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UK Renal Registry 18th Annual Report: Chapter 7 Adequacy of Haemodialysis in UK Adult Patients in 2014: National and Centre-specific Analyses

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Key Words
Adequacy · Haemodialysis · Urea reduction ratio

Summary

- Data suitable for urea reduction ratio (URR) analyses were available for 14,761 (71.9%) of the 20,539 patients receiving haemodialysis (HD) in the UK on the 30/9/2014.
- In 2014, 88.6% of prevalent HD patients achieved a URR >65%. The between centre range of prevalent patients achieving this target was wide (74.9–97.0%).
- The median URR in 2014 was 75%.
- URR was greater in those with longer dialysis vintage, with 91.2% of patients who had survived on renal replacement therapy (RRT) for more than two years achieving a URR >65% compared with only 73.4% of those on RRT for less than six months.
- Large variation between centres in the percentage of patients achieving the UK Renal Association's (RA) URR guideline persists.

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Introduction

The UK Renal Registry (UKRR) started collecting data from dialysis centres in England, Wales and Northern Ireland approximately 20 years ago. At that time haemodialysis facilities were limited, and one of the objectives of the UKRR, in collaboration with the UK Renal Association was to provide data on haemodialysis provision, and quality metrics compared to clinical standards set by the Renal Association [1], designed to establish parity between centres and improve provision and delivery of treatments.

The traditional paradigm for determining haemodialysis adequacy is based on sessional urea clearance, and both prospective and observational studies have reported an association between urea clearance and patient outcomes [2, 3]. The delivered dose of HD depends on both treatment factors (duration and frequency of dialysis sessions, dialyser size and characteristics, dialysate and blood flow rate) and patient characteristics (including size, protein intake, physical activity, haematocrit and vascular access) [4]. The most widely accepted measures of urea clearance are Kt/V, the ratio between the product of urea clearance (K, in ml/min) and dialysis session duration (t, in minutes) divided by the volume of distribution of urea in the body (V, in ml) and urea reduction ratio, which is derived solely from the percentage fall in serum urea during a dialysis treatment. Whilst Kt/V is a more accurate descriptor of urea clearance, its calculation is more complex and requires additional data items not commonly reported by most UK renal centres [5–7]. The UKRR has historically presented analyses based on URR rather than Kt/V for comparative audit of haemodialysis adequacy as these data are more widely available. On one hand, URR does not take into account the rebound in serum urea concentration at the end of dialysis, and so may over estimate delivered dialysis dose, particularly when higher blood pump speeds are used, whereas on the other hand URR does not include any estimate of residual renal function (RRF).

Clinical practice guidelines have been developed by various national and regional organisations [1, 8, 9], with considerable uniformity to the minimum dose of dialysis recommended, although there are differences in the methodology advised. Table 7.1 outlines the recommended UK RA audit measures for haemodialysis patients and whether the audit measure is currently reported in the annual UKRR report [1].

The objective of this chapter is to determine haemodialysis practice patterns in the UK, and the extent to which patients undergoing HD treatment received the dose of HD, as measured by URR, recommended by the current UK RA clinical practice guidelines [1].

Methods

Seventy-one renal centres in the UK submitted data electronically to the UKRR on a quarterly basis. The majority of these centres have satellite units but for the purposes of this study the data from the renal centres and their associated satellite units were amalgamated. Data from two groups of patients were

Table 7.1 Summary of recommended Renal Association audit measures relevant to haemodialysis adequacy [1]

RA audit measure	Included in UKRR annual report?	Reason for non-inclusion
Haemodialysis adequacy audit measures		
Audit measure: The proportion of patients in the main renal centre and its satellite units who are on twice weekly haemodialysis	No	Varying levels of reporting between centres
Audit measure: Cumulative frequency curves of urea reduction ratio measured using a standard method of post-dialysis sampling	Yes, but data not presented in the cumulative frequency format	
Audit measure: The proportion of patient non-attendances for haemodialysis sessions and the proportion of dialysis sessions shortened at the patient's request	No	Data not available
Audit measure: The proportion of thrice weekly haemodialysis sessions which have prescribed treatment times less than 4 hours	No	Varying levels of reporting between centres
Audit measure: The proportion of hospital (main and satellite unit) and home haemodialysis patients who are prescribed more frequent than thrice weekly haemodialysis	Yes	Not for home haemodialysis patients

analysed. Firstly, analysis was undertaken using data from the prevalent adult HD patient population as of the 30th September 2014. For this analysis, data for URR were taken from the 3rd quarter of 2014 unless that data point was missing in which case data from the 2nd quarter were taken. The prevalent population only included patients receiving HD who were alive on September 30th 2014. Data from those patients who had died before that date have not been included in the analysis. The second analysis involved adult incident patients who had commenced treatment with HD during 2013. For these patients, analysis was undertaken using the last recorded URR in the quarter in which the patient had started dialysis. The incident HD patient cohort was followed up for one year and the last recorded URR in the quarter after one year follow-up was used for this analysis.

Data from patients known to be receiving more or less than thrice weekly HD were omitted from the analysis for both the incident and prevalent population. Patients for whom data recording the number of dialysis sessions per week were missing, were assumed to be dialysing thrice weekly. However, because not all centres report frequency of HD, it is possible that data from a small number of patients receiving HD at a different frequency were included in the analyses. Home HD patients were excluded from the analysis.

