

Chapter 9: Bicarbonate, albumin, cholesterol

Overview of presentation

In the following section the figures use a common modified box-plot format with data presented separately for haemodialysis and peritoneal dialysis. The figures showing the percentage of patients reaching the Renal Association Standard include the 95% confidence interval calculated for this figure. Where medians are displayed, the 25th and 75th centiles for the unit are included. Figures showing the percentage within a range (as defined by the Renal Association Standard or a Renal Registry defined range) also include the 95% confidence interval calculated for this figure. Data completeness is indicated by the "percentage missing" figure below the unit code letter.

Albumin

Albumin measurement

Albumin measurement is complicated by the use of two different methodologies, bromocresol green (BCG) and bromocresol purple (BCP). As discussed in 1998 Registry report, the BCG method, unlike BCP, measures some immunoglobulin along with albumin. In non-uraemic sera, BCP is clearly the preferred method, however in uraemic sera there appears to be some interference with the BCP method. The difference in readings between the two methodologies varies across the range, with a greater discrepancy at lower albumin values (up to 5g/L) than high values.

	Method	Ref Range g/L	Derivation of ref Range
A	BCG	35-50	Manufacturer
B	BCG	35-55	Local
C	BCG	36-50	Not available
D	BCG	35-50	Text book
E	BCG	35-48	Text book
F	BCG	35-53	Manufacturer
G	BCG	35-50	Local
H	BCG	35-50	Manufacture
I	BCG	36-47	Local
J	BCP*	34-48	Local
K	BCG	37-49	Local
L	BCG	34-50	Not available
M	BCG	35-50	Local
N	BCG	35-50	Manufacturer
O	BCG	35-50	Text book
P	BCG	35-47	Local
Q	BCP*	30-52	Local
R	BCG	36-50	Local
T	BCG	30-48	Text book

Conversion g/dl = g/L x 0.1

Table 9.1 Methods and ranges of albumin measurement

Reference ranges for albumin vary widely and this is in part due to the use of different information sources for its derivation (table 9.1).

Centres J and Q use BCP and centres B, D (haemodialysis only) and T have a variable percentage of patients results supplied from both BCP and BCG laboratories. Although centre J uses BCP its laboratory still quotes a locally derived reference range of 34-48 g/L: this leads to low achievement of the Standard. Centre T does well in achieving the Standard as defined: this is due to a wide local reference range of 30-48 g/L. This wide albumin range was literature based and was not specifically set to 'include' both BCP and BCG methods.

The figures showing the percentage in 35 –50 g/L are laboratory harmonised and in addition use a range 30-45 g/L for the centres on BCP. No adjustment can be made for the two centres with results measured by both methodologies. Although centre J improves, it is still one of the centres with relatively low achievement of the Standard.

The percentage within range for England and Wales has been calculated excluding data from B, J, Q and T.

Haemodialysis

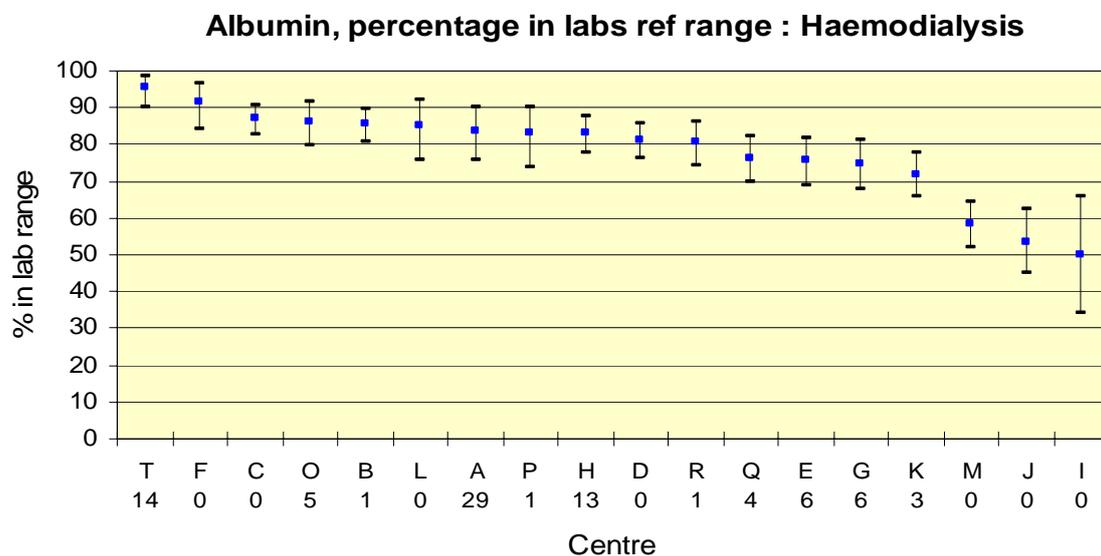


Figure 9.1 Percentage albumin in laboratory reference range on haemodialysis

The Renal Association Standard for albumin is that *all patients should be within the local normal range*

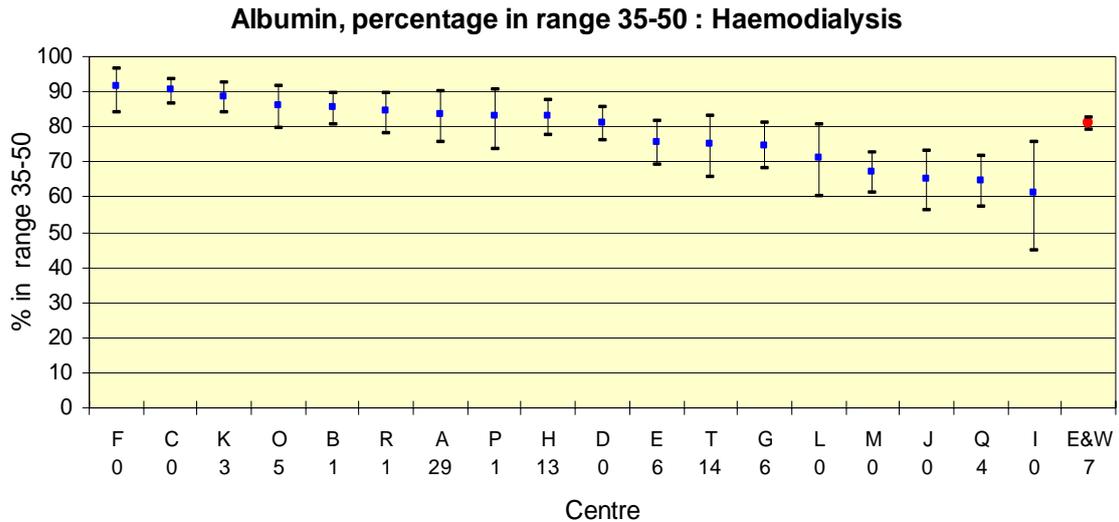


Figure 9.2 Percentage albumin in range 35-50 g/L on haemodialysis

A chi-squared test was used to determine whether the percentage of patients with albumin below and greater than or equal to the laboratory's lower reference range limit differed between centres. Centres using the BCP method to measure albumin have been included in the analysis since the local laboratory reference range has been used in the analysis. For patients on haemodialysis, the percentage of patients with albumin greater than or equal to the laboratory's lower reference range limit differed significantly between centres ($X^2 = 184.2$, d.f. = 17, $p < 0.001$).

