TABLE 53. *Items related to clinical symptoms at the introduction of dialysis (only patients begun on dialysis in 2007 who responded to the questionnaire using floppy disks)*

Clinical symptoms and signs or disorder at the introduction of dialysis	Symptom free	Experiencing symptoms	Subtotal	Unspecified	No information available	Total
Retention of body fluid: generalized edema, severe hypoproteinemia, pneumonedema	7 421	7541	14 962	502	15 046	30 510
(%)	(49.6)	(50.4)	(100.0)			
Fluid abnormality: uncontrollable electrolyte and acid–base imbalance	7 572	7210	14 782	611	15 117	30 510
(%)	(51.2)	(48.8)	(100.0)			
Digestive system: nausea, vomiting, loss of appetite, diarrhea	7 169	7549	14 718	658	15 134	30 510
(%)	(48.7)	(51.3)	(100.0)			
Cardiovascular system: serious hypertension, cardiac failure, pericarditis	9 101	5611	14 712	539	15 259	30 510
(%)	(61.9)	(38.1)	(100.0)			
Nervous system: central and peripheral nervous disorder, mental disorder	12 696	2035	14 731	647	15 132	30 510
(%)	(86.2)	(13.8)	(100.0)			
Blood abnormalities: severe anemia, bleeding tendency	8 594	6245	14 839	498	15 173	30 510
(%)	(57.9)	(42.1)	(100.0)			
Impaired eyesight: uremic retinopathy, diabetic retinopathy	11 243	3343	14 586	825	15 099	30 510
(%)	(77.1)	(22.9)	(100.0)			
History of cardiac infarction before the start of dialysis	14 620	1558	16 178	371	13 961	30 510
(%)	(90.4)	(9.6)	(100.0)			
Congestive cardiac failure	11 625	4465	16 090	364	14 056	30 510
(%)	(72.2)	(27.8)	(100.0)			
History of quadruple amputation, complication of arteriosclerosis obliterans, or aortic aneurysm ≥6 cm	15 295	1055	16 350	261	13 899	30 510
(%)	(93.5)	(6.5)	(100.0)			
History of brain infarction or transient ischaemic attack	13 711	2458	16 169	398	13 943	30 510
(%)	(84.8)	(15.2)	(100.0)			
Dementia	14 871	1412	16 283	225	14 002	30 510
(%)	(91.3)	(8.7)	(100.0)			
Chronic lung disease	15 557	592	16 149	253	14 108	30 510
(%)	(96.3)	(3.7)	(100.0)			
Collagen diseases	15 786	410	16 196	227	14 087	30 510
(%)	(97.5)	(2.5)	(100.0)			
Peptic ulcer	14 539	876	15 415	739	14 356	30 510
(%)	(94.3)	(5.7)	(100.0)			
Chronic hepatic disease (without portal hypertension) or chronic hepatitis	15 145	970	16 115	233	14 162	30 510
(%)	(94.0)	(6.0)	(100.0)			
Diabetes mellitus (without end-stage organ damage, patients treated by dietary therapy alone are not included)	11 605	4302	15 907	257	14 346	30 510
(%)	(73.0)	(27.0)	(100.0)			
Hemiplegia	15 231	952	16 183	182	14 145	30 510
(%)	(94.1)	(5.9)	(100.0)			
Diabetes mellitus: severe retinopathy, nervous disorder, renal disorder, labile diabetes	10 452	5530	15 982	249	14 279	30 510
(%)	(65.4)	(34.6)	(100.0)			
Malignant tumors (those without metastasis and who have survived five years since diagnosis are not included)	15 188	994	16 182	234	14 094	30 510
(%)	(93.9)	(6.1)	(100.0)			
Leukemia (acute and chronic)	16 146	109	16 255	175	14 080	30 510
(%)	(99.3)	(0.7)	(100.0)			
Lymphoma	16 065	113	16 178	233	14 099	30 510
(%)	(99.3)	(0.7)	(100.0)			
Moderate and end-stage hepatic disease	15 782	430	16 212	188	14 110	30 510
(%)	(97.3)	(2.7)	(100.0)			
Metastasizing malignant tumors	15 897	257	16 154	232	14 124	30 510
(%)	(98.4)	(1.6)	(100.0)			
Acquired immunodeficiency syndrome	13 544	75	13 619	2724	14 167	30 510
(%)	(99.4)	(0.6)	(100.0)			

TABLE 54. *Pre-dialysis serum creatinine concentration at the introduction to dialysis and gender (only patients begun on dialysis in 2007 who responded to the questionnaire using floppy disks)*

