Multiple frequency bioimpedance devices (BCM - Body Composition Monitor, BioScan 920-II, BioScan touch i8, InBody S10, and MultiScan 5000) for fluid management in people with chronic kidney disease having dialysis

Erratum to the EAG Diagnostic Assessment Report

Produced by Aberdeen Health Technology Assessment Group

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Contains no CIC/AIC

This erratum was produced following stakeholder comments on the EAG diagnostic assessment report (DAR). It is intended to replace pages 4 and 58, and the results presented in pages 92-96, 99, 100, and 102-116 of the DAR. The main reason for its production relates to a minor structural error identified in the modelled state transitions, which resulted in a small proportion of the peritoneal dialysis cohort (i.e. those listed for transplant and experiencing an incident CV event prior to a transplant) transitioning to the wrong post-transplant state. However, the appropriate corrections only change the base case ICERs by £2 (scenario 3, Table 20-21) to £8 (Scenario 1, Table 20-21). The subgroup analysis most affected by this change relates to the subgroup of PD patients (Table 24 of the EAG report). Here, the ICER changes by only £24 when the transition state is revised, from £14,085 to £14,061. Impacts on further scenario analyses are also minimal. The revisions also have no meaningful impact on the probabilistic results.

When checking through the economic results Tables, we also picked up on minor errors in the implementation of two of the subgroup analyses in Table 24 of our report – these are updated here but also have minimal impact on the ICERs: for those on dialysis with no comorbidity the ICER changes from £14,906 to £14,727; for those chronically overhydrated, the ICER changes from £59,701 to £59,382 (including dialysis costs) and from £14,409 to £14,576 (excluding dialysis costs).

(WMD=--0.39, 95%CI -0.62 to -0.15, p=0.001 and WMD=-1.54, 95%CI -3.01 to -0.07, p=0.04, respectively).

Evidence from non-randomised studies suggested no statistically differences of blood pressure between the following subgroups: patients in whom overhydration was reduced within 6 months compared with those whose overhydration was not reduced within 6 months; patients having short versus long dialysis; and patients who were normohydrated compared with those overhydrated.

Cost-effectiveness

Six main clinical effectiveness scenarios were explored in the cost-effectiveness modelling, with hazard ratios of varying magnitude applied to all-cause mortality and CV or all-cause hospitalisation rates. One of the scenarios also explored the impact of modelling a reduction in the use (cost) of blood pressure medication with bioimpedance guided fluid management. There was insufficient evidence to justify the inclusion of effects on dialysis requirements (number and duration of sessions), residual renal function, and the health related quality of life of dialysis patients (independent of effects on hospitalisation).

When dialysis costs were included in the model, the incremental cost-effectiveness ratios for bioimpedance guided fluid management ranged from £58,721 to £66,013 per QALY gained. These ICERs related to incremental costs that varied between £4,519 and £35,680, and corresponding incremental QALY gains that varied from 0.07 to 0.58. The costs of dialysis in added years made up the vast majority of the incremental costs. When dialysis costs were excluded from the model, the base case ICERs ranged from £15,212 to £21,206.

Sensitivity analyses

The cost-effectiveness results were found to be most sensitive to the effect of bioimpedance guided fluid management on all-cause mortality. When dialysis costs were included in the model, the ICER was most favourable (~£21,300) when the hazard ratio for all-cause mortality was set equal to one; i.e. no effect mortality leading to no extra dialysis costs, but retained benefits on non-fatal hospitalisation events. With dialysis costs and an effect on mortality included in the model, there

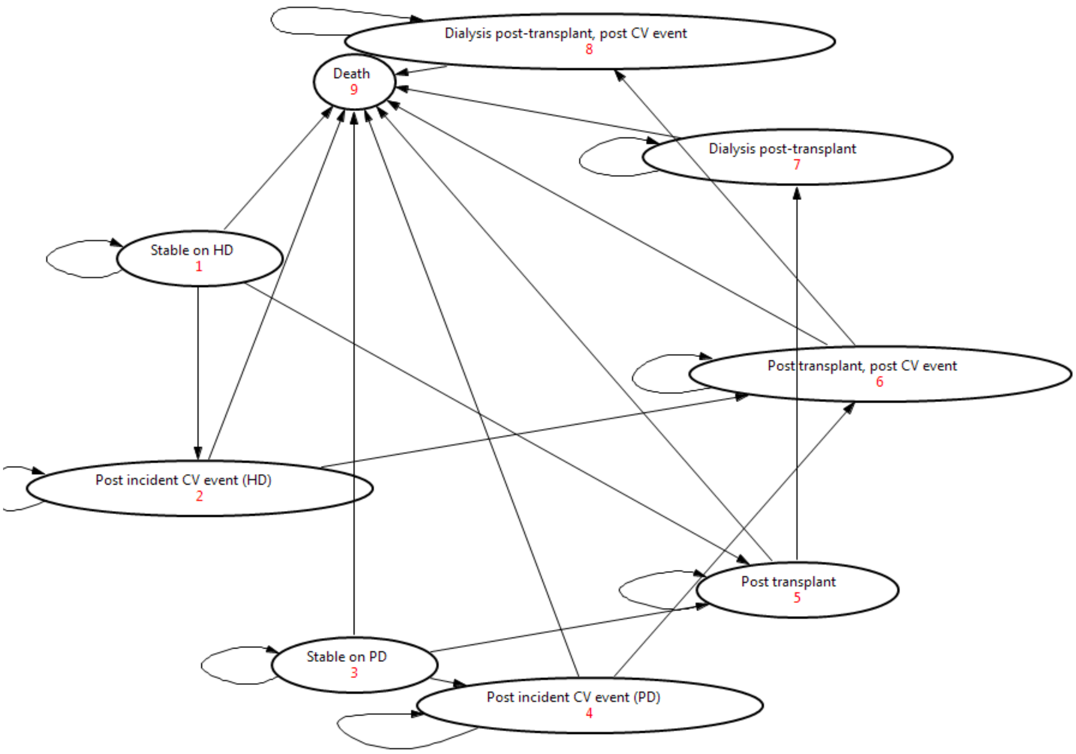

Figure 13 Schematic of the baseline model structure

Modelled baseline risks

The baseline risks of mortality were derived from a number of sources. The UK Renal Registry report was first consulted as a source of population based data. However, this report only provides detailed data on survival (by age) for incident renal replacement therapy (RRT) patients, without censoring for transplantation. This is not suited to the decision model structure (Figure 13), where mortality rates conditioned on remaining on dialysis and conditioned on transitioning to transplant are required. Therefore, the European Renal Association (European Dialysis and Transplant Association - EDTA) annual report was consulted.[94] This report includes adjusted 5-year survival curves with censoring for transplantation in the dialysis survival estimates. The data are reported from day 91, with adjustment based on cox regression for age, gender and primary diagnosis. The survival estimates on different modalities are expressed for a 60 year old cohort, 60% male, with the following distribution for cause of renal disease: diabetes (20%), hypertension (17%), glomerulonephritis (15%), and other cause (48%). This distribution of characteristics is reasonably similar to that of the UK dialysis population, although age is slightly higher in the incident UK cohort at 63 years, and diabetes and hypertension are reported as the primary renal diagnosis in