Centre K achieves the Standard poorly, but their laboratory lower reference range is the highest at 37 g/L and this has been locally derived. When comparing the centre using a range of 35-50 88% of patients are within this range.

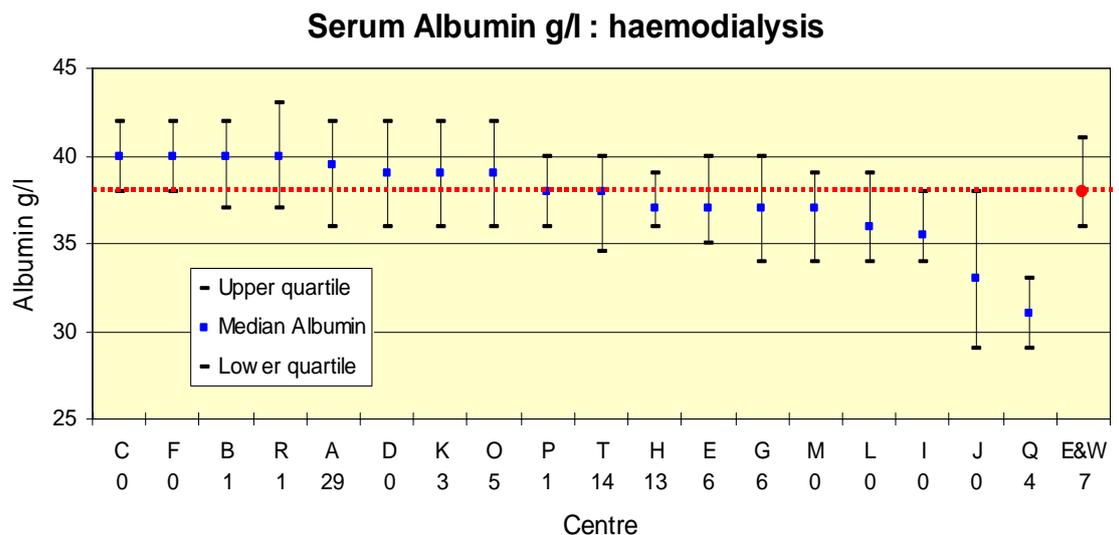


Figure 9.3 Serum albumin on haemodialysis

In figure 9.2 and 3, centres F and I are at either extreme of the albumin range and their 95% C.I. do not overlap, though both are the highest achievers of dialysis adequacy. Centre I also has the greatest percentage of patients with haemoglobin above 10 g/dl

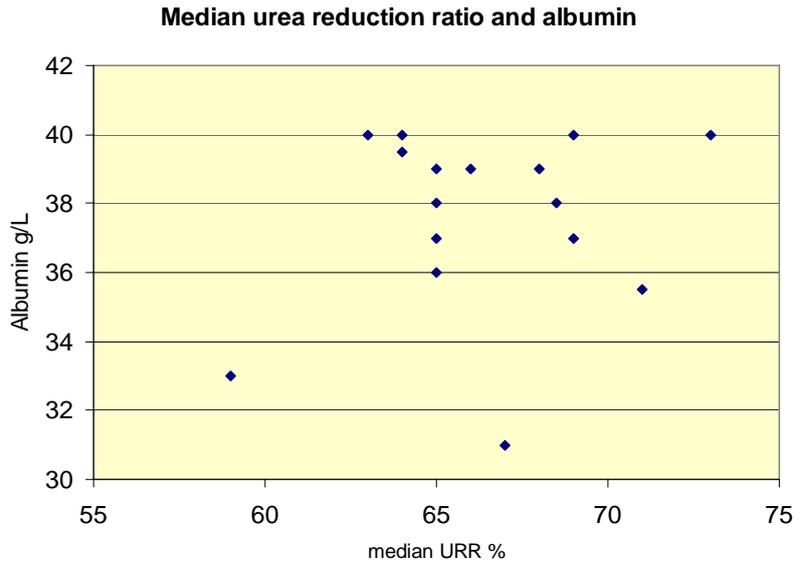


Figure 9.4 Median urea reduction ratio and albumin

The figure above shows a scatter plot of median URR achieved at centres against albumin. Even excluding the two centres on BCP with a median albumin of 31 and 33 g/L respectively, there does not appear to be any relationship. Analysing the data for percentage of albumin with a reference range of 35 –50 (30 – 45 BCP) g/L also showed no relationship for individual centres.

Peritoneal dialysis

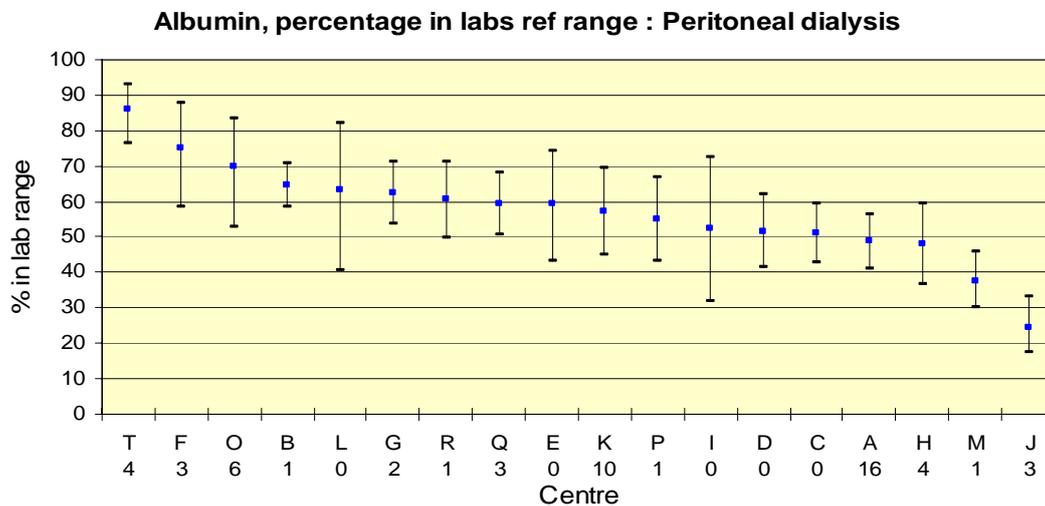


Figure 9.5 Percentage albumin in laboratory reference range on peritoneal dialysis

The R.A Standard for peritoneal dialysis is that **70% of patients should be within the local reference range.**

This was achieved by 3 centres with 5 others whose upper 95% C.I. included this value. The mix of laboratory methodology for centre T may account in figure 9.7 for the skewing of the data with very asymmetric upper and lower quartiles.

For patients on peritoneal dialysis, the percentage of patients with albumin greater than or equal to the laboratory's lower reference range limit differed significantly between centres ($X^2 = 113.2$, d.f. = 17, $p < 0.001$).