	Pre-dialysis serum creatinine concentration at the introduction to dialysis (mg/dL)																							
Gender	<2.0	2.0–2.9	3.0–3.9	4.0–4.9	5.0–5.9	6.0–6.9	7.0–7.9	8.0–8.9	9.0–9.9	10.0–10.9	11.0–11.9	12.0–12.9	13.0–13.9	14.0–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18.0–18.9	19.0–19.9	≥20.0	Subtotal	No information available	Total	Mean	SD
Male	49	149	334	633	1017	1290	1643	1850	1366	961	673	446	296	186	144	91	67	61	40	149	11 445	8 303	19 748	8.69	3.61
(%)	(0.4)	(1.3)	(2.9)	(5.5)	(8.9)	(11.3)	(14.4)	(16.2)	(11.9)	(8.4)	(5.9)	(3.9)	(2.6)	(1.6)	(1.3)	(0.8)	(0.6)	(0.5)	(0.3)	(1.3)	(100.0)				
Female	55	182	330	572	735	876	868	942	624	408	239	160	102	63	45	34	22	12	7	44	6 320	4 442	10 762	7.69	3.35
(%)	(0.9)	(2.9)	(5.2)	(9.1)	(11.6)	(13.9)	(13.7)	(14.9)	(9.9)	(6.5)	(3.8)	(2.5)	(1.6)	(1.0)	(0.7)	(0.5)	(0.3)	(0.2)	(0.1)	(0.7)	(100.0)				
Subtotal	104	331	664	1205	1752	2166	2511	2792	1990	1369	912	606	398	249	189	125	89	73	47	193	17 765	12 745	30 510	8.34	3.55
(%)	(0.6)	(1.9)	(3.7)	(6.8)	(9.9)	(12.2)	(14.1)	(15.7)	(11.2)	(7.7)	(5.1)	(3.4)	(2.2)	(1.4)	(1.1)	(0.7)	(0.5)	(0.4)	(0.3)	(1.1)	(100.0)				
No information available	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Total	104	331	664	1205	1752	2166	2511	2792	1990	1369	912	606	398	249	189	125	89	73	47	193	17 765	12 745	30 510	8.34	3.55
(%)	(0.6)	(1.9)	(3.7)	(6.8)	(9.9)	(12.2)	(14.1)	(15.7)	(11.2)	(7.7)	(5.1)	(3.4)	(2.2)	(1.4)	(1.1)	(0.7)	(0.5)	(0.4)	(0.3)	(1.1)	(100.0)				

Values in parentheses below each figure represent the percentage relative to the total of each row.

TABLE 55. *Pre-dialysis serum creatinine concentration at the introduction to dialysis and age (only patients begun on dialysis in 2007 who responded to the questionnaire using floppy disks)*

	Pre-dialysis serum creatinine concentrations at the introduction to dialysis (mg/dL)																							
Age (years)	<2.0	2.0–2.9	3.0–3.9	4.0–4.9	5.0–5.9	6.0–6.9	7.0–7.9	8.0–8.9	9.0–9.9	10.0–10.9	11.0–11.9	12.0–12.9	13.0–13.9	14.0–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18.0–18.9	19.0–19.9	≥20.0	Subtotal	No information available	Total	Mean	SD
< 15	0	1	1	2	1	1	4	0	1	0	0	0	0	0	0	0	0	0	0	0	11	17	28	5.83	1.93
(%)	(0.0)	(9.1)	(9.1)	(18.2)	(9.1)	(9.1)	(36.4)	(0.0)	(9.1)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(100.0)				