Table 19 Summary of effect estimates applied for bioimpedance guided fluid management in the main scenarios

Scenario	Relative effect on all-cause mortality; HR	Relative effect on non-fatal CV hospitalisation; HR	Effect on blood pressure medication costs (mean reduction); £	Proportional reduction in severe overhydration (ROH > 15%)
Scenario 1	0.689 (0.228-2.084)	1	0	NA
Scenario 2	0.689 (0.228-2.084)	0.912 (0.821-1.014)	0	NA
Scenario 3	0.912 (0.821-1.014)	0.912 (0.821-1.014)	0	NA
Scenario 4	0.912 (0.821-1.014)	0.912 (0.821-1.014)	-12.98	NA
Scenario 5*	NA	NA	NA	0.28
Scenario 6*	NA	NA	NA	0.38

Table 20 presents the model based cost-effectiveness findings for the main clinical effectiveness scenarios 1 to 6 (described above). Across the scenarios, bioimpedance guided fluid management comes out as the more costly strategy, resulting in increased costs to the health service between £4,519 and £35,680. These increased costs are accompanied by QALY gains under the alternative effectiveness scenarios between 0.07 and 0.58. The incremental cost-effectiveness ratios for bioimpedance testing range from £58,721 to £66,013 per QALY gained. It should be noted that the increased costs associated with bioimpedance guided fluid management are primarily driven by the high dialysis costs during life years gained. The cost of bioimpedance testing is modest, adding on average £101 per patient year.

As discussed in the methods section, others have argued for the exclusion of dialysis costs in the assessment of technologies that aim to extend survival of dialysis patients without influencing the need for dialysis, as they can act as an insurmountable hurdle to demonstrating cost-effectiveness. The results for effectiveness scenarios 1 to 6 with dialysis costs excluded are therefore provided for comparison in Table 21. It can be noted that this results in a large reduction in the ICERs for bioimpedance testing; now ranging between £15,212 and £21,206 per QALY gained. Note, however, that these point estimates are based on uncertain effects incorporated as deterministic point estimates.

Table 20 Deterministic cost-effectiveness scenarios for bioimpedance guided fluid management versus standard practice (including dialysis costs)

Strategy	Mean costs	Incremental costs	Mean QALYs	Incremental QALYs	ICER	NMB
1. Applying the point estimate for the pooled effect of BCM on mortality only						
Standard care	£158,124		2.7014			-£104,097
BCM	£193,805	£35,680	3.2719	0.5706	£62,532	-£128,366
2. Applying the point estimate for the pooled effect of BCM on mortality, and a linked effect on non-fatal CV events through the pooled reduction in PWV						
Standard care	£158,124		2.7014			-£104,097
BCM	£193,409	£35,285	3.2812	0.5798	£60,855	-£127,786
3. Applying linked effects on mortality and non-fatal CV events through the pooled reduction in PWV						
Standard care	£158,124		2.7014			-£104,097
BCM	£167,017	£8,892	2.8517	0.1504	£59,144	-£109,983
4. Applying linked effects on mortality and non-fatal CV events through the pooled reduction in PWV, and a 10% reduction in BP medications use						
Standard care	£158,124		2.7014			-£104,097
BCM	£166,953	£8,829	2.8517	0.1504	£58,721	-£109,919
5. Modelling effects of bioimpedance testing through associations between severe OH and mortality and all cause-hospitalisation (assumes a 28% reduction in severe OH)						
Standard care	£162,059		2.77			-£106,708

BCM	£166,578	£4,519	2.84	0.07	£66,013	-£109,858
6. Modelling effects of bioimpedance guided fluid management through associations between severe OH and mortality and all cause-hospitalisation (assumes a 38% reduction in severe OH)						
Standard care	£162,059		2.77			-£106,708
BCM	£168,019	£5,960	2.86	0.09	£64,157	-£110,810

NMB at willingness to pay of £20,000 per QALY

Table 21 Deterministic cost-effectiveness scenarios for bioimpedance guided fluid management versus standard practice (excluding dialysis costs)

Strategy	Mean costs	Incremental costs	Mean QALYs	Incremental QALYs	ICER	NMB
1. Applying the point estimate for the pooled effect of BCM on mortality only						
Standard care	£46,234		2.7014			£7,793
BCM	£55,579	£9,345	3.2719	0.5706	£16,378	£9,859
2. Applying the point estimate for the pooled effect of BCM on mortality, and a linked effect on non-fatal CV events through the pooled reduction in PWV						
Standard care	£46,234		2.7014			£7,793
BCM	£55,184	£8,950	3.2812	0.5798	£15,435	£10,440
3. Applying linked effects on mortality and non-fatal CV events through the pooled reduction in PWV						
Standard care	£46,234		2.7014			£7,793
BCM	£48,585	£2,351	2.8517	0.1504	£15,636	£8,449

4. Applying linked effects on mortality and non-fatal CV events through the pooled reduction in PWV, and a 10% reduction in BP medications use						
Standard care	£46,234		2.7014			£7,793
BCM	£48,521	£2,287	2.8517	0.1504	£15,212	£8,513
5. Modelling effects of bioimpedance testing through associations between severe OH and mortality and all cause-hospitalisation (assumes a 28% reduction in severe OH)						
Standard care	£47,066		2.77			£8,285
BCM	£48,517	£1,452	2.84	0.07	£21,206	£8,203
6. Modelling effects of bioimpedance guided fluid management through associations between severe OH and mortality and all cause-hospitalisation (assumes a 38% reduction in severe OH)						
Standard care	£47,066		2.77			£8,285
BCM	£48,863	£1,798	2.86	0.09	£19,350	£8,346

NMB at willingness to pay of £20,000 per QALY

Table 22 Breakdown of cumulative costs by categories

	Standard Care	Body Composition Monitor-BCM	Difference BCM versus standard care
Cumulative in-patient hospital costs	£21,795	£22,424	£629
Cumulative dialysis costs	£111,890	118,432	£6,542
Cumulative medication costs	£10,792	£11,423	£631
Cumulative outpatient costs	£6,076	£6,431	£355
Cumulative acute transplant cost	£1,066	£1,101	£35
Cumulative post-transplant follow-up costs	£6,505	£6,709	£204
Bioimpedance testing costs	N/A	£497	£479
Cumulative cost	£158,124	£167,017	£8,892

Deterministic sensitivity analysis

Figures 16 and 17 illustrate the effects of one way sensitivity analysis on key model input parameters, with dialysis costs included (Figure 16) and excluded (Figure 17). These reference ICER for both these tornado diagrams reflects clinical effectiveness scenario 3; i.e. a hazard ratio of 0.912, inferred through the pooled reduction in pulse wave velocity, applied to both all-cause mortality and CV hospitalisation.

