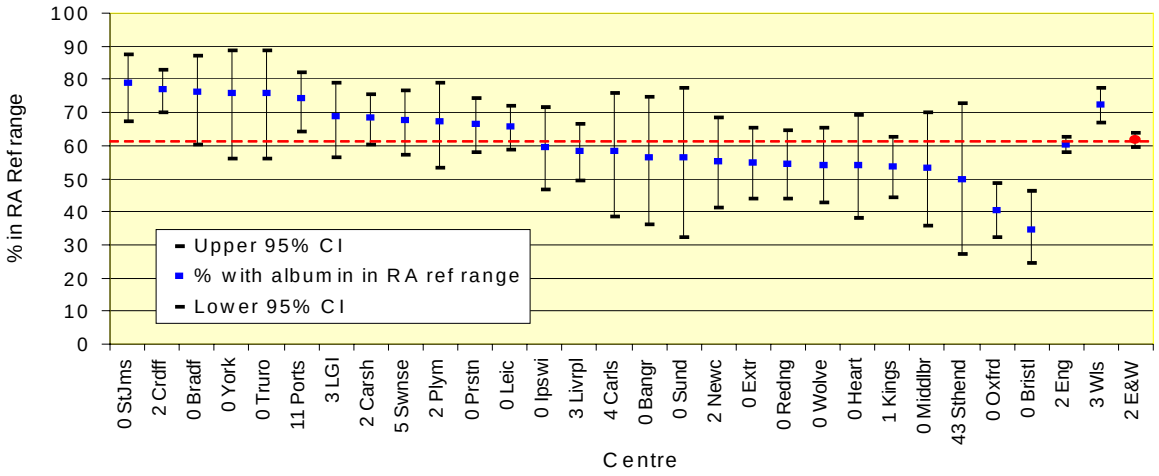


**Figure 10.4a. Percentage of peritoneal dialysis patients by unit with serum albumin >35g/L (BCG)**

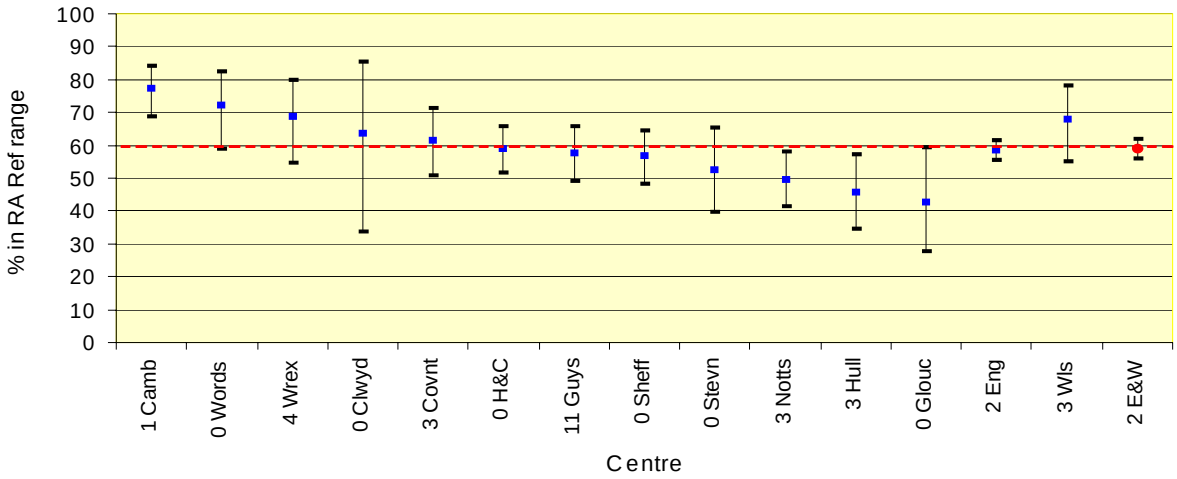


**Figure 10.4b. Percentage of peritoneal dialysis patients by unit with serum albumin >30g/L (BCP)**

### *Effect of time on treatment*

Figure 10.5 demonstrates the effect of time on treatment on the percentage of patients with serum albumin in the target range for both haemodialysis and PD. Over time, on haemodialysis, the number of patients with higher serum albumin rises, probably due to reduced survival of patients with lower serum albumin. In contrast, over time on peritoneal dialysis, serum albumin tends to fall. Possible explanations are the cumulative effect of serum albumin losses via the peritoneum, repeated peritonitis and underdialysis on prolonged PD.