Analyses of the data from both groups of patients included the calculation of the median URR and of the proportion of patients who had achieved the RA guideline (as outlined below) in each of the renal centres as well as for the country as a whole. The median URR and proportion of patients who achieved the RA guideline were also calculated separately for males and females. The number of dialysis sessions per week and the time per dialysis session is shown by renal centre.

All patients with data were included in the statistical analyses at a national level, although centres with fewer than 20 patients, or providing less than 50% data completeness were excluded from the comparison between centres. The number preceding the centre name in each figure indicates the percentage of missing data for that centre.

The UK RA clinical practice guidelines in operation at the time these data were collected were as follows:

HD should take place at least three times per week in nearly all patients. Reduction of dialysis frequency to twice per week because of insufficient dialysis facilities is unacceptable.

Every patient receiving thrice weekly HD should have consistently:

- ***either URR >65%***
- ***or equilibrated Kt/V (eKt/V) of >1.2 (or single pool Kt/V of >1.3) calculated from pre- and post-dialysis urea values, duration of dialysis and weight loss during dialysis).***

To achieve a URR above 65% or eKt/V above 1.2 consistently in the vast majority of the HD population clinicians should aim for a minimum target URR of 70% or minimum eKt/V of 1.4 in individual patients.

The duration of thrice weekly HD in adult patients with minimal residual renal function should not be reduced below 4 hours without careful consideration.

Patients receiving HD twice weekly for reasons of geography should receive a higher sessional dose of HD. If this cannot be achieved, then it should be recognised that there is a compromise between the practicalities of HD and the patient's long-term health.

Measurement of the 'dose' or 'adequacy' of HD should be performed monthly in all hospital HD patients and may be performed less frequently in home HD patients. All dialysis units should collect and report this data to their regional network and the UKRR.

Post-dialysis blood samples should be collected either by the slow-flow method, the simplified stop-flow method, or the stop dialysate flow method. The method used should remain consistent within renal units and should be reported to the Registry.

The RA clinical practice guidelines for HD dose apply specifically to patients undergoing thrice weekly HD. In these patients it is recommended that blood for biochemical measurement (including pre-dialysis urea for URR) should be taken before the mid-week dialysis session [1].

Results

Data completeness

Sixty four of the 71 renal centres submitted HD dose (URR) data to the UKRR (table 7.2). Data were available for 71.9% ($N = 14{,}761$) of the total prevalent population ($N = 20{,}539$) treated with HD who met the inclusion criteria for these analyses.

Fifty centres reported URR data on more than 90% of patients. Thirteen centres reported URR data on less than 50% of prevalent patients (Carshalton, Manchester RI, Newcastle, Reading, Brighton, Sunderland), with no URR data received from seven centres (London Barts, London King's, London Royal Free, London St Georges, Liverpool Aintree, Liverpool Royal Infirmary, Wirral).

Several centres had a reduction in the completeness of URR data submitted to the UKRR in 2014 compared with 2013 (data not shown). These changes may represent changes in data extraction, or a move by centres to utilising Kt/V rather than URR as the preferred measure of dialysis dose.

Of the total incident patient population ($N = 4{,}404$) who started HD during 2013 and meeting the inclusion criteria for URR analyses, 48.5% ($N = 2{,}137$) had URR data available during the first quarter of treatment (data not shown).

Data completeness on the number of HD sessions per week varied between centres (table 7.3). Seven centres in England and four centres in Wales returned no data. All centres in Northern Ireland returned data for 100% of their HD population. All centres in Scotland returned data in over 95% of their HD population.

Table 7.2. Percentage completeness of URR data returns for prevalent patients on HD by centre, on 30/9/2014

Centre	*N*	% completeness	Centre	*N*	% completeness
England					
B Heart	347	100.0	Sheff	487	96.7
B QEH	841	96.1	Shrew	142	97.9
Basldn	146	95.9	Stevng	389	99.7
Bradfd	179	100.0	Sthend	98	99.0
Brightn	347	4.3	Stoke	256	75.0
Bristol	443	100.0	Sund	173	0.6
Camb	265	96.2	Truro	118	82.2
Carlis	62	98.4	Wirral	169	0.0
Carsh	688	0.7	Wolve	276	90.9
Chelms	102	94.1	York	103	100.0
Colchr	109	91.7			
Covnt	323	99.1	**N Ireland**		
Derby	191	92.7	Antrim	113	97.4
Donc	159	99.4	Belfast	161	98.8
Dorset	248	100.0	Newry	82	84.2
Dudley	145	97.9	Ulster	88	98.9
Exeter	352	99.7	West NI	87	95.4
Glouc	206	100.0			
Hull	298	99.3	**Scotland**		
Ipswi	104	100.0	Abrdn	185	99.5
Kent	360	98.3	Airdrie	171	98.8
L Barts	889	0.0	D & Gall	29	96.6
L Guys	556	63.9	Dundee	150	100.0
L Kings	480	0.0	Edinb	250	100.0
L Rfree	650	0.0	Glasgw	529	99.6
L St.G	270	0.0	Inverns	53	100.0
L West	1,309	88.2	Klmarnk	123	100.0
Leeds	423	99.8	Krkcldy	135	99.3
Leic	790	99.5			
Liv Ain	131	0.0	**Wales**		
Liv Roy	257	0.0	Bangor	65	100.0
M RI	418	3.8	Cardff	416	99.0
Middlbr	302	99.3	Clwyd	73	97.3
Newc	233	13.7	Swanse	283	71.4
Norwch	275	98.2	Wrexm	101	100.0
Nottm	306	92.8			
Oxford	387	98.2	**England**	**17,445**	**67.6**
Plymth	128	93.8	**N Ireland**	**531**	**95.7**
Ports	499	95.6	**Scotland**	**1,625**	**99.6**
Prestn	475	77.9	**Wales**	**938**	**90.7**
Redng	256	9.8	**UK**	**20,539**	**71.9**
Salford	285	87.0			

For those centres returning data, three dialysis sessions a week was most prevalent, although a few centres reported >10% of HD patients receiving more or less than thrice weekly treatments (table 7.3). For example, Salford reported 20.1% of patients receiving more than three sessions a week, whereas Southend reported 14.0% of patients having less than three sessions per week.