When dialysis costs are included, the ICER for bioimpedance guided fluid management in most sensitive to changes in the hazard ratio for the effect on all-cause mortality. The most favourable ICER occurs when the hazard ratio on all-cause mortality is equal to one, as this equalises survival and eliminates the excess dialysis costs incurred in added years.

When dialysis costs are excluded, the ICER remains most sensitive to the hazard ratio on all-cause mortality, but the most favourable ICER occurs for the largest effect (i.e. 0.879). Results are also moderately sensitive to the utility multiplier for haemodialysis, the cost of haemodialysis, and the hazard ratio for CV hospitalisation. However, when dialysis costs are included, the ICER remains well above £30,000 when these parameters are varied within their ranges. Conversely, the ICERs all remain below £30,000 when the parameters are varied individually within their ranges (referent to clinical effectiveness scenario 3) with dialysis costs excluded.

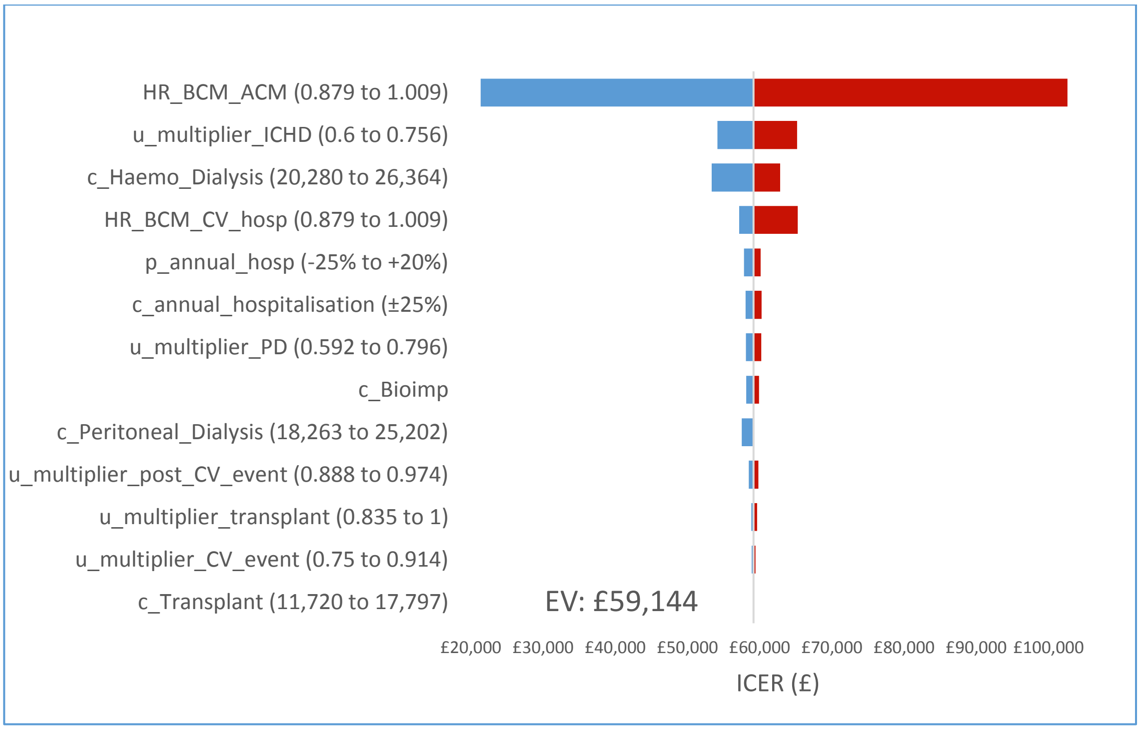

Figure 16 One-way sensitivity analysis: BCM – Body Composition Monitor versus standard care (Clinical effectiveness scenario 3 – including dialysis costs)

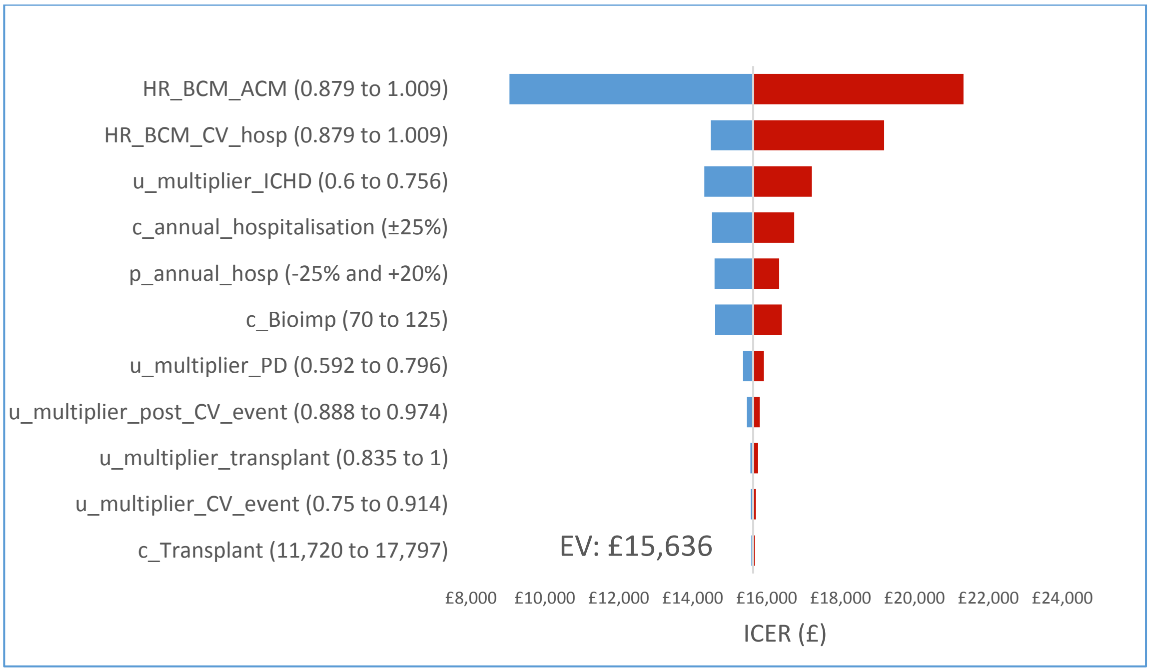

Figure 17 One-way sensitivity analysis: BCM – Body Composition Monitor versus standard care (Clinical effectiveness scenario 3 – excluding dialysis costs)