15–29	0	2	2	4	3	4	3	15	8	17	11	11	9	5	8	3	6	8	3	12	134	117	251	12.81	5.55
(%)	(0.0)	(1.5)	(1.5)	(3.0)	(2.2)	(3.0)	(2.2)	(11.2)	(6.0)	(12.7)	(8.2)	(8.2)	(6.7)	(3.7)	(6.0)	(2.2)	(4.5)	(6.0)	(2.2)	(9.0)	(100.0)				
30–4	1	8	12	26	41	59	71	118	114	87	85	57	47	26	29	19	20	18	18	44	900	706	1 606	10.96	4.91
(%)	(0.1)	(0.9)	(1.3)	(2.9)	(4.6)	(6.6)	(7.9)	(13.1)	(12.7)	(9.7)	(9.4)	(6.3)	(5.2)	(2.9)	(3.2)	(2.1)	(2.2)	(2.0)	(2.0)	(4.9)	(100.0)				
45–59	9	39	77	143	214	320	414	591	468	372	246	186	124	78	65	52	28	19	13	78	3 536	2 421	5 957	9.44	3.88
(%)	(0.3)	(1.1)	(2.2)	(4.0)	(6.1)	(9.0)	(11.7)	(16.7)	(13.2)	(10.5)	(7.0)	(5.3)	(3.5)	(2.2)	(1.8)	(1.5)	(0.8)	(0.5)	(0.4)	(2.2)	(100.0)				
60–74	43	102	246	426	687	898	1081	1203	902	586	387	238	164	106	65	37	28	22	11	42	7 274	5 193	12 467	8.29	3.13
(%)	(0.6)	(1.4)	(3.4)	(5.9)	(9.4)	(12.3)	(14.9)	(16.5)	(12.4)	(8.1)	(5.3)	(3.3)	(2.3)	(1.5)	(0.9)	(0.5)	(0.4)	(0.3)	(0.2)	(0.6)	(100.0)				
75–89	46	163	306	573	767	848	914	837	480	297	179	110	53	34	22	14	7	6	2	17	5 675	4 087	9 762	7.27	3.01
(%)	(0.8)	(2.9)	(5.4)	(10.1)	(13.5)	(14.9)	(16.1)	(14.7)	(8.5)	(5.2)	(3.2)	(1.9)	(0.9)	(0.6)	(0.4)	(0.2)	(0.1)	(0.1)	(0.0)	(0.3)	(100.0)				
≥ 90	5	15	20	30	39	36	24	28	17	10	4	4	1	0	0	0	0	0	0	0	233	188	421	6.33	2.48
(%)	(2.1)	(6.4)	(8.6)	(12.9)	(16.7)	(15.5)	(10.3)	(12.0)	(7.3)	(4.3)	(1.7)	(1.7)	(0.4)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(100.0)				
Subtotal	104	330	664	1204	1752	2166	2511	2792	1990	1369	912	606	398	249	189	125	89	73	47	193	17 763	12 729	30 492	8.34	3.55
(%)	(0.6)	(1.9)	(3.7)	(6.8)	(9.9)	(12.2)	(14.1)	(15.7)	(11.2)	(7.7)	(5.1)	(3.4)	(2.2)	(1.4)	(1.1)	(0.7)	(0.5)	(0.4)	(0.3)	(1.1)	(100.0)				
No information available	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	16	18	3.35	1.77
Total	104	331	664	1205	1752	2166	2511	2792	1990	1369	912	606	398	249	189	125	89	73	47	193	17 765	12 745	30 510	8.34	3.55
(%)	(0.6)	(1.9)	(3.7)	(6.8)	(9.9)	(12.2)	(14.1)	(15.7)	(11.2)	(7.7)	(5.1)	(3.4)	(2.2)	(1.4)	(1.1)	(0.7)	(0.5)	(0.4)	(0.3)	(1.1)	(100.0)				
Mean	73.23	72.85	72.28	72.31	71.58	70.34	69.29	67.18	65.60	63.99	62.75	61.85	60.22	60.19	56.31	56.90	53.80	52.55	49.02	52.56	67.37	67.29	67.33		
SD	10.62	13.44	11.65	12.00	11.54	11.64	11.62	12.27	12.47	12.88	13.30	13.27	13.61	13.34	14.55	13.78	15.06	17.20	13.93	15.40	13.08	13.41	13.22		