Again there was a wide variation between centres in completeness of data on dialysis session time (table 7.4). The great majority of prevalent patients dialysed between 3.5–5.0 hours, although there was variation. Taking centres with 99% or greater data completion for time per dialysis session, then London King's reported 16.3% of patients dialysing <3.5 hours per session, and Newcastle reported dialysing 1.3% of patients for more than five hours per session.

Achieved URR

The UK median URR reported for prevalent HD patients was 75.0% (centre range 71.0–82.5%) (figure 7.1a), with a

Table 7.3. Number of dialysis sessions for prevalent patients on HD by centre, on 30/9/2014

Centre	*N*	Percentage completeness	Percentage		
			<3 sessions	3 sessions	>3 sessions
England					
B Heart	381	83.7	8.8	89.3	1.9
B QEH	841	0.0			
Basldn	152	98.7	0.0	96.0	4.0
Bradfd	192	100.0	5.7	93.2	1.0
Brightn	348	99.7	0.0	99.7	0.3
Bristol	471	100.0	4.0	94.1	1.9
Camb	298	98.7	9.2	88.8	2.0
Carlis	65	96.9	4.8	95.2	0.0
Carsh	693	99.3	0.4	99.3	0.3
Chelms	115	99.1	9.6	88.6	1.8
Colchr	109	100.0	0.0	100.0	0.0
Covnt	323	2.5			
Derby	191	61.8	0.0	100.0	0.0
Donc	160	95.6	0.7	99.3	0.0
Dorset	252	99.2	1.2	98.4	0.4
Dudley	148	99.3	1.4	98.0	0.7
Exeter	375	99.7	4.5	93.9	1.6
Glouc	206	0.0			
Hull	298	1.0			
Ipswi	110	76.4	6.0	92.9	1.2
Kent	378	99.2	3.2	95.2	1.6
L Barts	889	0.0			
L Guys	556	0.0			
L Kings	480	100.0	0.0	100.0	0.0
L Rfree	650	0.0			
L St.G	272	90.1	0.8	99.2	0.0
L West	1,320	41.4			
Leeds	449	98.9	5.9	94.1	0.0
Leic	797	98.5	0.9	99.1	0.0
Liv Ain	141	99.3	2.1	92.9	5.0
Liv Roy	295	98.3	0.7	86.9	12.4
M RI	421	23.5			
Middlbr	304	19.1			
Newc	237	100.0	0.4	98.3	1.3
Norwch	281	99.6	1.4	97.9	0.7
Nottm	310	99.0	1.3	98.7	0.0
Oxford	387	100.0	0.0	100.0	0.0
Plymth	128	0.0			
Ports	541	98.5	6.0	92.1	1.9
Prestn	475	0.0			
Redng	259	98.8	0.4	98.8	0.8
Salford	360	99.7	0.8	79.1	20.1
Sheff	510	99.8	4.5	95.5	0.0
Shrew	153	100.0	5.2	92.8	2.0
Stevng	421	99.3	5.5	92.3	2.2
Sthend	114	100.0	14.0	86.0	0.0
Stoke	267	99.6	0.8	95.9	3.4
Sund	190	96.8	0.0	90.8	9.2
Truro	130	90.0	7.7	89.7	2.6
Wirral	187	98.9	1.1	90.3	8.6
Wolve	276	7.6			
York	112	97.3	0.9	91.7	7.3

Table 7.3. Continued

Centre	*N*	Percentage completeness	Percentage		
			<3 sessions	3 sessions	>3 sessions
N Ireland					
Antrim	114	100.0	0.0	99.1	0.9
Belfast	168	100.0	0.6	95.8	3.6
Newry	86	100.0	4.7	95.3	0.0
Ulster	91	100.0	1.1	96.7	2.2
West NI	99	100.0	2.0	87.9	10.1
Scotland					
Abrdn	196	100.0	1.5	94.4	4.1
Airdrie	171	97.1	0.0	100.0	0.0
D & Gall	41	100.0	4.9	70.7	24.4
Dundee	153	99.4	0.0	98.0	2.0
Edinb	251	99.6	0.4	99.6	0.0
Glasgw	533	95.5	0.6	99.2	0.2
Inverns	56	100.0	0.0	94.6	5.4
Klmarnk	123	98.4	0.0	100.0	0.0
Krkcldy	136	97.8	0.8	99.2	0.0
Wales					
Bangor	65	0.0			
Cardff	416	0.0			
Clwyd	79	94.9	1.3	92.0	6.7
Swanse	283	0.0			
Wrexm	101	0.0			
England	**18,018**	**65.4**	**2.7**	**95.1**	**2.1**
N Ireland	**558**	**100.0**	**1.4**	**95.2**	**3.4**
Scotland	**1,660**	**97.8**	**0.6**	**97.8**	**1.5**
Wales	**944**	**7.9**			
UK	**21,180**	**66.3**	**2.4**	**95.4**	**2.2**