Table 23 Scenario analyses referent to base clinical effectiveness scenario 3 (all analyses exclude dialysis costs unless stated otherwise)

Strategy	**Mean costs**	**Incremental costs**	**Mean QALYs**	**Incremental QALYs**	**ICER**	**NMB**
Base case scenario 3: applying linked effects on mortality and non-fatal CV events, estimated through the pooled reduction in PWV (HR of 0.912 applied to both all-cause mortality and CV hospitalisation)						
Standard care	£46,234		2.7014			£7,793
Bioimpedance guided	£48,585	£2,351	2.8517	0.1504	£15,636	£8,449
1. Applying an increased cost of monitoring in adults by increasing the number of tests per patient to 12 annually (229.65)						
Standard care	£46,234		2.7014			£7,793
BCM	£49,214	£2,980	2.8517	0.1504	£19,818	£7,820
2. Applying the estimated costs of bioimpedance monitoring in paediatric centres with lower throughput (assuming 4 tests annually)* (£245.32)						
Standard care	£46,234		2.7014			£7,793
BCM	£49,291	£3,056	2.8517	0.1504	£20,329	£7,743
3. Applying the estimated costs of bioimpedance monitoring in paediatric centres with lower throughput (assuming 12 tests annually)* (£347.06)						
Standard care	£46,234		2.7014			£7,793
BCM	£49,790	£3,555	2.8517	0.1504	£23,647	£7,244
4. Applying the cost of BioScan for bioimpedance monitoring (£84.51)						
Standard care	£46,234		2.7014			£7,793
BioScan	£48,502	£2,268	2.8517	0.1504	£15,085	£8,532
5. Applying the cost of Inbody S10 for bioimpedance monitoring (£90.36)						
Standard care	£46,234		2.7014			£7,793

Inbody S10	£48,531	£2,297	2.8517	0.1504	£15,275	£8,503
6. Applying the cost of MultiScan 5000 for bioimpedance monitoring (£91.22)						
Standard care	£46,234		2.7014			£7,793
MultiScan 5000	£48,535	£2,301	2.8517	0.1504	£15,303	£8,499
7. Applying the lowest estimated annual bioimpedance monitoring from Table 15 (£70)						
Standard care	£46,234		2.7014			£7,793
BCM	£48,431	£2,197	2.8517	0.1504	£14,611	£8,603
8. Applying the highest estimated annual bioimpedance monitoring cost from 15 (£125)						
Standard care	£46,234		2.7014			£7,793
BCM	£48,701	£2,467	2.8517	0.1504	£16,405	£8,333
9. Applying an alternative lower cost per CV hospitalization event (£1386 per CV event)						
Standard care	£44,136		2.7014			£9,891
BCM	£46,559	£2,423	2.8517	0.1504	£16,114	£10,475
10. Applying alternative age adjusted utility multipliers for dialysis and post-transplant[123]						
Standard care	£46,234		2.9799			£13,363
BCM	£48,585	£2,351	3.1481	0.1682	£13,978	£14,376
11. Assume bioimpedance guided management results in a 2% improvement in the health state utility over the lifetime of dialysis patients (including dialysis costs)						
Standard care	£158,124		2.7014			-£104,097
BCM	£167,017	£8,892	2.9013	0.1999	£44,477	-£108,991
12. Assume bioimpedance guided management results in a 2% improvement in the health state utility over the lifetime of dialysis patients (excluding dialysis costs)						
Standard care	£46,234		2.7014			£7,793

BCM	£48,585	£2,351	2.9013	0.1999	£11,758	£9,441
13. Assume bioimpedance guided management results in a 5% improvement in the health state utility over the lifetime of dialysis patients (including dialysis costs)						
Standard care	£158,124		2.7014			-£104,097
BCM	£167,017	£8,892	2.9757	0.2743	£32,418	-£107,504
14. Assume bioimpedance guided management results in a 5% improvement in the health state utility over the lifetime of dialysis patients (excluding dialysis costs)						
Standard care	£46,234		2.7014			£7,793
BCM	£48,585	£2,351	2.9757	0.2743	£8,570	£10,928
15. Assume bioimpedance guided management results in a 10% reduction in dialysis costs over the lifetime of patients						
BCM	£155,174		2.8517			-£98,140
Standard care	£158,124	£2,951	2.7014	-0.1504	Dominated	-£104,097
16. Assume bioimpedance guided management results in a 5% reduction in dialysis costs over the lifetime of patients						
Standard care	£158,124		2.7014			-£104,097
BCM	£161,095	£2,971	2.8517	0.1504	£19,759	-£104,061
17. Applying only an effect on non-fatal CV events (HR= 0.912), excluding any effect on mortality (including dialysis costs)						
Standard care	£158,124		2.7014			-£104,097
BCM	£158,277	£153	2.7085	0.0072	£21,327	-£104,107
18. Applying a smaller effect on mortality and non-fatal CV events (HR = 0.95 for both)						
Standard care	£46,234		2.7014			£7,793
BCM	£47,757	£1,523	2.7853	0.084	£18,135	£7,949
19. Applying a larger effect of bioimpedance monitoring on both CV events and mortality (0.803); consistent with the cross sectional main effect of a unit change in PWV reported by Verbeke et al[106].						

Standard care	£46,234		2.7014			£7,793
BCM	£51,161	£4,927	3.0603	0.359	£13,726	£10,045
20. Applying differential effects on mortality (HR = 0.95) and non-fatal CV events (HR = 0.803) – including dialysis costs						
Standard care	£158,124		2.7014			-£104,097
BCM	£162,747	£4,623	2.7984	0.097	£47,644	-£106,780
21. Applying differential effects on mortality (HR = 0.95) and non-fatal CV events (HR = 0.803) – excluding dialysis costs						
Standard care	£46,234		2.7014			£7,793
BCM	£47,203	£969	2.7984	0.097	£9,987	£8,764
22. Excluding all non-CV causes of hospitalisation form the analysis – including dialysis costs						
Standard care	£144,951		2.7138			-£90,676
BCM	£153,079	£8,128	2.8649	0.1511	£53,784	-£95,781
23. Applying no effects of bioimpedance monitoring beyond 3 years; HR for all-cause mortality and CV hospitalisation = 0.912 up to three years						
Standard care	£46,234		2.7014			£7,793
BCM	£47,772	£1,537	2.7853	0.0839	£18,324	£7,933
24. Applying no effects of bioimpedance monitoring beyond 3 years; HR for all-cause mortality and CV hospitalisation = 0.95 up to three years						
Standard care	£46,234		2.7014			£7,793
BCM	£47,308	£1,074	2.7488	0.0474	£22,642	£7,667

*Note, these scenarios are not conducted for child cohorts, they just reflect higher estimated costs of bioimpdence testing based on the level of throughput observed in paediatric dialysis centres; NMB at willingness to pay of £20,000 per QALY

Subgroup analysis

Table 24 presents the results considering key subgroups of the dialysis population.