Values in parentheses below each figure represent the percentage relative to the total of each row.

TABLE 56. *Pre-dialysis serum creatinine concentration at the introduction to dialysis and primary diseases (only patients begun on dialysis in 2007 who responded to the questionnaire using floppy disks)*

	Pre-dialysis serum creatinine concentrations at the introduction to dialysis (mg/dL)																							
Primary disease	<2.0	2.0–2.9	3.0–3.9	4.0–4.9	5.0–5.9	6.0–6.9	7.0–7.9	8.0–8.9	9.0–9.9	10.0–10.9	11.0–11.9	12.0–12.9	13.0–13.9	14.0–14.9	15.0–15.9	16.0–16.9	17.0–17.9	18.0–18.9	19.0–19.9	≥20.0	Subtotal	No information available	Total	Mean	SD
Chronic glomerulonephritis	19	58	99	203	339	426	535	661	482	352	242	169	113	80	72	38	30	30	19	75	4042	2 958	7 000	9.03	4.04
(%)	(0.5)	(1.4)	(2.4)	(5.0)	(8.4)	(10.5)	(13.2)	(16.4)	(11.9)	(8.7)	(6.0)	(4.2)	(2.8)	(2.0)	(1.8)	(0.9)	(0.7)	(0.7)	(0.5)	(1.9)	(100.0)				
Chronic pyelonephritis		1	4	4	15	12	16	19	15	18	8	5	6	2	2	4	0	1	0	1	133	81	214	9.12	3.80
(%)		(0.8)	(3.0)	(3.0)	(11.3)	(9.0)	(12.0)	(14.3)	(11.3)	(13.5)	(6.0)	(3.8)	(4.5)	(1.5)	(1.5)	(3.0)	(0.0)	(0.8)	(0.0)	(0.8)	(100.0)				
Rapidly progressive glomerulonephritis	1	7	9	23	30	39	34	34	33	22	18	15	12	6	3	3	1	1	1	3	295	216	511	8.50	3.52
(%)	(0.3)	(2.4)	(3.1)	(7.8)	(10.2)	(13.2)	(11.5)	(11.5)	(11.2)	(7.5)	(6.1)	(5.1)	(4.1)	(2.0)	(1.0)	(1.0)	(0.3)	(0.3)	(0.3)	(1.0)	(100.0)				
Nephropathy of pregnancy / pregnancy toxemia	0	0	0	3	2	3	6	4	3	3	1	1	0	1	0	0	0	0	0	1	28	11	39	9.04	5.36
(%)	(0.0)	(0.0)	(0.0)	(10.7)	(7.1)	(10.7)	(21.4)	(14.3)	(10.7)	(10.7)	(3.6)	(3.6)	(0.0)	(3.6)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(3.6)	(100.0)				
Other nephritides that cannot be classified	0	1	5	1	6	8	8	13	9	9	3	5	5	1	3	0	1	2	0	1	81	50	131	9.31	3.65
(%)	(0.0)	(1.2)	(6.2)	(1.2)	(7.4)	(9.9)	(9.9)	(16.0)	(11.1)	(11.1)	(3.7)	(6.2)	(6.2)	(1.2)	(3.7)	(0.0)	(1.2)	(2.5)	(0.0)	(1.2)	(100.0)				
Polycystic kidney disease	1	0	2	11	24	50	74	88	51	41	32	17	13	9	7	4	4	0	2	9	439	255	694	9.37	3.77
(%)	(0.2)	(0.0)	(0.5)	(2.5)	(5.5)	(11.4)	(16.9)	(20.0)	(11.6)	(9.3)	(7.3)	(3.9)	(3.0)	(2.1)	(1.6)	(0.9)	(0.9)	(0.0)	(0.5)	(2.1)	(100.0)				
Nephrosclerosis	7	30	73	142	212	277	302	344	227	165	105	56	43	27	15	13	12	8	2	12	2072	1 308	3 380	8.16	3.06
(%)	(0.3)	(1.4)	(3.5)	(6.9)	(10.2)	(13.4)	(14.6)	(16.6)	(11.0)	(8.0)	(5.1)	(2.7)	(2.1)	(1.3)	(0.7)	(0.6)	(0.6)	(0.4)	(0.1)	(0.6)	(100.0)				
Malignant hypertension	0	1	1	1	8	14	11	16	11	10	6	4	7	1	1	4	2	1	1	3	103	85	188	9.91	4.17
(%)	(0.0)	(1.0)	(1.0)	(1.0)	(7.8)	(13.6)	(10.7)	(15.5)	(10.7)	(9.7)	(5.8)	(3.9)	(6.8)	(1.0)	(1.0)	(3.9)	(1.9)	(1.0)	(1.0)	(2.9)	(100.0)				
Diabetic nephropathy	49	157	343	595	867	1047	1187	1235	896	551	362	234	139	81	56	36	21	18	11	48	7933	5 438	13 371	7.94	3.20
(%)	(0.6)	(2.0)	(4.3)	(7.5)	(10.9)	(13.2)	(15.0)	(15.6)	(11.3)	(6.9)	(4.6)	(2.9)	(1.8)	(1.0)	(0.7)	(0.5)	(0.3)	(0.2)	(0.1)	(0.6)	(100.0)				
Systemic lupus erythematosus nephritis	1	5	11	24	11	13	21	19	12	8	3	5	1	1	0	0	1	0	1	1	138	87	225	7.24	3.43
(%)	(0.7)	(3.6)	(8.0)	(17.4)	(8.0)	(9.4)	(15.2)	(13.8)	(8.7)	(5.8)	(2.2)	(3.6)	(0.7)	(0.7)	(0.0)	(0.0)	(0.7)	(0.0)	(0.7)	(0.7)	(100.0)				
Amyloidal kidney	1	4	4	10	16	9	12	14	6	4	4		2	1	0	0	0	0	0	0	87	70	157	6.97	2.60