When analysed by a range of 35 – 50 g/dl there are still 3 centres within the Standard but T has dropped out. An additional 6 centres (R,I,B,G,E) also have a 95% C.I. which includes the 70% Standard.

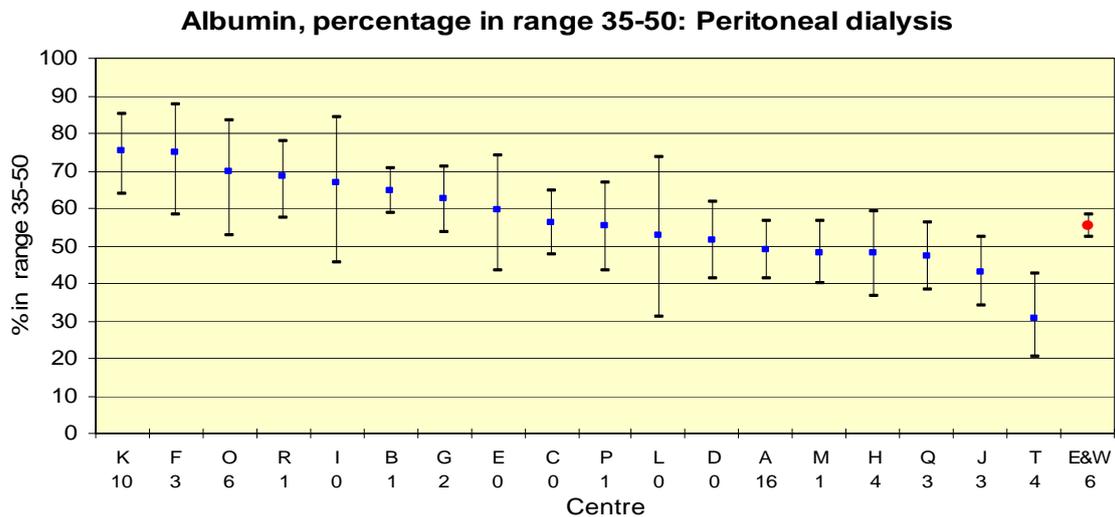


Figure 9.6 Percentage albumin in range 35-50 g/L on peritoneal dialysis

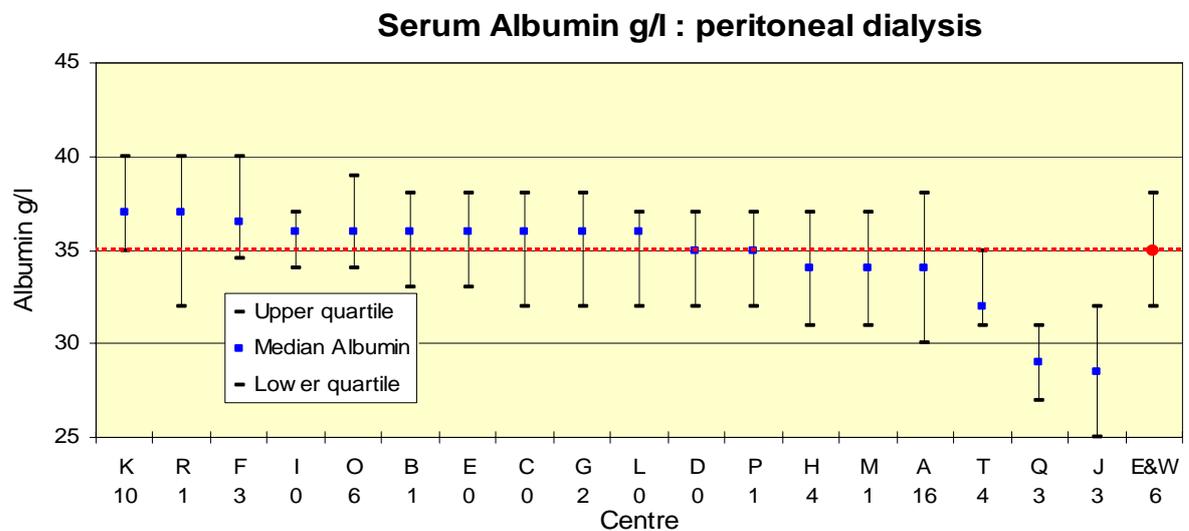


Figure 9.7 Serum albumin on peritoneal dialysis

The median albumin for BCG centres ranged from 34-37 g/L on peritoneal dialysis compared with 36 – 40g/L on haemodialysis. The centre variation in median albumin using BCG is small, although there are significant variations between centres in meeting the Standard or in achieving the 35 – 50 g/L range.

Changes in albumin 1997 – 1998

The three time points on the figures are 1st quarter 1997, 1st quarter 1998 and 4th quarter 1998

Haemodialysis

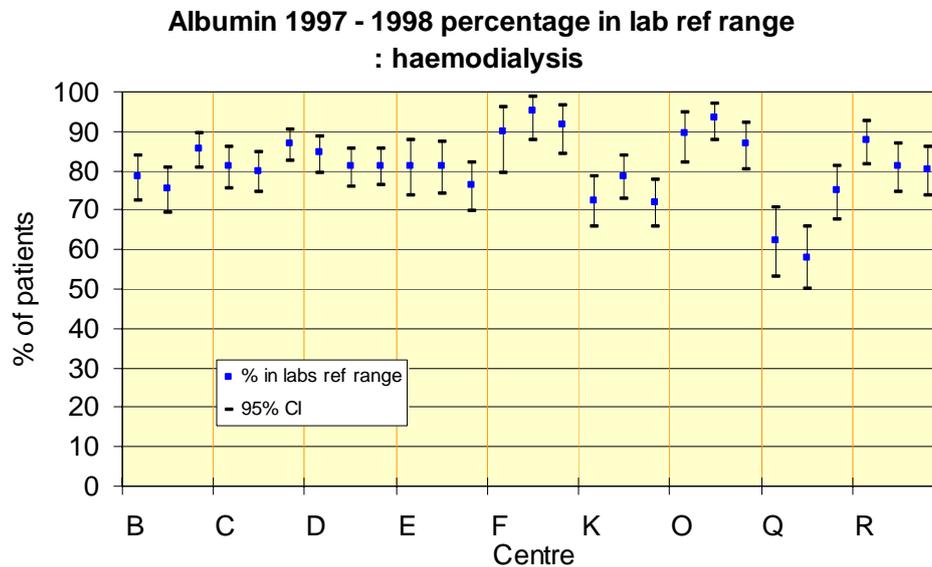


Figure 9.8 Percentage albumin in laboratory reference range on haemodialysis, 1997-1998