## *Bicarbonate*

Comparative audit of serum bicarbonate among renal units is also hampered by non-clinical factors. Different methodologies are used in different laboratories, and even when methods are the same, different normal ranges may be used.[1] Delay in transport to the laboratories can lead to significant reductions in serum bicarbonate[5] and this is difficult to standardise. A small number of units had few data for serum bicarbonate, particularly for haemodialysis patients, suggesting that this was not collected on a routine basis.

The RA Standards document 3rd edition[4] recommended changes in the standards used for audit of serum bicarbonate for both haemodialysis and peritoneal dialysis patients.

The current recommendations are:

***Serum bicarbonate before a HD session measured with minimal delay after venepuncture should be between 20 and 26mmol/L***
***For continuous peritoneal dialysis (CAPD) patients, serum bicarbonate measured with minimal delay after venepuncture should be between 25 and 29mmol/L***

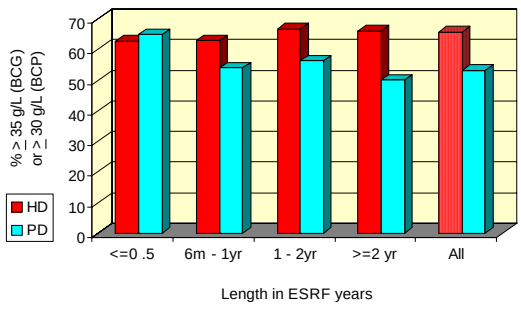


**Figure 10.5. Changes over time on haemodialysis and peritoneal dialysis shown as percentage of patients with serum albumin ≥ 35g/L (BCG method) or ≥ 30g/L (BCP)**

### *Haemodialysis*

The median serum bicarbonate varied from 27mmol/L to 19mmol/L. The median value for all E&W patients was 23mmol/L (5–95% centile range 17–30) (Figure 10.6). The percentage of patients with serum bicarbonate below 22mmol/L predialysis ranged from 3 to 62% with a mean value of 15% (Figure 10.7).

A comparison of the units at each end of the scale suggests there must be a systematic difference accounting for the differences in acid base balance. This might be due to prescribed dialysis treatment (e.g. standard dialysis bicarbonate concentration) or measurement methods. Carshalton had the highest median value (27 mmol/L) with 53% of patients above the range 22–26mmol/L pre-dialysis indicating a significant number of alkalotic patients even at the start of dialysis. Informal enquiries indicated that 40% of patients at Carshalton are treated by on-line haemodiafiltration and that use of a higher bicarbonate dialysate concentration (40 mmol/L) is common (J Kwan, personal communication). In contrast, the Nottingham data indicate poor control of acidosis with the majority of patients (74%) with pre-dialysis bicarbonate less than the lower limit of normal range (19 mmol/L). The Nottingham laboratory had the lowest reference range in the 2002 report, but it is unlikely that this alone explains these variations. Delays in transportation and handling in the laboratory

may be additional factors (S Roe, R Burden, personal communication) but further detailed comparisons between units are required to understand these differences.

### *Peritoneal dialysis*

Again there are large differences in control of acidaemia across the UK with median values varying from 31 to 23 mmol/L, with a median for E&W of 27 mmol/L (5–95% centile range 21–33) (Figure 10.8). The percentage of patients with serum bicarbonate below 25mmol/L ranged from 8 to 64% with a mean value of 24% (Figure 10.9). The precise influence of attempts to control acidaemia more aggressively by prescription of oral bicarbonate supplements or other strategies is unknown.

## *Conclusions*

Continued difficulties with albumin and bicarbonate measurement methodologies, and with the normal ranges, make it difficult to draw any definitive conclusions from comparative audit of these parameters.

However, serial albumin measurements performed in a single laboratory are still useful markers in individual patients, mainly as a negative acute phase reactant. Further progress will only be made by standardisation of albumin measurement methods, and by advances in diagnosis and treatment which lead to correction of hypoalbuminaemia and parallel improvement in clinical outcomes.

There is a huge variation in the control of acidaemia across UK nephrology centres.