(%)	(1.1)	(4.6)	(4.6)	(11.5)	(18.4)	(10.3)	(13.8)	(16.1)	(6.9)	(4.6)	(4.6)		(2.3)	(1.1)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(100.0)				
Gouty kidney	0	1	4	1	1	7	7	13	11	2	3	2	2	3	3	1	2	0	0	0	63	22	85	9.32	3.49
(%)	(0.0)	(1.6)	(6.3)	(1.6)	(1.6)	(11.1)	(11.1)	(20.6)	(17.5)	(3.2)	(4.8)	(3.2)	(3.2)	(4.8)	(4.8)	(1.6)	(3.2)	(0.0)	(0.0)	(0.0)	(100.0)				
Renal failure due to congenital abnormal metabolism	0	1	1	1	1	3	4	4	3	0	3	1	1	0	1	0	1	0	0	0	25	10	35	8.91	3.66
(%)	(0.0)	(4.0)	(4.0)	(4.0)	(4.0)	(12.0)	(16.0)	(16.0)	(12.0)	(0.0)	(12.0)	(4.0)	(4.0)	(0.0)	(4.0)	(0.0)	(4.0)	(0.0)	(0.0)	(0.0)	(100.0)				
Kidney and urinary tract tuberculosis	0	1	1	1	0	0	5	2	0	2	0	0	0	0	0	0	0	0	0	0	12	4	16	7.14	2.61
(%)	(0.0)	(8.3)	(8.3)	(8.3)	(0.0)	(0.0)	(41.7)	(16.7)	(0.0)	(16.7)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(100.0)				
Kidney and urinary tract stone	0	1	0	2	2	5	5	2	5	4	2	3	1	0	0	0	0	0	3	2	37	17	54	10.27	5.14
(%)	(0.0)	(2.7)	(0.0)	(5.4)	(5.4)	(13.5)	(13.5)	(5.4)	(13.5)	(10.8)	(5.4)	(8.1)	(2.7)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(8.1)	(5.4)	(100.0)				
Kidney and urinary tract tumor	3	2	7	3	8	8	12	6	7	6	4	2	2	1	2	2	0	0	0	1	76	68	144	7.95	3.82
(%)	(3.9)	(2.6)	(9.2)	(3.9)	(10.5)	(10.5)	(15.8)	(7.9)	(9.2)	(7.9)	(5.3)	(2.6)	(2.6)	(1.3)	(2.6)	(2.6)	(0.0)	(0.0)	(0.0)	(1.3)	(100.0)				
Obstructive urinary tract difficulty	0	0	0	2	4	3	9	9	9	6	3	3	1	0	2	0	1	1	1	1	55	42	97	9.93	4.31
(%)	(0.0)	(0.0)	(0.0)	(3.6)	(7.3)	(5.5)	(16.4)	(16.4)	(16.4)	(10.9)	(5.5)	(5.5)	(1.8)	(0.0)	(3.6)	(0.0)	(1.8)	(1.8)	(1.8)	(1.8)	(100.0)				
Myeloma	0	0	4	0	1	9	11	16	8	9	4	5	0	2	1	0	1	1	1	2	75	64	139	9.52	3.56
(%)	(0.0)	(0.0)	(5.3)	(0.0)	(1.3)	(12.0)	(14.7)	(21.3)	(10.7)	(12.0)	(5.3)	(6.7)	(0.0)	(2.7)	(1.3)	(0.0)	(1.3)	(1.3)	(1.3)	(2.7)	(100.0)				
Hypoplastic kidney	1	1	1	2	0	3	2	6	0	3	2	1	1	1	0	0	0	1	0	3	28	19	47	10.07	5.80
(%)	(3.6)	(3.6)	(3.6)	(7.1)	(0.0)	(10.7)	(7.1)	(21.4)	(0.0)	(10.7)	(7.1)	(3.6)	(3.6)	(3.6)	(0.0)	(0.0)	(0.0)	(3.6)	(0.0)	(10.7)	(100.0)				
Unspecified	9	40	64	124	145	184	192	230	148	120	94	65	42	29	20	14	8	7	5	28	1 568	1 457	3 025	8.50	3.83
(%)	(0.6)	(2.6)	(4.1)	(7.9)	(9.2)	(11.7)	(12.2)	(14.7)	(9.4)	(7.7)	(6.0)	(4.1)	(2.7)	(1.8)	(1.3)	(0.9)	(0.5)	(0.4)	(0.3)	(1.8)	(100.0)				
Reintroduction after transplantation	0	0	1	4	5	4	10	11	6	1	0	4	2	0	1	2	0	0	0	0	51	40	91	8.53	3.08
(%)	(0.0)	(0.0)	(2.0)	(7.8)	(9.8)	(7.8)	(19.6)	(21.6)	(11.8)	(2.0)	(0.0)	(7.8)	(3.9)	(0.0)	(2.0)	(3.9)	(0.0)	(0.0)	(0.0)	(0.0)	(100.0)				
Others	12	20	30	47	55	42	45	46	48	31	13	9	5	3	0	4	4	2	0	2	418	348	766	7.26	3.40
(%)	(2.9)	(4.8)	(7.2)	(11.2)	(13.2)	(10.0)	(10.8)	(11.0)	(11.5)	(7.4)	(3.1)	(2.2)	(1.2)	(0.7)	(0.0)	(1.0)	(1.0)	(0.5)	(0.0)	(0.5)	(100.0)				
Subtotal	104	331	664	1204	1752	2166	2508	2792	1990	1367	912	606	398	249	189	125	89	73	47	193	17 759	12 650	30 409	8.34	3.55
(%)	(0.6)	(1.9)	(3.7)	(6.8)	(9.9)	(12.2)	(14.1)	(15.7)	(11.2)	(7.7)	(5.1)	(3.4)	(2.2)	(1.4)	(1.1)	(0.7)	(0.5)	(0.4)	(0.3)	(1.1)	(100.0)				
No information available	0	0	0	1	0	0	3	0	0	2	0	0	0	0	0	0	0	0	0	0	6	95	101	7.97	2.19
Total	104	331	664	1205	1752	2166	2511	2792	1990	1369	912	606	398	249	189	125	89	73	47	193	17 765	12 745	30 510	8.34	3.55
(%)	(0.6)	(1.9)	(3.7)	(6.8)	(9.9)	(12.2)	(14.1)	(15.7)	(11.2)	(7.7)	(5.1)	(3.4)	(2.2)	(1.4)	(1.1)	(0.7)	(0.5)	(0.4)	(0.3)	(1.1)	(100.0)				