Separate analyses were considered by comorbidity status (none; at least one), dialysis modality (haemodialysis, peritoneal dialysis), starting age of the cohort (55 years), and transplant listing (yes/no). For comparability, all of these analyses were conducted with clinical effectiveness scenario 3 (HR = 0.912 for the effect of bioimpedance monitoring on mortality and CV hospitalisation). Finally, we also conducted a subgroup analysis using the overhydration states in the model (clinical effectiveness scenarios 6), with the effect of bioimpedance testing modelled through a plausible proportional reduction in severe overhydration (ROH > 15%) – reducing the risk of all-cause mortality and CV hospitalisation. This analysis focusses on the subgroup that are identified as being severely overhydrated at baseline, and assumes a 38% reduction over follow-up (Table 24, scenarios 8 and 9).

These analyses didn't reveal any large differences in cost-effectiveness by subgroups. The ICER is a bit higher in the subgroup waitlisted for transplant, as they spend less time on dialysis and so benefit less from the modelled reduction in all-cause mortality and CV hospitalisation conferred by bioimpedance guided fluid management. In the scenario focussing on the severely overhydrated subgroup, the ICER is ~£5000 lower than in the corresponding base case for that clinical effectiveness scenario, but when dialysis costs are included the ICER remains well above accepted thresholds (£59,382) – as it does for all the subgroups (results not shown).

Table 24 Subgroup analysis (using clinical effectiveness scenario 3 unless otherwise stated)

Strategy	Mean costs	Incremental costs	Mean QALYs	Incremental QALYs	ICER	NMB
1. People on dialysis who have comorbidities and higher hospitalisation rate*						
Standard care	£47,021		2.6974			£6,927
BCM	£49,399	£2,378	2.8476	0.1502	£15,827	£7,554
2. People on dialysis with no comorbidities and lower hospitalisation rate*						
Standard care	£42,638		2.7166			£11,693
BCM	£44,858	£2,220	2.8673	0.1507	£14,727	£12,488
3. People on haemodialysis (start age: 67; years on dialysis: 3)						
Standard care	£45,833		2.5803			£5,773
BCM	£48,204	£2,371	2.7272	0.1469	£16,137	£6,341
4. People on peritoneal dialysis (start age: 64; years on dialysis: 2)						
Standard care	£53,237		3.3991			£14,745
BCM	£55,413	£2,176	3.5538	0.1547	£14,061	£15,664
5. Mixed haemodialysis/peritoneal dialysis cohort aged 55						
Standard care	£80,080		4.7224			£14,368
BCM	£82,707	£2,627	4.8879	0.1655	£15,876	£15,050
6. Patients listed for a transplant*						
Standard care	£87,370		4.1844			-£3,682
BCM	£90,120	£2,750	4.3199	0.1355	£20,297	-£3,722

7. Patients not listed for transplant*						
Standard care	£39,807		2.4696			£9,586
BCM	£42,095	£2,288	2.6223	0.1527	£14,989	£10,351
8. Chronically overhydrated patients only, at increased risk of mortality and all-cause hospitalisation; using modelling structure and assumptions of clinical effectiveness scenario 6 (38% reduction of chronic overhydration with bioimpedance monitoring relative to standard practice) – dialysis costs included						
Standard care	£119,413		2.04			-£78,613
BCM	£168,019	£48,606	2.86	0.82	£59,382	-£110,819
9. Chronically overhydrated patients only, at increased risk of mortality and all-cause hospitalisation; using modelling structure and assumptions of clinical effectiveness scenario 6 (38% reduction of chronic overhydration with bioimpedance monitoring relative to standard practice) – dialysis costs excluded						
Standard care	£36,932		2.04			£3,868
BCM	£48,863	£11,931	2.86	0.82	£14,576	£8,337

*Note, the model is not designed to adjust for different mortality rates in these subgroups. NMB at willingness to pay of £20,000 per QALY

Probabilistic cost-effectiveness results

For comparison with the deterministic results in Table 20 and 21, Tables 25 and 26 present the results for clinical effectiveness scenarios 1, 3 and 4 based on 1000 probabilistic iterations of the model, with dialysis costs included (Table 25) and excluded (Table 26). The point estimates of the ICERs are very similar to the deterministic ICERs. The final column in Tables 25 and 26 indicate the probability of standard practice and bioimpedance testing being the preferred strategy given a willingness to pay of £20,000 per QALY gained. With dialysis costs included, the probability of bioimpedance testing being cost-effective is ~26% under scenario 1 and less than 6% in scenarios 3 and 4.

With the dialysis costs excluded, the probability of bioimpedance testing being cost-effective at a threshold of £20,000 increases substantially; to ~67-75% for across effectiveness scenarios 1, 3, and 4 (Table 26). There remains a high degree of uncertainty inherent in the approach required to link effects of bioimpedance monitoring on arterial stiffness (PWV), to effects on mortality and non-fatal CV events, which is not fully captured in the probabilistic model. Thus the probability of cost-effectiveness in scenarios 3 and 4 may give a somewhat unrealistic impression of precision.

For further comparison, the incremental cost-effectiveness scatter-plots for bioimpedance testing versus standard practice, and the corresponding cost effectiveness acceptability curves, are presented in Figures 18-21 below, for scenarios 1 and 3 (including dialysis costs). The corresponding figures with dialysis costs excluded are presented in Figures 22-25.