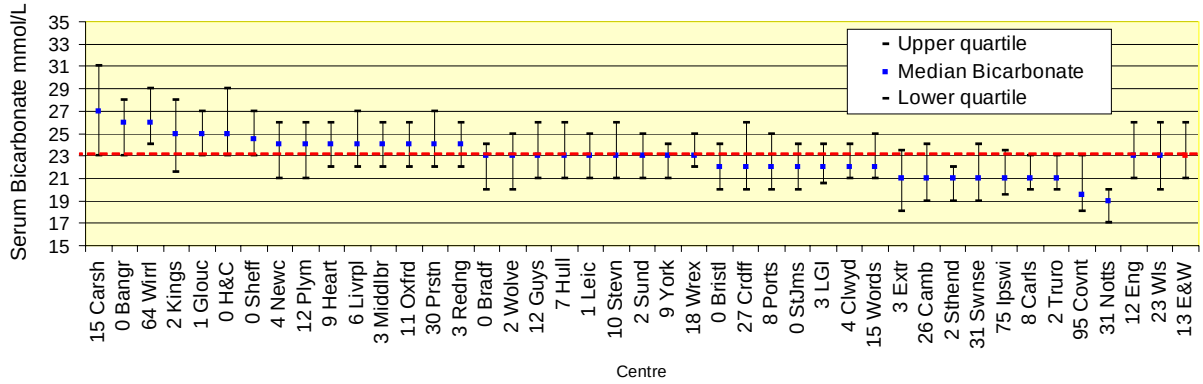


**Figure 10.6. Serum bicarbonate in haemodialysis patients (median and quartile values)**

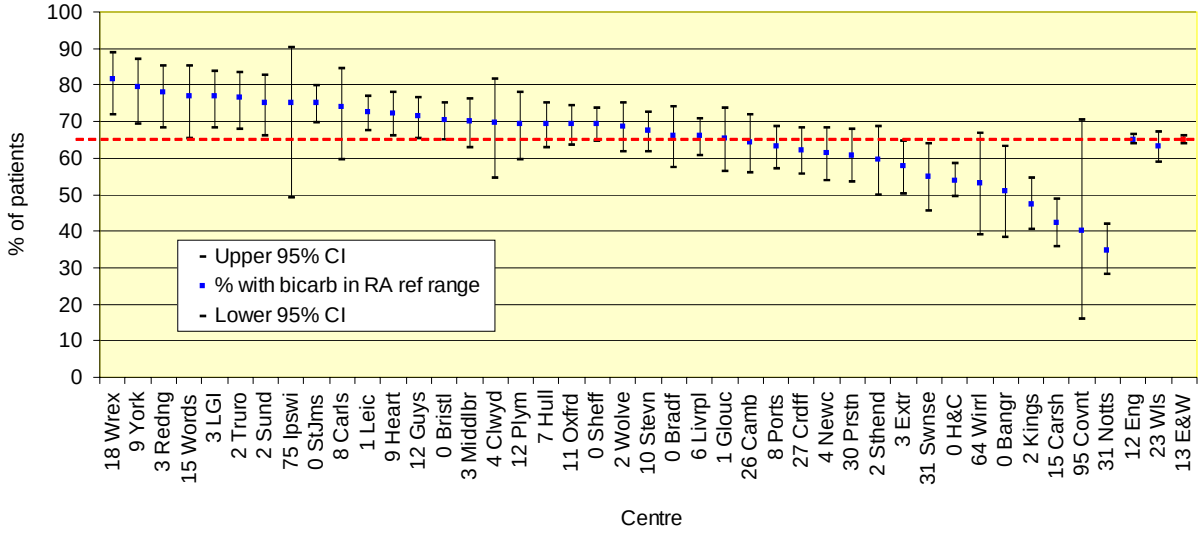


**Figure 10.7. Percentage of haemodialysis patients with pre-dialysis serum bicarbonate in range 20–26mmol/L**

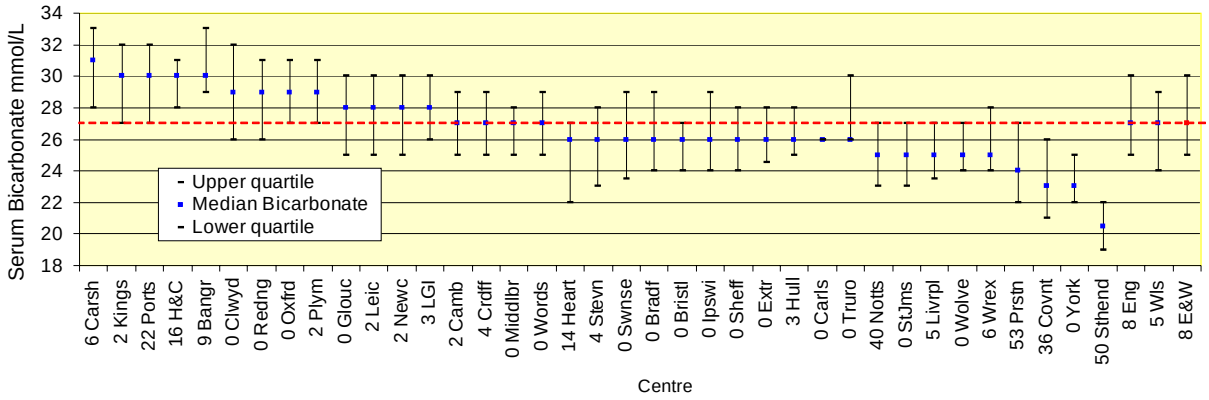


**Figure 10.8. Serum bicarbonate in peritoneal dialysis patients (median and quartile values)**

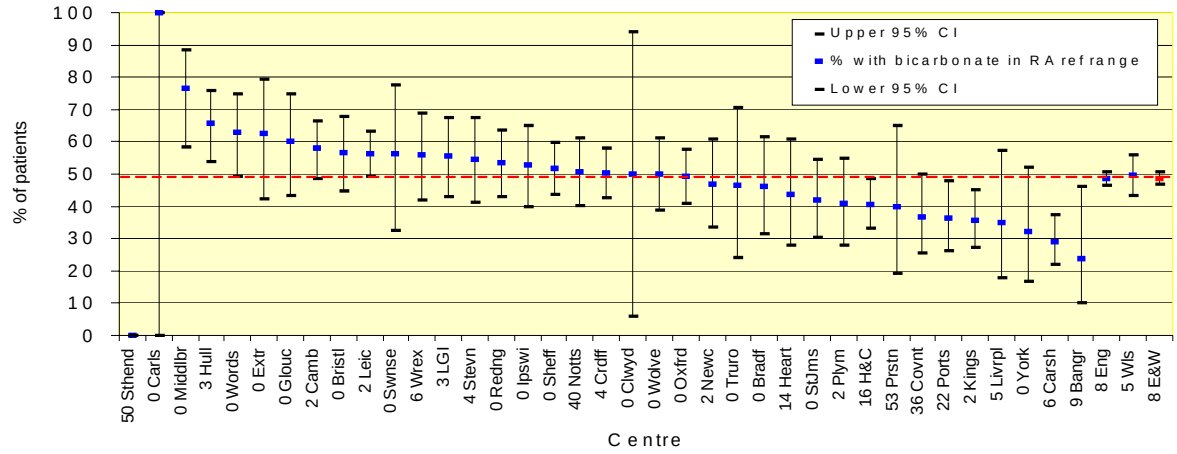


**Figure 10.9. Percentage of peritoneal dialysis patients with serum bicarbonate in range 25–29mmol/L**

Both acidosis and alkalosis are prevalent in some units. The Standards document has previously highlighted the theoretical dangers of alkalosis. Methodological factors are contributory but it is also likely that this reflects significant differences in practice. These differences require further investigation and explanation.

## References


1. UK Renal Registry: Third Annual Report. UK Renal Registry, Bristol, UK 2000
2. Wick MJ, Wilkems K, Moritz MA. Albumin testing methods differ: implications for the dialysis patient. *Dial Transplant* 1994;23:282–286
3. Carfray A, Patel K, Whitaker P, *et al.* Albumin as an outcome measure in haemodialysis patients: the effect of variation in assay method. *Nephrol Dial Transplant* 2000;15:1819–1822
4. Renal Association Standards Committee. *Treatment of adults and children with renal failure: standards and audit measures* (3rd edition). Royal College of Physicians, London 2002
5. Kirschbaum B. Spurious metabolic acidosis in hemodialysis patients. *Am J Kid Dis* 2000;35:1068–1071