Values in parentheses below each figure represent the percentage relative to the total of each row.

TABLE 57. *Estimated glomerular filtration rates (eGFR) at the introduction to dialysis and the treatment methods used at the end of year of introduction (only patients begun on dialysis in 2007 who responded to the questionnaire using floppy disks)*

	eGFR at the introduction to dialysis (mL/min/1.73 m²)																				
Method of dialysis	<1.0	1.0–1.9	2.0–2.9	4.0–5.9	6.0–7.9	8.0–9.9	10.0–11.9	12.0–13.9	14.0–15.9	16.0–17.9	18.0–19.9	20.0–21.9	22.0–23.9	24.0–25.9	26.0–27.9	28.0–29.9	≥30.0	Subtotal	No information available	Total	Mean	SD
Facility hemodialysis	22	326	4513	5390	2126	843	370	203	106	87	47	26	12	15	13	5	29	14 133	13 926	28 059	5.44	3.39
(%)	(0.2)	(2.3)	(31.9)	(38.1)	(15.0)	(6.0)	(2.6)	(1.4)	(0.8)	(0.6)	(0.3)	(0.2)	(0.1)	(0.1)	(0.1)	(0.0)	(0.2)	(100.0)				
Hemodiafiltration	1	9	123	176	61	26	9	7	1	7	2	2	1	1	1	1	0	428	338	766	5.70	3.63
(%)	(0.2)	(2.1)	(28.7)	(41.1)	(14.3)	(6.1)	(2.1)	(1.6)	(0.2)	(1.6)	(0.5)	(0.5)	(0.2)	(0.2)	(0.2)	(0.2)	(0.0)	(100.0)				
Hemofiltration	0	0	1	5	3	1	0	0	0	0	0	0	0	0	0	0	0	10	12	22	5.86	1.82
(%)	(0.0)	(0.0)	(10.0)	(50.0)	(30.0)	(10.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(100.0)				
Hemoadsorption	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	–	–
(%)																						
Home hemodialysis	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	3	3.25	0.25
(%)	(0.0)	(0.0)	(100.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(100.0)				
Peritoneal dialysis	0	12	273	315	96	35	14	6	4	0	1	1	1	0	1	1	3	763	894	1 657	5.19	4.11
(%)	(0.0)	(1.6)	(35.8)	(41.3)	(12.6)	(4.6)	(1.8)	(0.8)	(0.5)	(0.0)	(0.1)	(0.1)	(0.1)	(0.0)	(0.1)	(0.1)	(0.4)	(100.0)				
Total	23	347	4912	5886	2286	905	393	216	111	94	50	29	14	16	15	7	32	15 336	15 174	30 510	5.43	3.43
(%)	(0.1)	(2.3)	(32.0)	(38.4)	(14.9)	(5.9)	(2.6)	(1.4)	(0.7)	(0.6)	(0.3)	(0.2)	(0.1)	(0.1)	(0.1)	(0.0)	(0.2)	(100.0)				

Values in parentheses below each figure represent the percentage relative to the total of each row.

TABLE 58. *Estimated glomerular filtration rates (eGFR) at the introduction to dialysis and gender (only patients begun on dialysis in 2007 who responded to the questionnaire using floppy disks)*

	eGFR at introduction into dialysis (mL/min/1.73 m²)																				
Gender	<1.0	1.0–1.9	2.0–2.9	4.0–5.9	6.0–7.9	8.0–9.9	10.0–11.9	12.0–13.9	14.0–15.9	16.0–17.9	18.0–19.9	20.0–21.9	22.0–23.9	24.0–25.9	26.0–27.9	28.0–29.9	≥30.0	Subtotal	No information available	Total	Mean	SD
Male	10	174	2515	4169	1649	661	280	153	68	65	35	16	8	14	8	3	21	9 849	9 899	19 748	5.68	3.49
(%)	(0.1)	(1.8)	(25.5)	(42.3)	(16.7)	(6.7)	(2.8)	(1.6)	(0.7)	(0.7)	(0.4)	(0.2)	(0.1)	(0.1)	(0.1)	(0.0)	(0.2)	(100.0)				
Female	13	173	2397	1717	637	244	113	63	43	29	15	13	6	2	7	4	11	5 487	5 275	10 762	4.99	3.29
(%)	(0.2)	(3.2)	(43.7)	(31.3)	(11.6)	(4.4)	(2.1)	(1.1)	(0.8)	(0.5)	(0.3)	(0.2)	(0.1)	(0.0)	(0.1)	(0.1)	(0.2)	(100.0)				
Subtotal	23	347	4912	5886	2286	905	393	216	111	94	50	29	14	16	15	7	32	15 336	15 174	30 510	5.43	3.43
(%)	(0.1)	(2.3)	(32.0)	(38.4)	(14.9)	(5.9)	(2.6)	(1.4)	(0.7)	(0.6)	(0.3)	(0.2)	(0.1)	(0.1)	(0.1)	(0.0)	(0.2)	(100.0)				
No information available	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	–	–
Total	23	347	4912	5886	2286	905	393	216	111	94	50	29	14	16	15	7	32	15 336	15 174	30 510	5.43	3.43
(%)	(0.1)	(2.3)	(32.0)	(38.4)	(14.9)	(5.9)	(2.6)	(1.4)	(0.7)	(0.6)	(0.3)	(0.2)	(0.1)	(0.1)	(0.1)	(0.0)	(0.2)	(100.0)				

Values in parentheses below each figure represent the percentage relative to the total of each row.