Table 25 Probabilistic cost-effectiveness scenarios for bioimpedance guided fluid management versus standard practice (including dialysis costs)

Strategy	Mean costs	Incremental costs	Mean QALYs	Incremental QALYs	ICER	Probability cost-effective at £20,000 threshold
1. Clinical effectiveness scenario 1; applying the point estimate for the pooled effect of BCM on mortality only						
Standard care	£159,712		2.6868			0.737
BCM	£191,748	£32,036	3.1875	0.5007	£63,983	0.263
2. Clinical effectiveness scenario 3; applying linked effects on mortality and non-fatal CV events through the pooled reduction in PWV (HR = 0.9123 on both CV events and mortality)						
Standard care	£157,264		2.6989			0.941
BCM	£166,057	£8,793	2.8495	0.1506	£58,396	0.059
3. Clinical effectiveness scenario 4; applying linked effects on mortality and non-fatal CV events through the pooled reduction in PWV (HR = 0.9123 on both CV events and mortality), and a 10% reduction in BP medications use						
Standard care	£157,332		2.693			0.952
BCM	£165,979	£8,646	2.842	0.149	£58,011	0.048

Table 26 Probabilistic cost-effectiveness scenarios for bioimpedance guided fluid management versus standard practice (excluding dialysis costs)

Strategy	Mean costs	Incremental costs	Mean QALYs	Incremental QALYs	ICER	Probability cost-effective at £20,000 threshold
1. Clinical effectiveness scenario 1; applying the point estimate for the pooled effect of BCM on mortality only						
Standard care	£45,967		2.7003			0.328
BCM	£53,907	£7,940	3.1884	0.4881	£16,269	0.672
2. Clinical effectiveness scenario 3; applying linked effects on mortality and non-fatal CV events through the pooled reduction in PWV (HR = 0.9123 on both CV events and mortality)						
Standard care	£45,962		2.6953			0.306
BCM	£48,255	£2,293	2.8425	0.1472	£15,579	0.694
3. Clinical effectiveness scenario 4; applying linked effects on mortality and non-fatal CV events through the pooled reduction in PWV (HR = 0.9123 on both CV events and mortality), and a 10% reduction in BP medications use						
Standard care	£45,937		2.6905			0.255
BCM	£48,190	£2,253	2.8406	0.15	£15,015	0.745

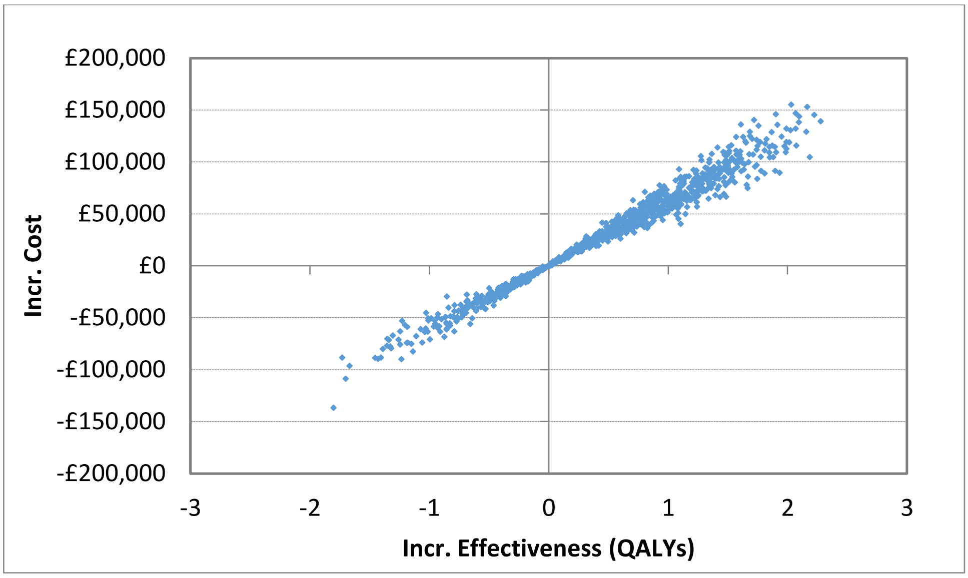

Figure 18 Incremental cost-effectiveness scatter plot: BCM – Body Composition Monitor versus standard care (Clinical effectiveness scenario 1 – including dialysis costs)

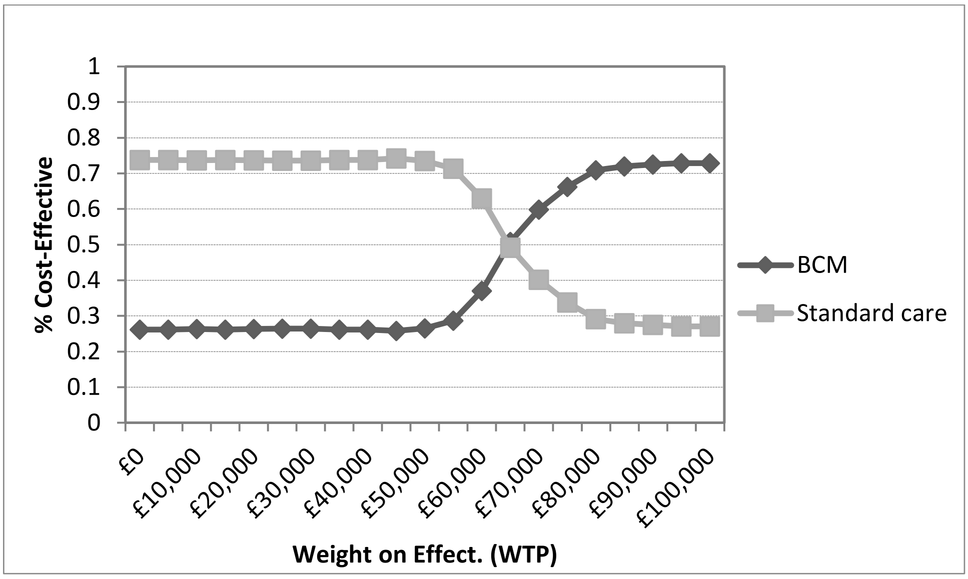

Figure 19 Cost-effectiveness acceptability curves: BCM – Body Composition Monitor versus standard care (Clinical effectiveness scenario 1 – including dialysis costs)