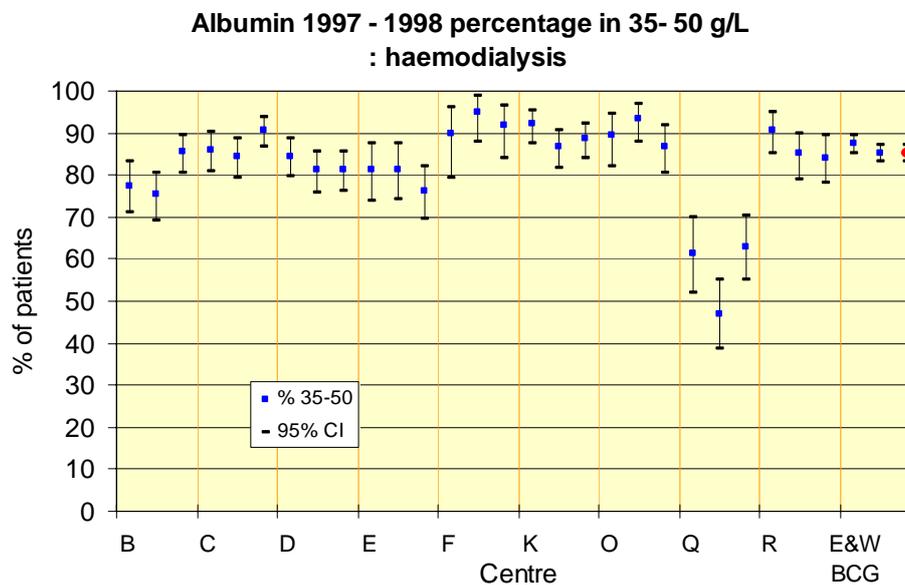


Figure 9.9 Percentage albumin in range 35-50 g/L on haemodialysis, 1997-1998

Peritoneal dialysis

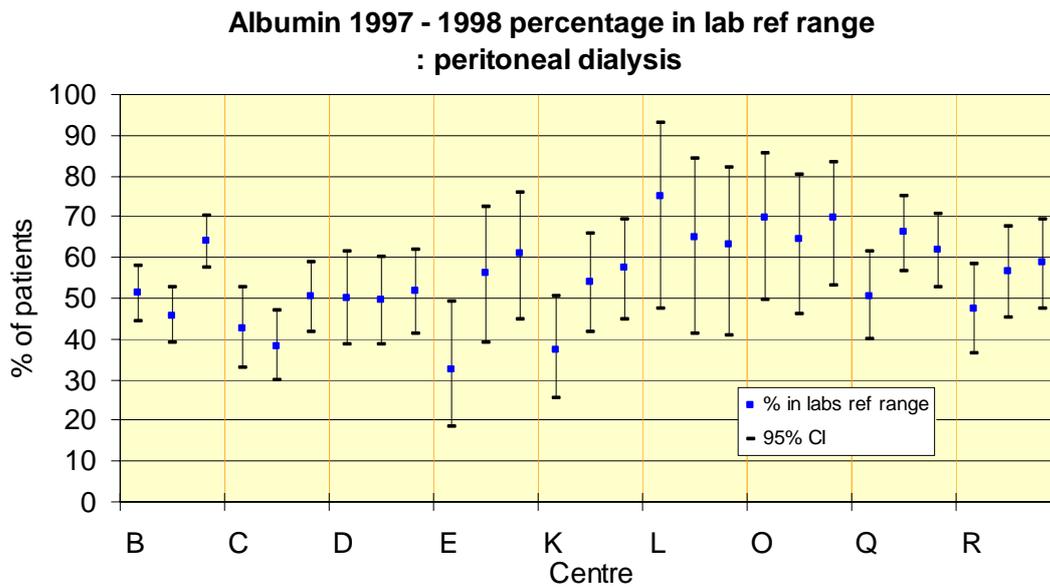


Figure 9.10 Percentage albumin in laboratory reference range on peritoneal dialysis, 1997-1998

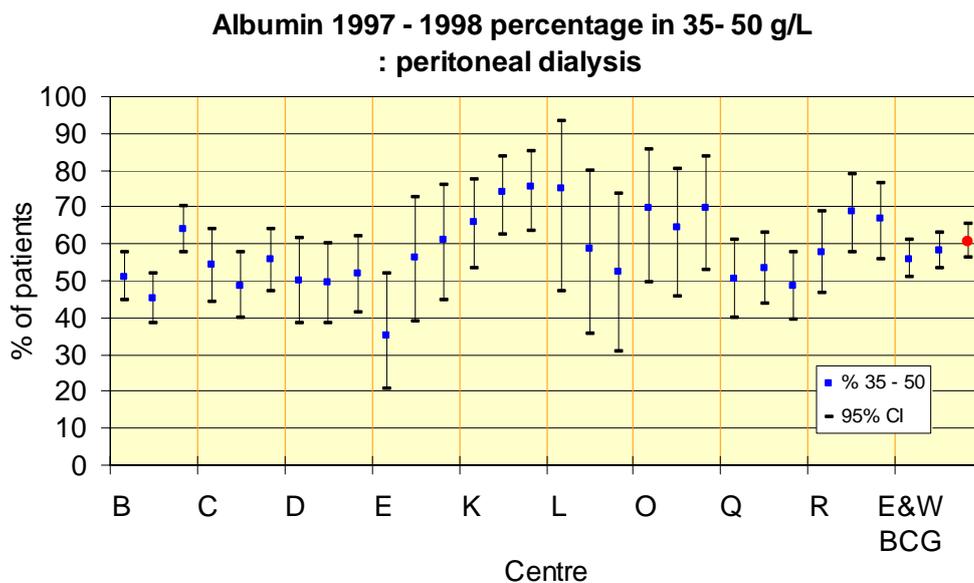


Figure 9.11 Percentage albumin in range 35-50 g/L on peritoneal dialysis, 1997-1998

There appears to be a trend to an increase in albumin of peritoneal dialysis patients over 2 years. There are marked increases for centres E and K although the 95% CI still overlap. Centre B with the smallest CI may be showing a significant improvement. Centre E has increased dialysis adequacy in peritoneal dialysis patients and reduced peritonitis rates during this period (personal communication). Centre K is unable to account for this rise by any change in practice.

Change in albumin for 1998

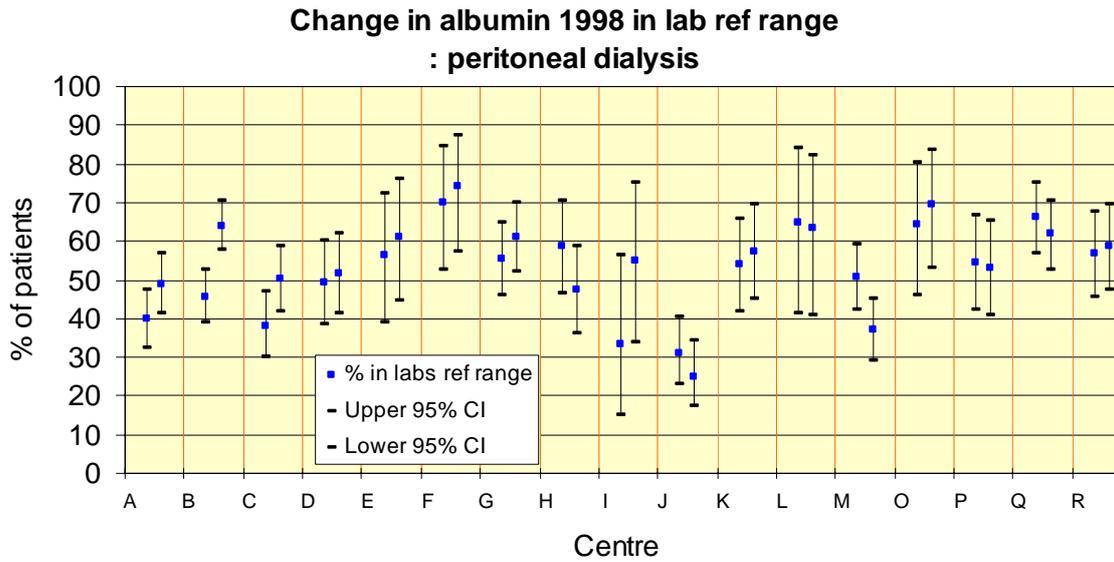


Figure 9.12 Change in albumin in laboratory reference range on peritoneal dialysis, 1998