Blank cells denote no data returned by that centre or data not shown due to <50% data completeness

median URR for women of 78.0% (centre range 71.0–87.0%) compared with a median for men of 74.0% (centre range 69.0–81.0%) (figures 7.1b, 7.1c). The percentage of patients achieving the UK RA guideline of a URR >65% was 88.6% for the UK, with a centre range of 74.9–97.0% (figure 7.2). There continued to be variation between renal centres in the percentage of prevalent patients with a URR of >65%, with 23 centres attaining the UK RA clinical practice guideline for >90% of patients and 34 centres reporting a URR of >65% in 75–90% of patients (figure 7.2). The percentage of prevalent male HD patients achieving the URR target was 86.5% for the UK, with a centre range of 64.7–96.2%, compared to 92.0% for prevalent female HD patients, with a centre range of 73.6–100%.

Changes in URR over time

The proportion of patients attaining the UK RA guideline (sessional URR >65%) increased from 70.7% to 88.6% from 2001–2014, whilst the median URR has risen from 70.0% to 75.0% during the same time period (figure 7.3). However, between 2011 and 2014, there has been no substantial increase in median URR reported by centres in the UK, or in the percentage of patients achieving the UK RA target.

Variation of achieved URR with time on dialysis

The proportion of prevalent HD patients who attained the UK RA clinical guideline for sessional URR was greatest for those who had been on dialysis for the longest time (figure 7.4). In 2014, 73.4% of those dialysed for less than six months had a URR >65%, whilst 91.2% of patients who had survived and continued on RRT for more than two years had a URR within the guideline target. In all strata of time on dialysis, there has been an improvement in the proportion of patients receiving the target dose between 2000–2011, thereafter there has been no substantial increase.

Table 7.4. Time per dialysis session for prevalent patients on HD by centre, on 30/9/2014

Centre	*N*	Percentage completeness	Percentage per dialysis session		
			<3.5 hours	3.5–5 hours	5+ hours
England					
B Heart	347	76.7	4.5	95.1	0.4
B QEH	841	0.0			
Basldn	146	98.6	11.8	88.2	0.0
Bradfd	179	99.4	8.4	91.6	0.0
Brightn	347	99.7	2.0	98.0	0.0
Bristol	443	100.0	5.6	94.4	0.0
Camb	265	0.0			
Carlis	62	96.8	5.0	95.0	0.0
Carsh	688	97.7	1.8	98.2	0.0
Chelms	102	99.0	5.9	94.1	0.0
Colchr	109	100.0	0.0	100.0	0.0
Covnt	323	4.6			
Derby	191	61.8	0.8	99.2	0.0
Donc	159	95.6	11.2	88.8	0.0
Dorset	248	99.2	2.8	97.2	0.0
Dudley	145	99.3	8.3	91.7	0.0
Exeter	352	100.0	19.0	81.0	0.0
Glouc	206	0.0			
Hull	298	2.3			
Ipswi	104	75.0	2.6	97.4	0.0
Kent	360	99.7	17.0	83.0	0.0
L Barts	889	0.0			
L Guys	556	14.2			
L Kings	480	100.0	16.3	83.8	0.0
L Rfree	650	0.0			
L St.G	270	80.0	1.4	98.6	0.0
L West	1,309	41.3			
Leeds	423	99.5	6.9	93.1	0.0
Leic	790	81.9	3.1	95.5	1.4
Liv Ain	131	100.0	14.5	85.5	0.0
Liv Roy	257	100.0	8.2	90.7	1.2
M RI	418	23.2			
Middlbr	302	100.0	19.2	79.8	1.0
Newc	233	99.6	6.0	92.7	1.3
Norwch	275	99.6	16.1	83.9	0.0
Nottm	306	99.0	6.6	93.1	0.3
Oxford	387	100.0	8.3	91.5	0.3
Plymth	128	0.0			
Ports	499	0.0			
Prestn	475	0.4			
Redng	256	94.1	0.8	99.2	0.0
Salford	285	94.4	6.3	93.3	0.4
Sheff	487	86.2	50.2	49.3	0.5
Shrew	142	100.0	12.7	87.3	0.0
Stevng	389	99.7	33.5	66.5	0.0
Sthend	98	100.0	26.5	73.5	0.0
Stoke	256	100.0	5.5	94.5	0.0
Sund	173	85.0	7.5	92.5	0.0
Truro	118	94.1	18.9	80.2	0.9
Wirral	169	100.0	17.8	81.7	0.6
Wolve	276	7.6			
York	103	99.0	2.0	98.0	0.0