TABLE 59. *Estimated glomerular filtration rates (eGFR) at the introduction to dialysis and age (only patients begun on dialysis in 2007 who responded to the questionnaire using floppy disks)*

	eGFR at the introduction to dialysis (mL/min/1.73 m²)																					
Age (years)	<1.0	1.0–1.9	2.0–2.9	4.0–5.9	6.0–7.9	8.0–9.9	10.0–11.9	12.0–13.9	14.0–15.9	16.0–17.9	18.0–19.9	20.0–21.9	22.0–23.9	24.0–25.9	26.0–27.9	28.0–29.9	≥30.0	Subtotal	No information available	Total	Mean	SD
<15	0	0	0	2	1	3	1	2	1	0	0	0	0	0	0	0	0	10	18	28	9.68	3.14
(%)	(0.0)	(0.0)	(0.0)	(20.0)	(10.0)	(30.0)	(10.0)	(20.0)	(10.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(100.0)				
15–29	0	14	52	29	10	2	3	1	2	0	0	0	0	0	0	0	1	114	137	251	4.51	3.60
(%)	(0.0)	(12.3)	(45.6)	(25.4)	(8.8)	(1.8)	(2.6)	(0.9)	(1.8)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.9)	(100.0)				
30–4	3	56	329	257	68	32	13	4	3	4	0	4	0	0	0	1	0	774	832	1 606	4.54	2.72
(%)	(0.4)	(7.2)	(42.5)	(33.2)	(8.8)	(4.1)	(1.7)	(0.5)	(0.4)	(0.5)	(0.0)	(0.5)	(0.0)	(0.0)	(0.0)	(0.1)	(0.0)	(100.0)				
45–59	7	117	1170	1105	366	125	56	29	14	14	10	3	1	2	3	2	5	3 029	2 928	5 957	4.96	3.27
(%)	(0.2)	(3.9)	(38.6)	(36.5)	(12.1)	(4.1)	(1.8)	(1.0)	(0.5)	(0.5)	(0.3)	(0.1)	(0.0)	(0.1)	(0.1)	(0.1)	(0.2)	(100.0)				
60–74	5	115	2069	2508	943	315	146	85	38	32	18	13	5	8	5	3	15	6 323	6 144	12 467	5.37	3.54
(%)	(0.1)	(1.8)	(32.7)	(39.7)	(14.9)	(5.0)	(2.3)	(1.3)	(0.6)	(0.5)	(0.3)	(0.2)	(0.1)	(0.1)	(0.1)	(0.0)	(0.2)	(100.0)				
75–89	8	44	1246	1917	855	406	167	87	49	42	21	8	7	6	7	1	9	4 880	4 882	9762	5.91	3.37
(%)	(0.2)	(0.9)	(25.5)	(39.3)	(17.5)	(8.3)	(3.4)	(1.8)	(1.0)	(0.9)	(0.4)	(0.2)	(0.1)	(0.1)	(0.1)	(0.0)	(0.2)	(100.0)				
≥90	0	1	46	68	43	22	7	8	4	2	1	1	1	0	0	0	2	206	215	421	6.67	4.16
(%)	(0.0)	(0.5)	(22.3)	(33.0)	(20.9)	(10.7)	(3.4)	(3.9)	(1.9)	(1.0)	(0.5)	(0.5)	(0.5)	(0.0)	(0.0)	(0.0)	(1.0)	(100.0)				
Subtotal	23	347	4912	5886	2286	905	393	216	111	94	50	29	14	16	15	7	32	15 336	15 156	30 492	5.43	3.43
(%)	(0.1)	(2.3)	(32.0)	(38.4)	(14.9)	(5.9)	(2.6)	(1.4)	(0.7)	(0.6)	(0.3)	(0.2)	(0.1)	(0.1)	(0.1)	(0.0)	(0.2)	(100.0)				
No information available	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	18		
Total	23	347	4912	5886	2286	905	393	216	111	94	50	29	14	16	15	7	32	15 336	15 174	30 510	5.43	3.43
(%)	(0.1)	(2.3)	(32.0)	(38.4)	(14.9)	(5.9)	(2.6)	(1.4)	(0.7)	(0.6)	(0.3)	(0.2)	(0.1)	(0.1)	(0.1)	(0.0)	(0.2)	(100.0)				
Mean	63.17	57.26	65.06	67.96	69.80	70.82	70.59	70.68	70.27	70.91	71.50	65.59	75.64	71.81	69.80	62.57	68.91	67.39	67.28	67.33		
SD	14.73	15.35	13.26	12.41	12.30	12.92	12.95	12.79	15.11	12.51	11.70	16.50	10.53	11.07	12.43	13.65	14.59	13.07	13.37	13.22		

Values in parentheses below each figure represent % relative to the total of each row.