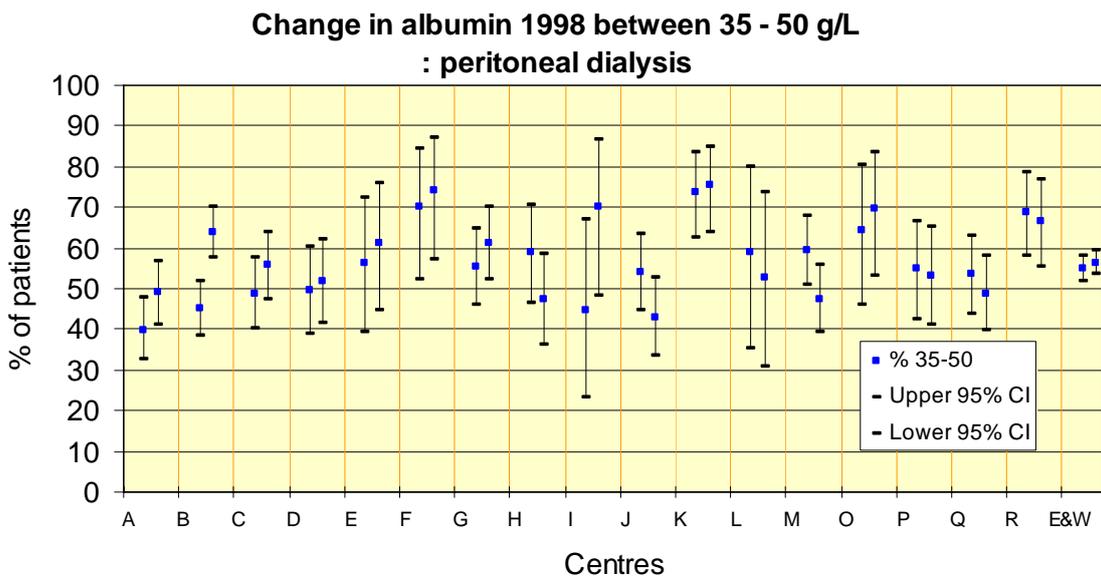


Figure 9.13 Change in albumin between 35-50 g/L on peritoneal dialysis, 1998

Bicarbonate

Bicarbonate measurement

There is no laboratory harmonisation factor available for bicarbonate as it is technically difficult to distribute stable samples for comparative quality assurance. Laboratory methodologies and reference ranges are listed in table 9.2.

Centre	Methodology	Ref range mmol/L	Derivation of ref Range
A	PEPC	24-30	Manufacturer
B	Enzymatic	22-30	Local
C	PEPC	22-31	Not available
D	PEPC	20-29	Text book
E	Actual	22-30	Text book
F	Electrode	24-32	Text book
G	Enzymatic	22-30	Local
H	PEPC	20-30	Manufacturer
I	PEPC	23-30	Local
J	PEPC	24-30	Text book
K	PEPC	20-28	Local
L	PEPC	23-30	Not available
M	PEPC	24-30	Local
N	PEPC	23-31	Manufacturer
O	PEPC	22-29	Text book
P	PEPC	22-29	Local
Q	PEPC	18-28	Local
R	Beckman	22-31	Local
T	PEPC	23-30	Local

Table 9.2 Bicarbonate methodology and reference ranges

Haemodialysis

The Renal Association Standard is that all patients *should be within the local normal range*.

Home dialysis patients are excluded from this analysis as sera may have been sent through the post with decay of samples and misleading results.

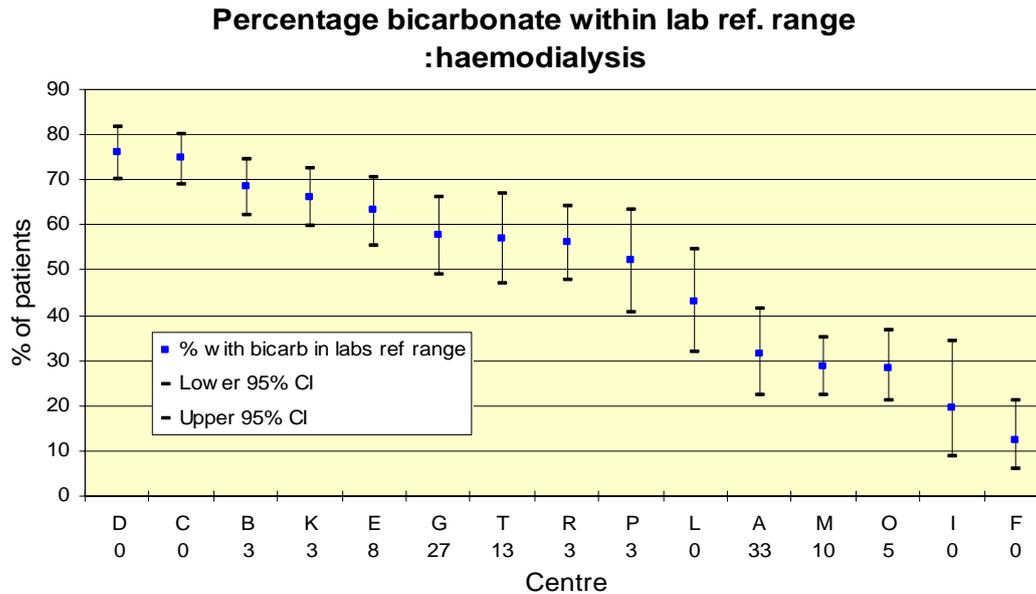


Figure 9.14 Percentage bicarbonate in laboratory reference range on haemodialysis

A chi-squared test was used to determine whether the percentage of patients with bicarbonate within the Standard varied between centres. For patients on haemodialysis, the percentage of patients with bicarbonate within the Standard differed significantly between centres ($X^2 = 292.4$, d.f. = 14, $p < 0.001$).