Table 7.4. Continued

Centre	*N*	Percentage completeness	Percentage per dialysis session		
			<3.5 hours	3.5–5 hours	5+ hours
N Ireland					
Antrim	113	100.0	1.8	98.2	0.0
Belfast	161	100.0	9.3	90.7	0.0
Newry	82	100.0	9.8	90.2	0.0
Ulster	88	100.0	3.4	96.6	0.0
West NI	87	100.0	17.2	82.8	0.0
Scotland					
Abrdn	185	98.9	1.1	97.3	1.6
Airdrie	171	95.3	5.5	93.9	0.6
D & Gall	29	82.8	0.0	95.8	4.2
Dundee	150	99.3	3.4	96.6	0.0
Edinb	250	99.2	9.3	89.9	0.8
Glasgw	529	94.9	1.6	93.8	4.6
Inverns	53	100.0	1.9	98.1	0.0
Klmarnk	123	90.2	0.0	100.0	0.0
Krkcldy	135	97.8	14.4	84.8	0.8
Wales					
Bangor	65	0.0			
Cardff	416	0.0			
Clwyd	73	97.3	33.8	66.2	0.0
Swanse	283	0.0			
Wrexm	101	0.0			
England	**17,445**	**60.3**	**10.6**	**89.1**	**0.3**
N Ireland	**531**	**100.0**	**8.1**	**91.9**	**0.0**
Scotland	**1,625**	**96.3**	**4.3**	**93.7**	**2.0**
Wales	**938**	**7.6**			
UK	**20,539**	**61.8**	**9.9**	**89.6**	**0.5**

Blank cells denote no data returned by that centre or data not shown due to <50% data completeness

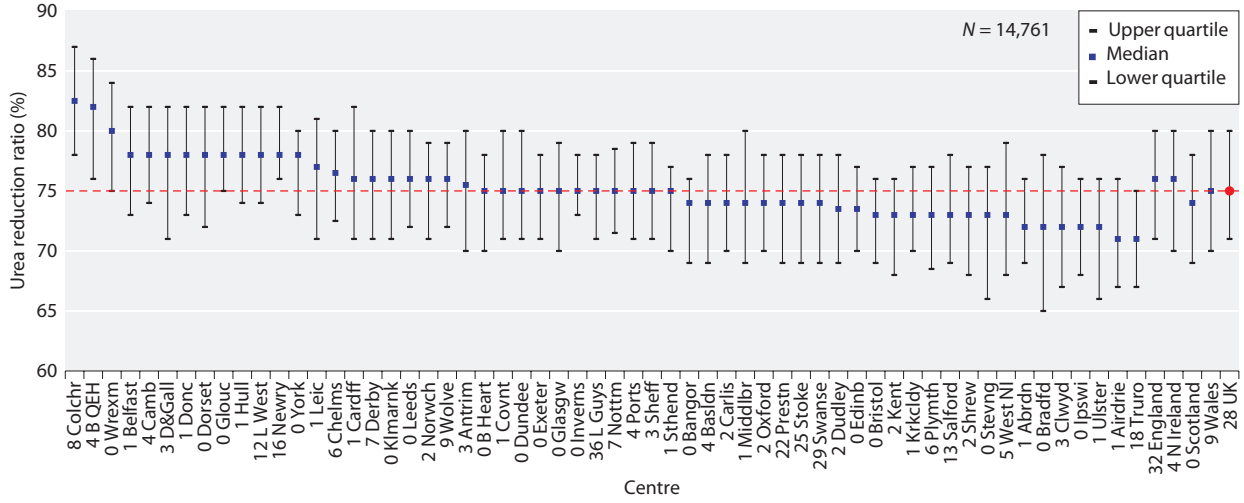

Fig. 7.1a. Median URR achieved in prevalent patients on HD by centre, 30/9/2014

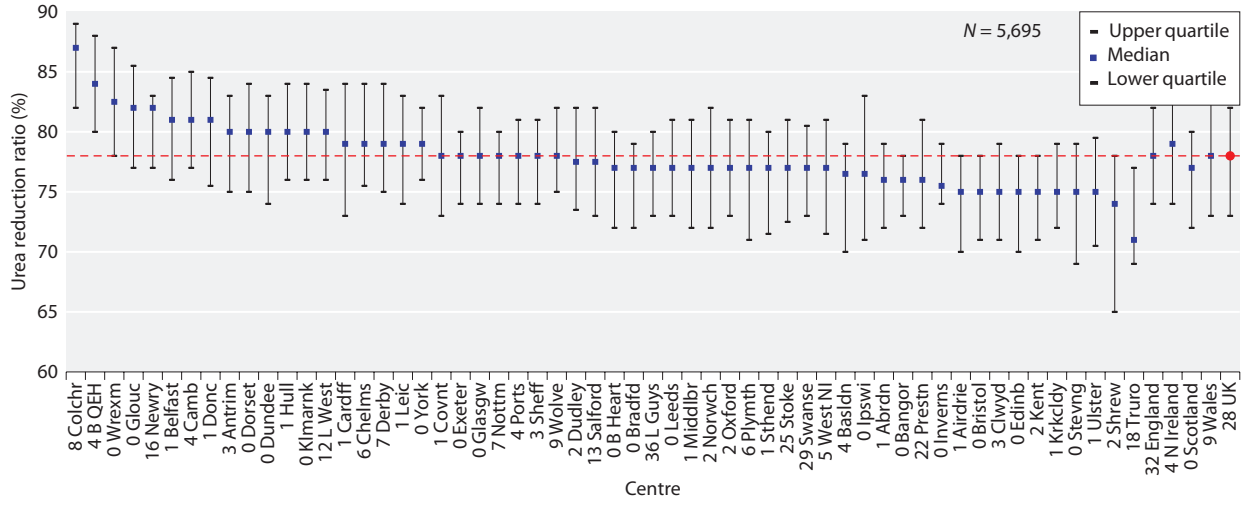

Fig. 7.1b. Median URR achieved in female prevalent patients on HD by centre, 30/9/2014