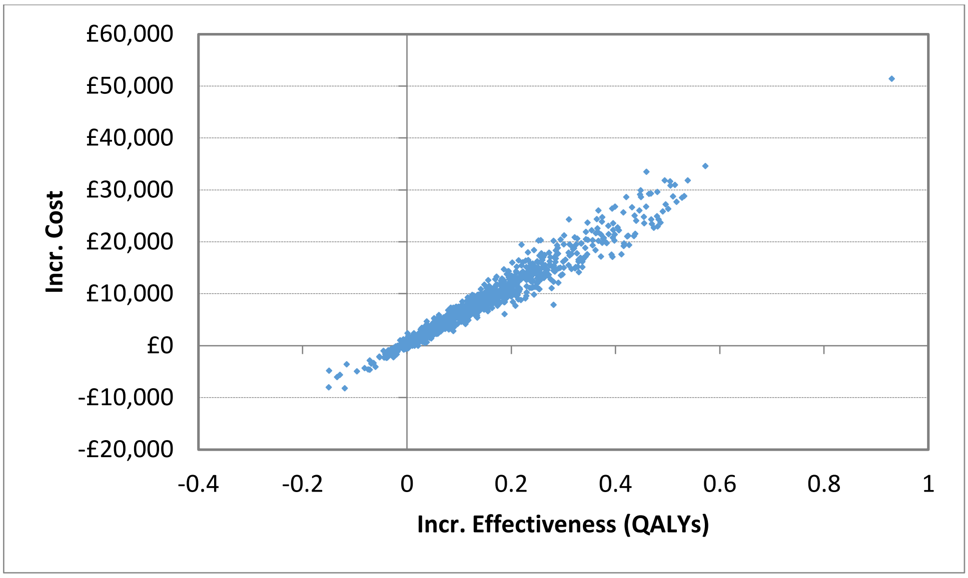

Figure 20 Incremental cost-effectiveness scatter plot: BCM – Body Composition Monitor versus standard care (Clinical effectiveness scenario 3 – including dialysis costs)

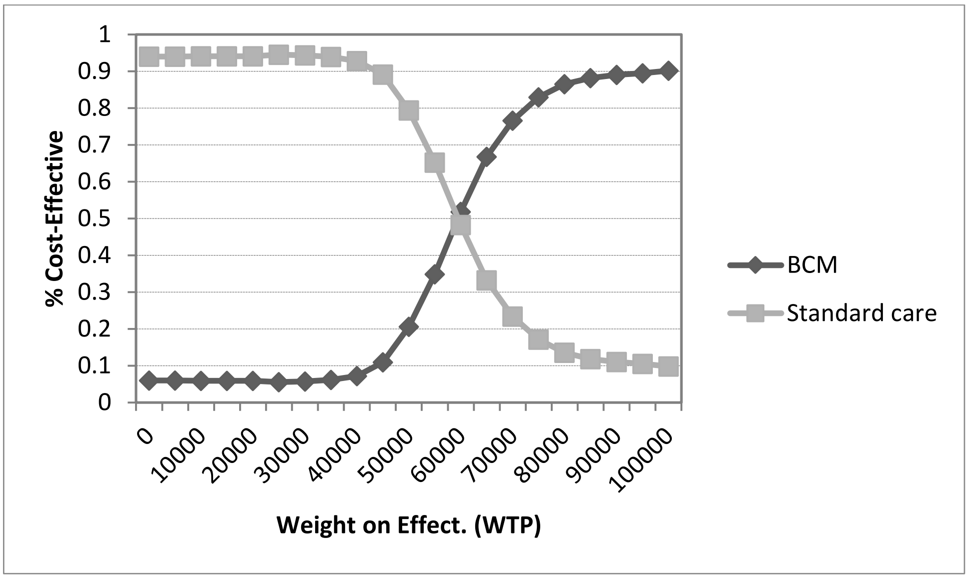

Figure 21 Cost-effectiveness acceptability curves: BCM – Body Composition Monitor versus standard care (Clinical effectiveness scenario 3 – including dialysis costs)

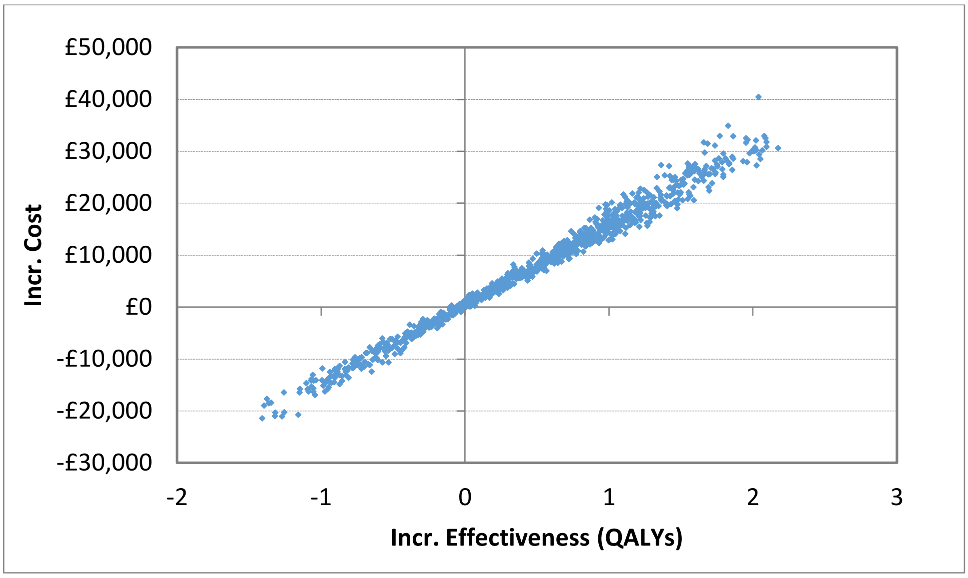

Figure 22 Incremental cost-effectiveness scatter plot: BCM – Body Composition Monitor versus standard care (Clinical effectiveness scenario 1 – excluding dialysis costs)

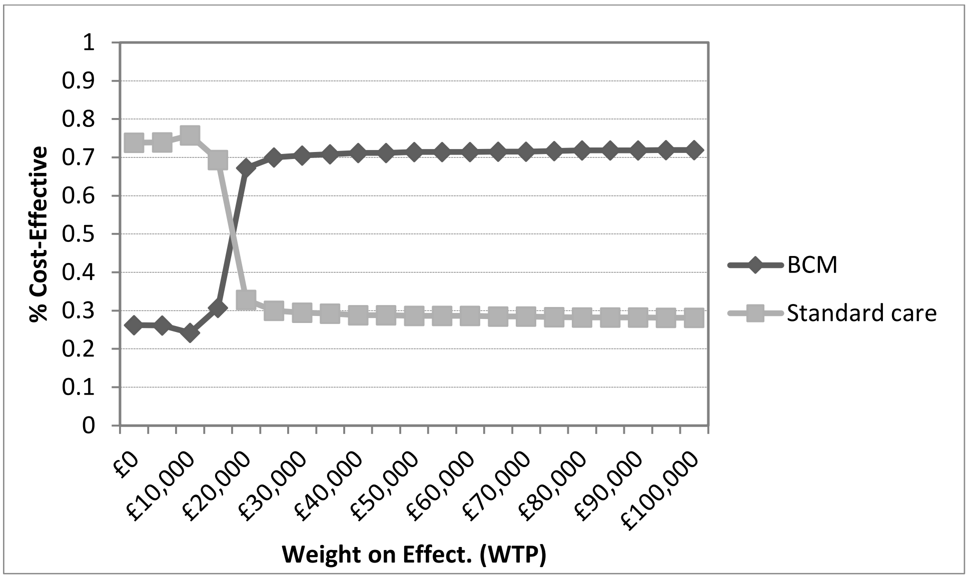

Figure 23 Cost-effectiveness acceptability curves: BCM – Body Composition Monitor versus standard care (Clinical effectiveness scenario 1 – excluding dialysis costs)