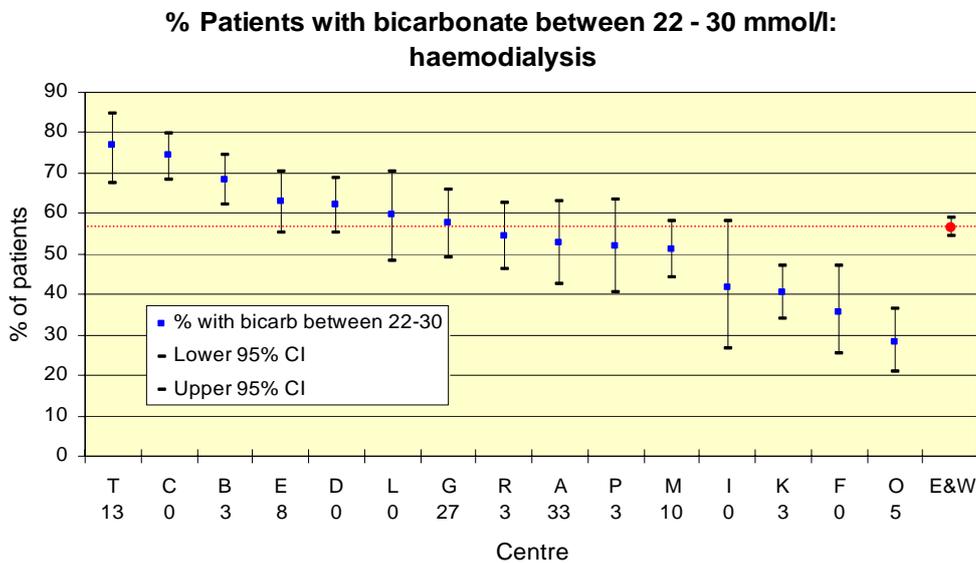


Figure 9.15 Percentage patients with bicarbonate in range 22-30 mmol/L on haemodialysis

The median serum bicarbonate on haemodialysis varied from 20 – 24 mmol/L. Centres F and I had the some of the lowest bicarbonates and also had the highest urea reduction ratios.

Whether analysed as percentage within the laboratory reference range or the range 22-30 mmol/L there were significant variations between centres.

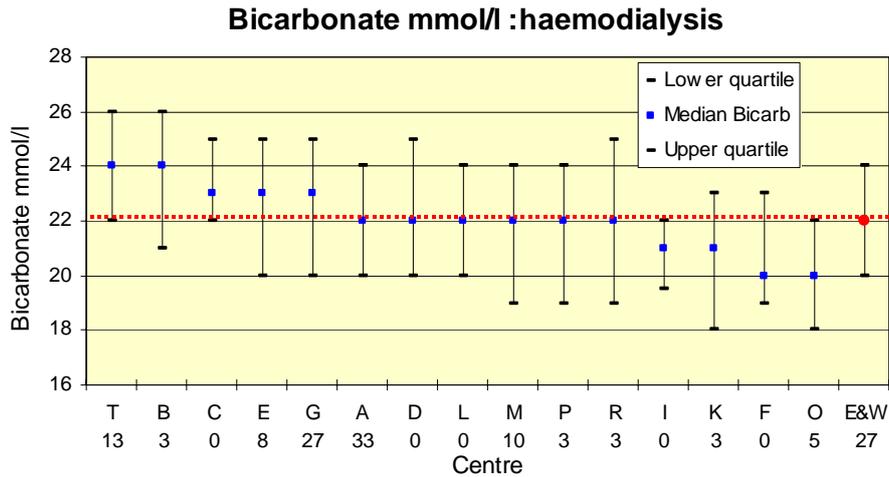


Figure 9.16 Median bicarbonate (mmol/L) on haemodialysis

Peritoneal dialysis

The Renal Association Standard is that patients should have a bicarbonate between *the lower local normal to upper local normal +3mmol/L*.

For patients on peritoneal dialysis, the percentage of patients with bicarbonate within the Standard differed significantly between centres ($X^2 = 63.7$, d.f. = 14, $p < 0.001$).

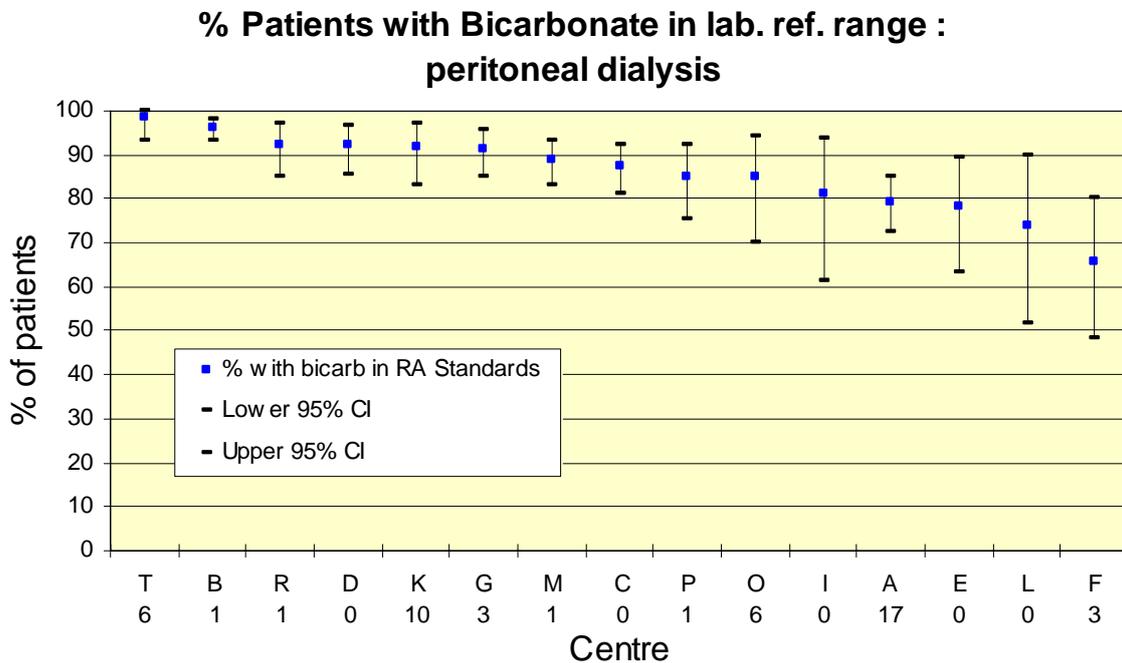


Figure 9.17 Percentage patients with bicarbonate in laboratory reference range on peritoneal dialysis

Serum bicarbonate for patients on peritoneal dialysis also varied widely from a median of 24 to 29 mmol/L. Centres B & T have high bicarbonate values for both peritoneal dialysis and haemodialysis and this might be related to laboratory measurement. This

contrasts with centre M with the highest values on peritoneal dialysis and ‘middle’ values on haemodialysis.