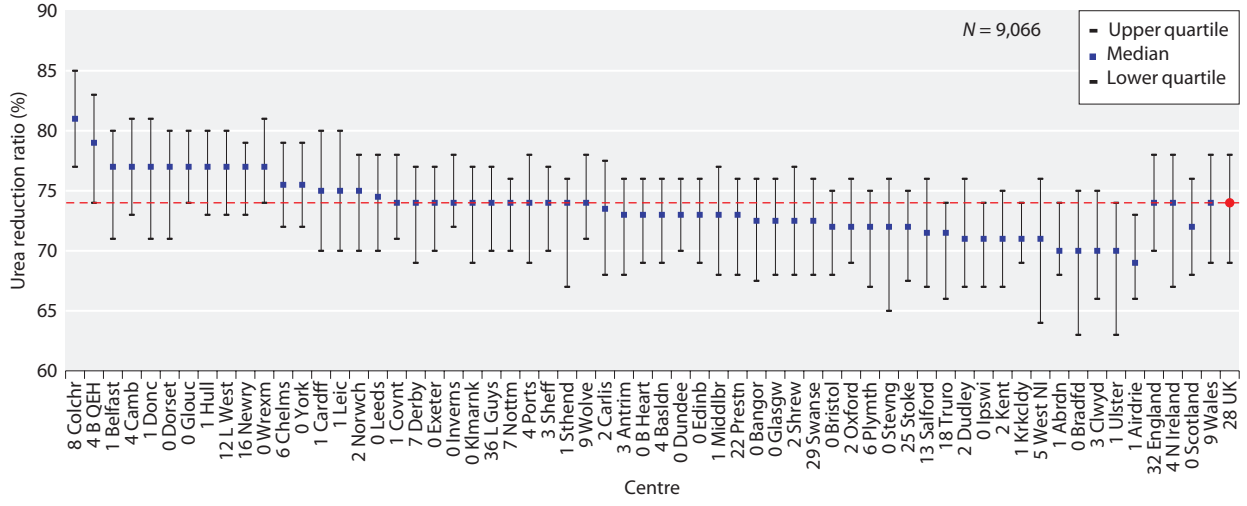

Fig. 7.1c. Median URR achieved in male prevalent patients on HD by centre, 30/9/2014

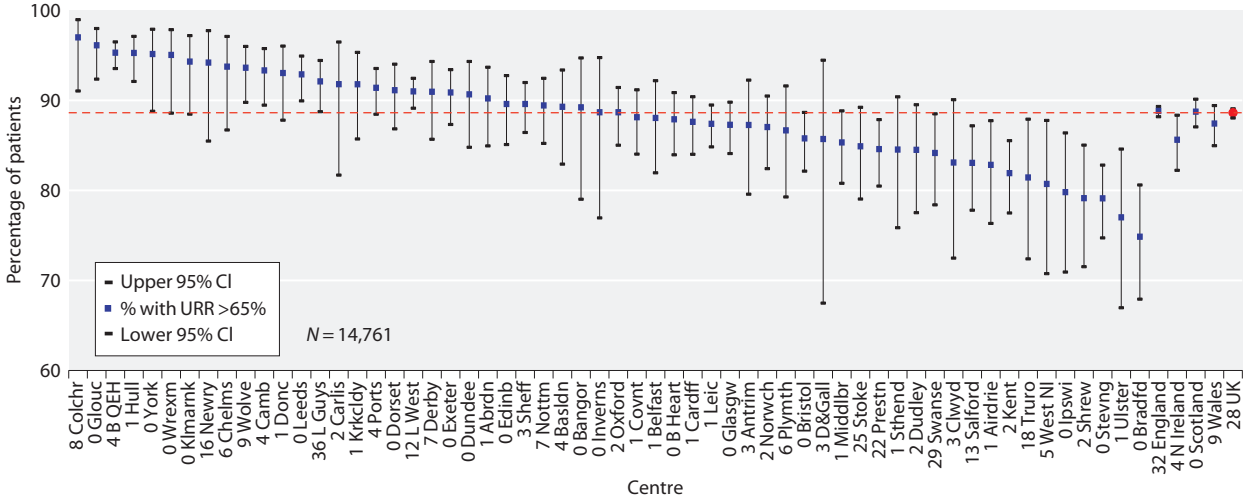

Fig. 7.2. Percentage of prevalent patients on HD with URR >65% by centre, 30/9/2014

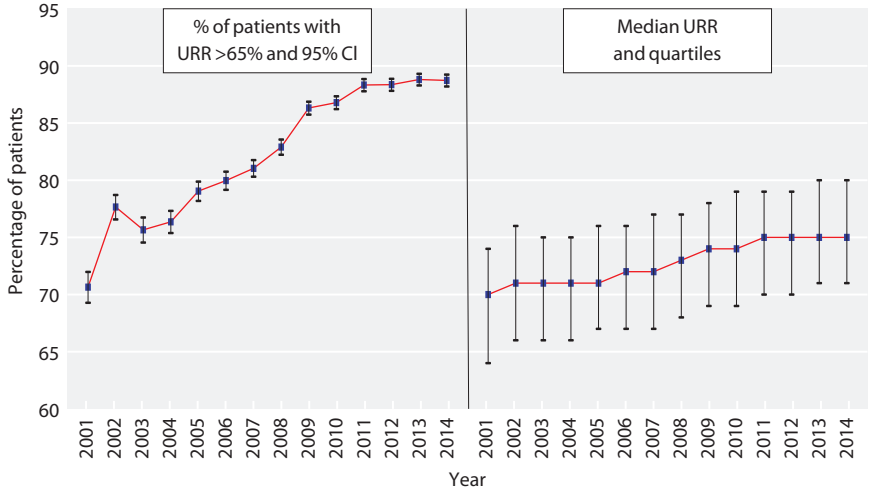

Fig. 7.3. Change in the percentage of prevalent patients on HD with URR >65% and the median URR between 2001 and 2014