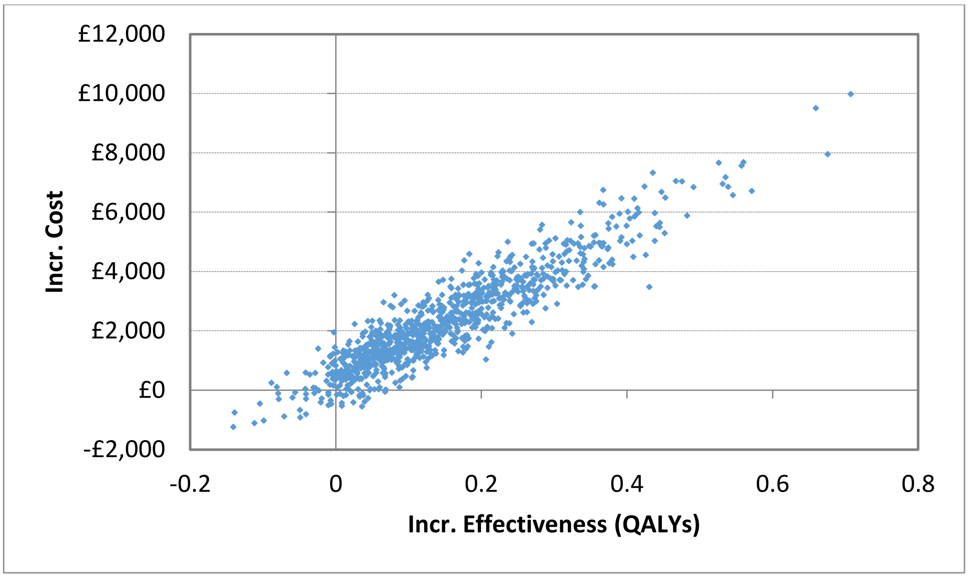

Figure 24 Incremental cost-effectiveness scatter plot: BCM – Body Composition Monitor versus standard care (Clinical effectiveness scenario 3 – excluding dialysis costs)

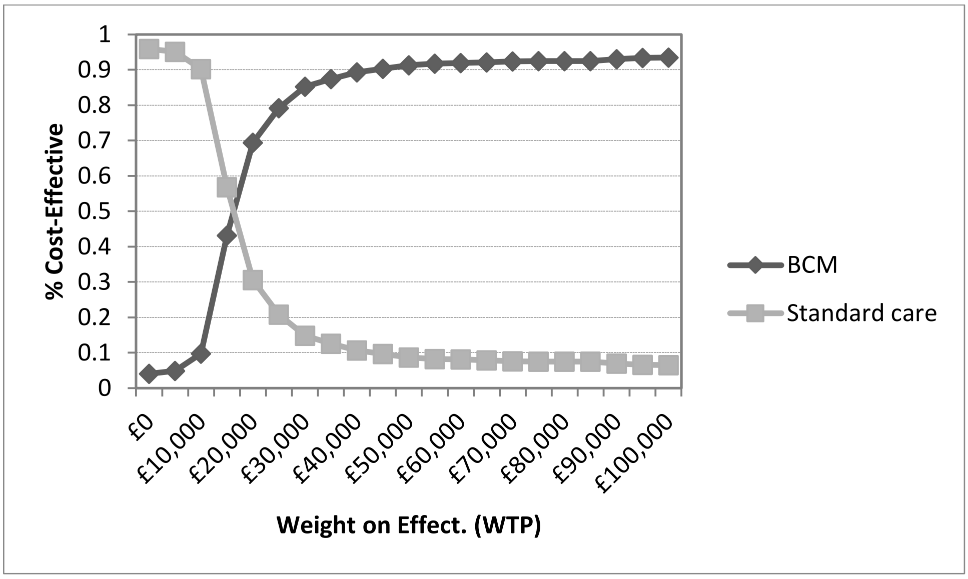

Figure 25 Cost-effectiveness acceptability curves: BCM – Body Composition Monitor versus standard care (Clinical effectiveness scenario 3 – excluding dialysis costs)

4.3 Interpretation of the cost-effectiveness results

The cost-effectiveness results above are based on limited evidence for the effects of bioimpedance guided fluid management on mainly surrogate endpoints (PWV, hydrations status). There is very limited high quality evidence available by which to link intervention induced changes in these surrogate endpoints to changes in health outcomes. Therefore, the indirect/linked modelling scenarios rely on observational associations to estimate possible effects of bioimpedance guided fluid management on final health outcomes. As a consequence, the results of the cost-effectiveness modelling are somewhat speculative and subject to considerable uncertainty, which is not fully reflected in the probabilistic sensitivity analysis.

Nevertheless, the results reveal some useful insights. Given the high costs of dialysis, it is unlikely that bioimpedance guided management will be cost-effective against accepted thresholds (£20-£30,000 per QALY gained) if it reduces mortality with these costs included in the model. Table 22 indicates that dialysis costs in additional years make up 74% of the incremental cost of bioimpedance guided management under clinical effectiveness scenario 3 (a modest and equal effect on both mortality and CV hospitalisation). Further scenario analyses suggest that the effect on mortality would have to be accompanied by a 5% reduction in dialysis costs over the lifetime of patients for the ICER to drop below £20,000 under clinical effectiveness scenario 3. Alternatively, with an accompanying 5% improvement in quality of life over the lifetime of patients, the ICER drops close to £30,000. With greater effects on mortality (and dialysis costs included), the magnitude of these accompanying effects would also have to increase to offset the greater increases in dialysis costs in extra years. Bioimpedance guided fluid management also becomes potentially cost-effective with dialysis costs included when no effect on mortality is assumed but an effect on the CV hospitalisation rate is retained. This all but eliminates the incremental cost associated with the bioimpedance guided strategy (reducing it to £153), but also greatly reduces the QALY gain which comes primarily from increased survival in the base case clinical effectiveness scenarios. The plausibility of these additional scenarios is uncertain given the available clinical evidence.

It can also be noted from the modelled scenarios that when dialysis costs are excluded from the model, the effects of bioimpedance guided management do not need to be