% Patients with Bicarbonate between 22-30 mmol/l: peritoneal dialysis

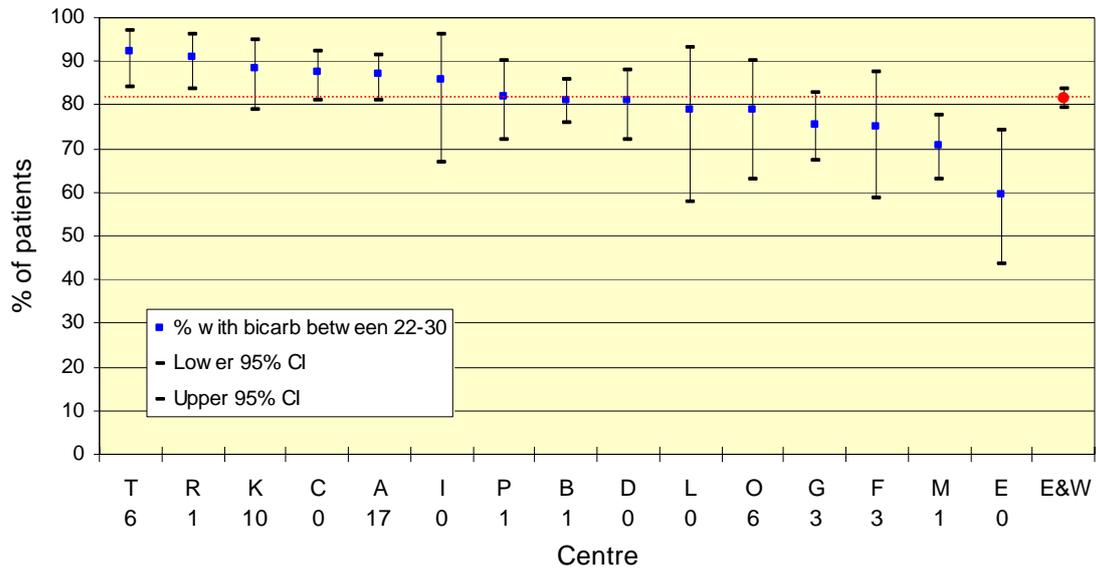


Figure 9.18 Percentage patients with bicarbonate in range 22-30 mmol/L on peritoneal dialysis

Bicarbonate mmol/l: peritoneal dialysis

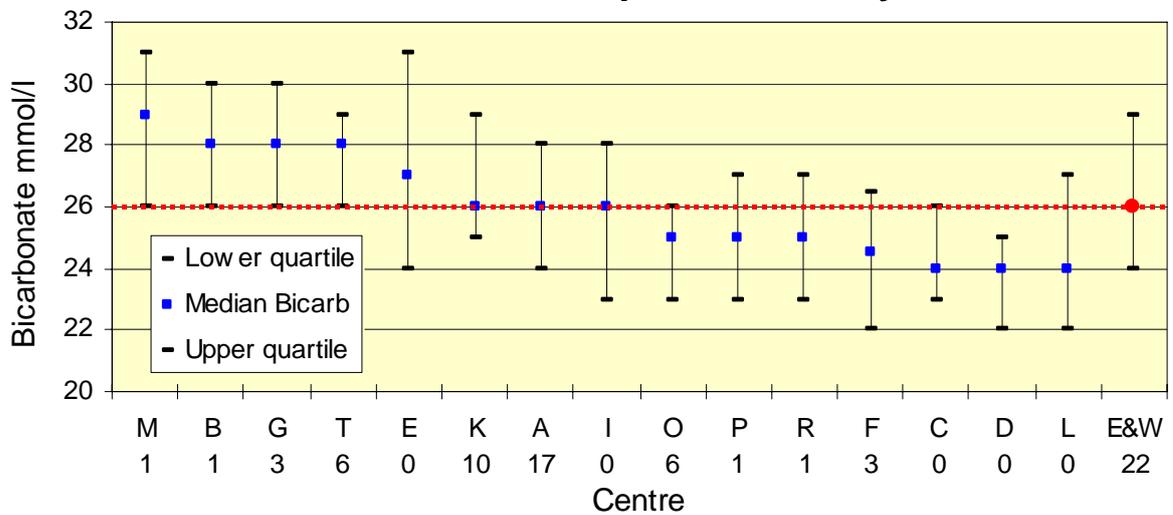


Figure 9.19 Bicarbonate (mmol/L) on peritoneal dialysis

Cholesterol

Conversion factor: mg/dl = mmol/L x 38.5

The Renal Standards document has no recommended reference range for serum cholesterol

Introduction

The Renal Registry is able to harmonise cholesterol data to facilitate direct comparisons of measurements between centres.

Most nephrologists are probably looking towards serum cholesterol levels of <5.2 mmol/L for men and women, especially in patients with vascular disease or diabetes, in accordance with the Chief Medical Officer's guidelines. The Renal Registry has analysed the most recent cholesterol data over one year as many centres only measure this annually. It may even be the case, where this has been measured previously and the result was normal without use of a lipid-lowering agent, that the centre may not measure it again. The treatment modality was defined on 31/12/98. Some patients may have changed modality over the course of the preceding year, but they were included in their category of modality on 31/12/98.

Haemodialysis

A chi-squared test was used to determine whether the percentage of patients with cholesterol ≤ 5.2 differed between centres. Note that the analysis considered laboratory harmonised cholesterol.

For patients on haemodialysis, the percentage of patients with cholesterol ≤ 5.2 differed significantly between centres ($X^2 = 13.8$, d.f. = 5, $p=0.017$).

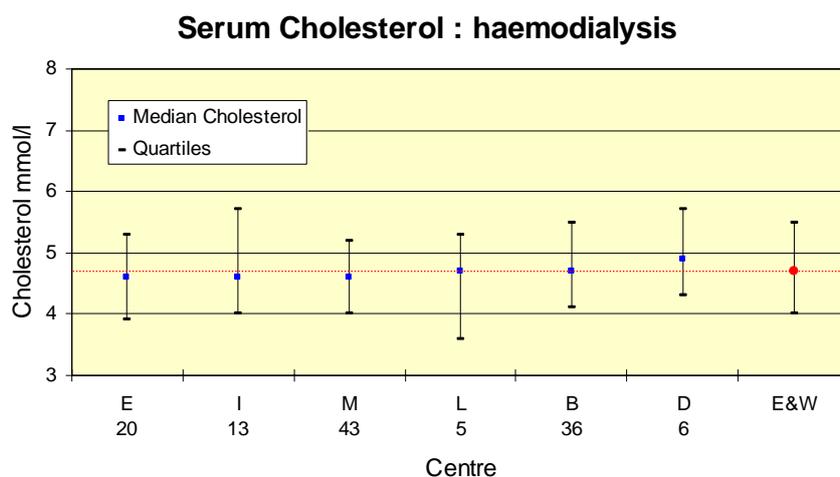


Figure 9.20 Median serum cholesterol (mmol/L) on haemodialysis

**Cholesterol, percentage < 5.2 mmol/l :
Haemodialysis**

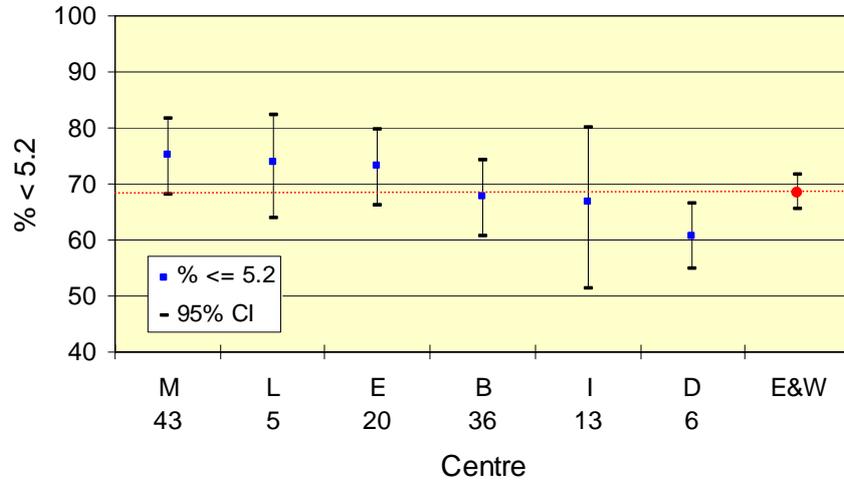


Figure 9.21 Percentage cholesterol < 5.2 mmol/L on haemodialysis

Peritoneal dialysis

For patients on peritoneal dialysis, the percentage of patients with cholesterol ≤ 5.2 was **not** found to differ significantly between centres ($X^2 = 18.2$, d.f. = 11, $p=0.077$).