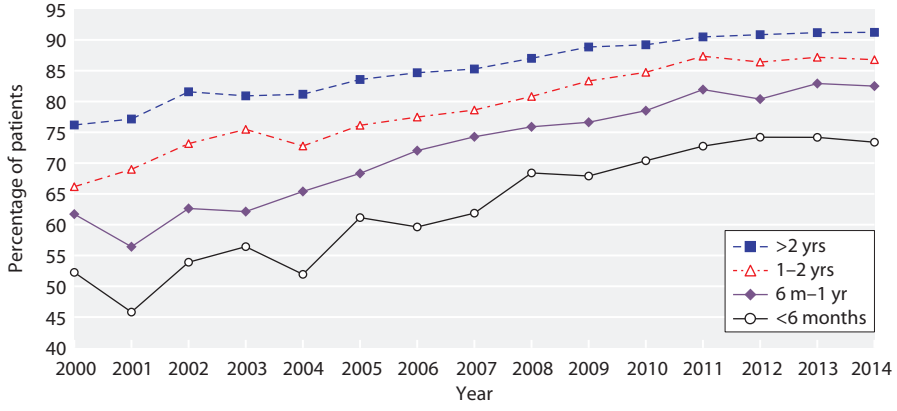

Fig. 7.4. Percentage of prevalent patients on HD achieving URR >65% by time on RRT between 2000 and 2014

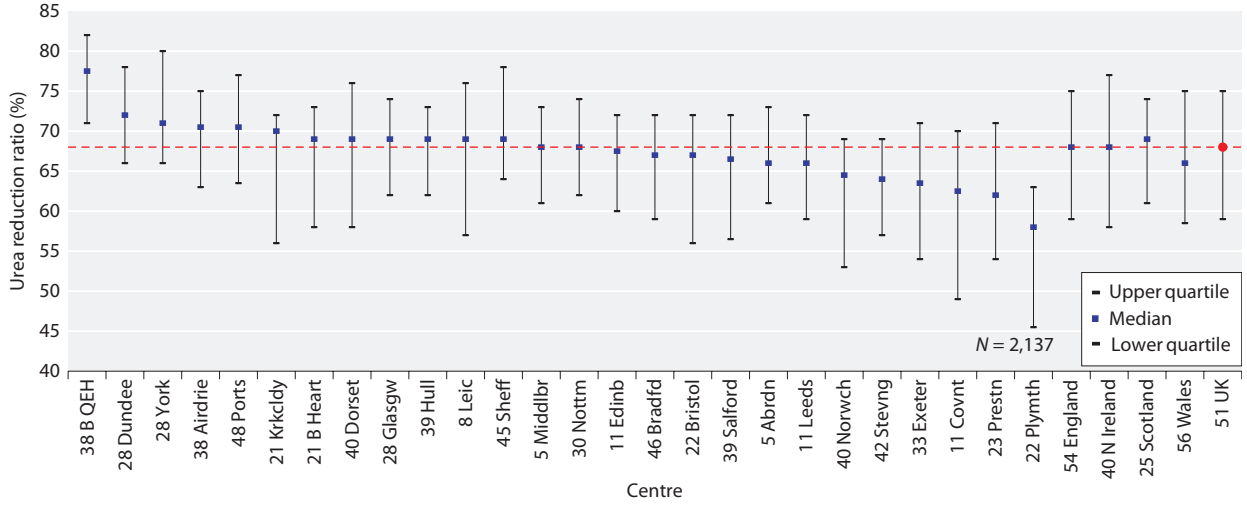

Fig. 7.5a. Median URR in the first quarter of starting RRT in incident patients who started HD in 2013

The median URR during the first quarter after initiating HD treatment of the incident HD population in the UK in 2013 was 68% (centre range 58.0–77.5%) (figure 7.5a). At the end of twelve months, the median URR for this incident cohort was higher (median URR 74%, centre range 70–81%) (figure 7.5b).

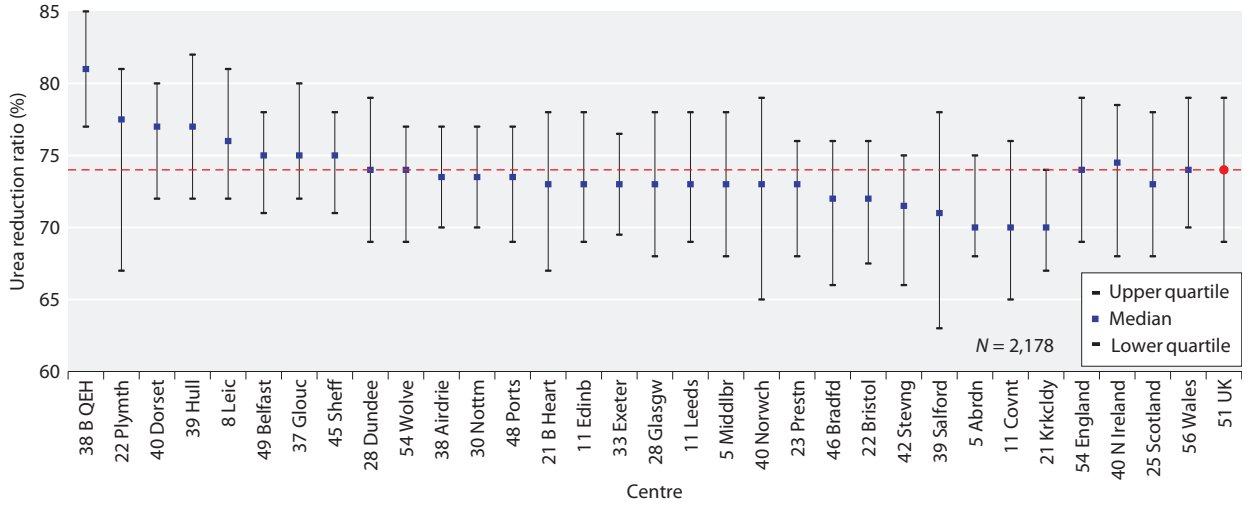

Fig. 7.5b. Median URR one year after starting RRT for incident patients who started HD in 2013

Conclusions

Although the dose of delivered HD is recognised as having an important influence on outcome in HD patients treated with low flux HD, it remains unclear as to whether higher urea clearance targets add benefit [2, 10]. More recently, higher convective volume clearance achieved with haemodiafiltration has been reported to be associated with improved patient survival [11]. The UKRR does not currently systematically collect data on haemodialysis modality or dialyser flux.

Since 2000, the proportion of UK patients achieving the RA guideline for URR has steadily increased, with more than 88% of the prevalent 2014 HD population achieving the target, with a median URR of 75%. This increase in delivered URR not only reflects improvements in clinical practice and delivery of dialysis, but also enhanced coverage and quality of the data collected by the UKRR and renal centres over the years. However, it must be acknowledged that not all centres contributed data. This may be due to the difficulties in providing pre and post treatment results, as with many centres now dialysing in outlying satellites utilising evening and overnight shifts, leading to difficulties in establishing pre and post samples by registering different laboratory dates. In addition pre and post urea data has to be cleaned by excluding samples from HD patients admitted as inpatients. Secondly, with the introduction of dialysis machines with on-line clearance, some centres have opted to record Kt/V data, which is not currently collected by the UKRR.

Although the URR delivered has increased over time there remained a wide range (74.9–97.0%) between dialysis centres in the percentage of prevalent HD patients achieving a URR of >65%. This is likely to reflect genuine differences in the HD dose delivered consequent to both individual patient and centre level factors, although standardised methods for urea sampling are advised [1], inconsistency in sampling methodology for the post-dialysis urea sample may also play a part in the variations reported. Understanding individual renal centre practice would be informative, for example some centres may determine residual renal function and adjust dialysis sessions accordingly. Observational evidence supports that preservation of residual renal function is associated with improved survival [12], and reduced extracellular water expansion [13], although there appears to be no benefit maintaining overhydration in patients to try and preserve residual renal function [14]. Some centres may be adopting an incremental approach to the imitation of HD [15], starting patients on twice weekly dialysis schedules or prescribing shorter dialysis sessions, as the median URR for patients initiating dialysis was lower in the first quarter of starting dialysis, and then increased over the course of the first year of haemodialysis, but remained lower than that of prevalent patients established on dialysis, suggesting that dialysis treatments were being adjusted according to residual renal function. Although this may account for some of the differences in dialysis frequency and session times, other centres are known to favour higher blood flows and shorter, but more efficient dialysis sessions. In the future the UKRR

will collect data from individual patient dialysis sessions, which will allow closer inspection of centre practices.

The median URR was higher for women and more women achieved the URR target in the UK than men. This does not necessarily reflect a greater dose of HD for women, and may simply reflect differences in dietary intake and lower pre-dialysis serum urea values in women [10, 16]. Paradoxically, although URR may be higher for women, clearance of larger solutes may be lower, as typically women have shorter session times than men [10, 16].

The UK government changed reimbursement policy to encourage the provision of more frequent dialysis sessions, by switching to payment for each individual in-centre treatment session [17]. However only four centres reported providing $\geqslant$10% of patients receiving more frequent dialysis than thrice weekly, and five other centres $\geqslant$5%. This may reflect logistical problems in terms of provision, although the option of more frequent dialysis may also not have universal support from patients.

Although urea clearance is the paradigm for dialysis adequacy, debate continues as to whether urea clearance is representative of the clearance of azotaemic toxin [18, 19]. In addition to clearance of azotaemic toxins, the dialysis prescription also encompasses volume control, sodium and divalent cation balance and correction of metabolic acidosis. As such, basing and evaluating HD dose simply on urea clearance has been criticised, with patient outcomes reported to be improved by longer sessional times independent of urea removal [20] and that clearance of 'middle molecules' may also have an important effect [11, 21]. However, no consensus has yet emerged on alternative markers of HD adequacy [18]. The UKRR has historically reported URR, predominantly for logistical reasons with the URR being the simplest measure of dialysis adequacy to calculate, and the measure of dialysis adequacy that is most complete when returned to the UKRR. However, limitations of the URR must be recognised [22]. The revised UKRR data set, due to be embedded in the 2016 dialysis centre returns, should help contribute to further improvements in both UK URR data capture, as well as Kt/V reporting in addition to dialysis centre prescription practices.

Conflicts of interest: the authors declare no conflicts of interest

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