Serum Cholesterol : Peritoneal dialysis

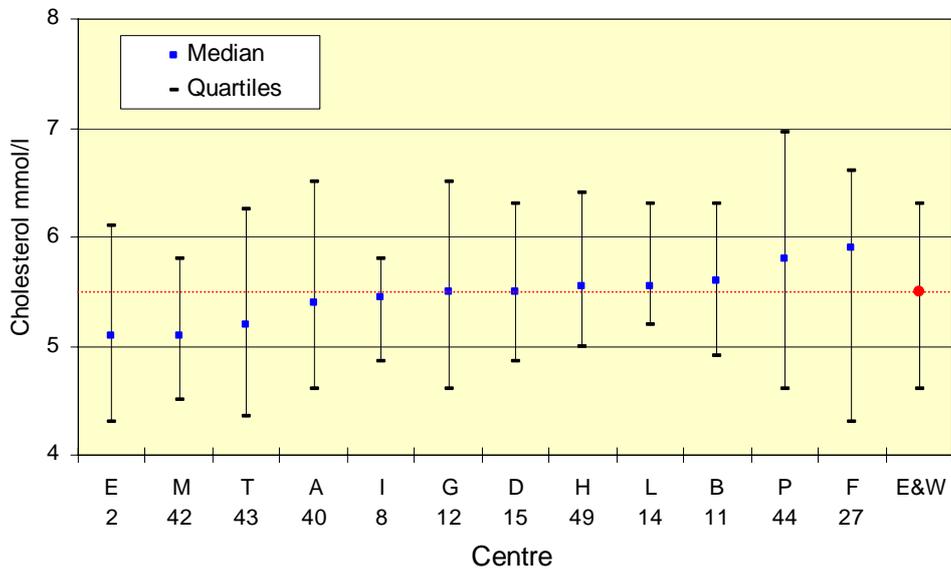


Figure 9.22 Serum cholesterol (mmol/L) on peritoneal dialysis

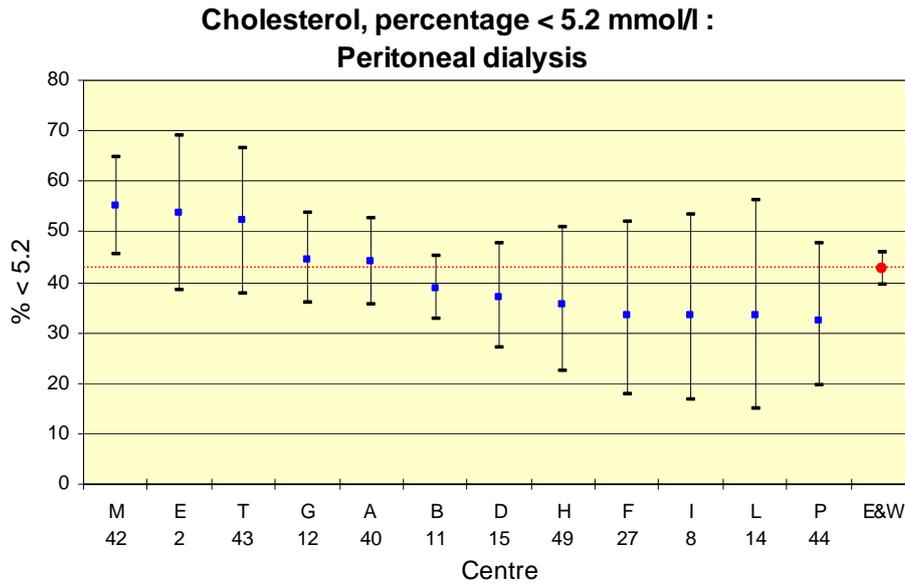


Figure 9.23 Percentage cholesterol < 5.2 mmol/L on peritoneal dialysis

Change in cholesterol 1997 – 1998

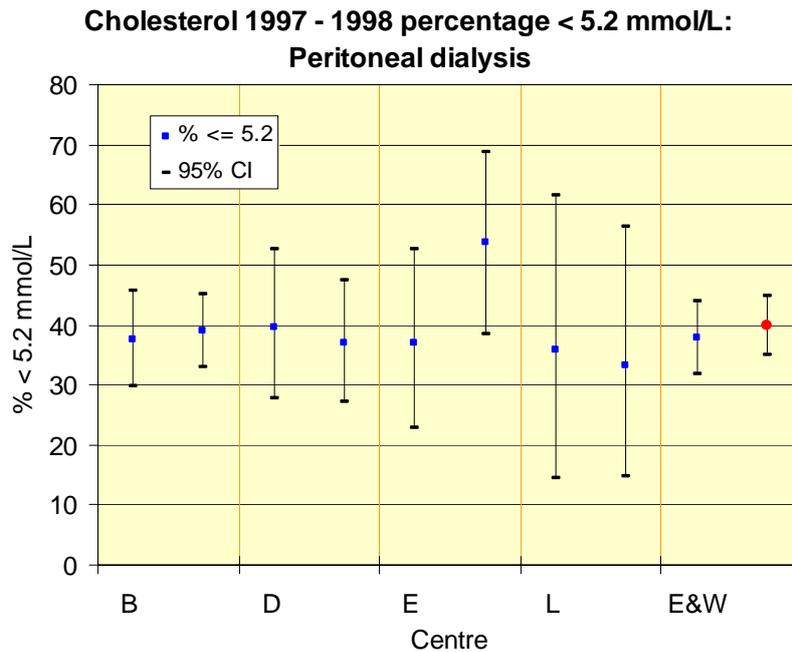


Figure 9.24 Percentage cholesterol < 5.2 mmol/L on peritoneal dialysis, 1997-1998

There was insufficient data on haemodialysis patients to look at changes. For patients on peritoneal dialysis there was no significant change towards lower cholesterol over the two year period

Conclusions

1. Albumin remains a complex methodological issue and also creates interpretive difficulties with calcium measurement.
2. There are problems with stability of bicarbonate
3. The Association of Clinical Biochemists has instigated a national audit of laboratory reference ranges to address problems with the use of reference ranges to drive Standards