TABLE 60. *Estimated glomerular filtration rates (eGFR) at the introduction to dialysis and primary diseases (only patients begun on dialysis in 2007 who responded to the questionnaire using floppy disks)*

	eGFR at introduction into dialysis (mL/min/1.73 m^2)																					
Primary disease	<1.0	1.0–1.9	2.0–2.9	4.0–5.9	6.0–7.9	8.0–9.9	10.0–11.9	12.0–13.9	14.0–15.9	16.0–17.9	18.0–19.9	20.0–21.9	22.0–23.9	24.0–25.9	26.0–27.9	28.0–29.9	≥30.0	Subtotal	No information available	Total	Mean	SD
Chronic glomerulonephritis	8	128	1338	1273	416	147	60	29	17	19	6	2	3	3	3	1	8	3461	3 539	7 000	4.94	3.30
(%)	(0.2)	(3.7)	(38.7)	(36.8)	(12.0)	(4.2)	(1.7)	(0.8)	(0.5)	(0.5)	(0.2)	(0.1)	(0.1)	(0.1)	(0.1)	(0.0)	(0.2)	(100.0)				
Chronic pyelonephritis	1	4	46	37	13	6	0	0	1	1	0	0	0	0	0	0	0	109	105	214	4.63	2.31
(%)	(0.9)	(3.7)	(42.2)	(33.9)	(11.9)	(5.5)	(0.0)	(0.0)	(0.9)	(0.9)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(100.0)				
Rapidly progressive glomerulonephritis	0	11	94	83	37	15	6	1	2	2	1	0	0	1	0	0	0	253	258	511	5.08	2.99
(%)	(0.0)	(4.3)	(37.2)	(32.8)	(14.6)	(5.9)	(2.4)	(0.4)	(0.8)	(0.8)	(0.4)	(0.0)	(0.0)	(0.4)	(0.0)	(0.0)	(0.0)	(100.0)				
Nephropathy of pregnancy / pregnancy toxemia	1	0	12	7	3	0	0	0	0	0	0	0	0	0	0	0	0	23	16	39	3.96	1.70
(%)	(4.3)	(0.0)	(52.2)	(30.4)	(13.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(100.0)				
Other nephritides that cannot be classified	0	3	30	24	7	3	3	0	0	1	0	0	0	0	0	0	0	71	60	131	4.84	2.65
(%)	(0.0)	(4.2)	(42.3)	(33.8)	(9.9)	(4.2)	(4.2)	(0.0)	(0.0)	(1.4)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(100.0)				
Polycystic kidney disease	2	15	163	155	43	6	2	0	1	0	1	0	0	0	0	0	0	388	306	694	4.41	1.79
(%)	(0.5)	(3.9)	(42.0)	(39.9)	(11.1)	(1.5)	(0.5)	(0.0)	(0.3)	(0.0)	(0.3)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(100.0)				
Nephrosclerosis	0	25	610	709	268	110	44	29	10	8	4	2	2	1	2	0	1	1 825	1 555	3 380	5.31	2.90
(%)	(0.0)	(1.4)	(33.4)	(38.8)	(14.7)	(6.0)	(2.4)	(1.6)	(0.5)	(0.4)	(0.2)	(0.1)	(0.1)	(0.1)	(0.1)	(0.0)	(0.1)	(100.0)				
Malignant hypertension	0	5	30	36	13	1	1	0	0	0	0	0	0	0	0	0	0	86	102	188	4.36	1.74
(%)	(0.0)	(5.8)	(34.9)	(41.9)	(15.1)	(1.2)	(1.2)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(100.0)				
Diabetic nephropathy	10	82	1852	2785	1170	468	199	120	49	41	28	17	8	8	8	2	13	6 860	6 511	13 371	5.73	3.44
(%)	(0.1)	(1.2)	(27.0)	(40.6)	(17.1)	(6.8)	(2.9)	(1.7)	(0.7)	(0.6)	(0.4)	(0.2)	(0.1)	(0.1)	(0.1)	(0.0)	(0.2)	(100.0)				
Systemic lupus erythematosus nephritis	1	0	36	41	19	14	3	1	2	1	1	1	0	0	0	0	1	121	104	225	6.15	3.98
(%)	(0.8)	(0.0)	(29.8)	(33.9)	(15.7)	(11.6)	(2.5)	(0.8)	(1.7)	(0.8)	(0.8)	(0.8)	(0.0)	(0.0)	(0.0)	(0.0)	(0.8)	(100.0)				
Amyloidal kidney	0	0	22	19	15	8	2	1	0	1	1	1	0	0	0	1	0	71	86	157	6.48	4.50
(%)	(0.0)	(0.0)	(31.0)	(26.8)	(21.1)	(11.3)	(2.8)	(1.4)	(0.0)	(1.4)	(1.4)	(1.4)	(0.0)	(0.0)	(0.0)	(1.4)	(0.0)	(100.0)				
Gouty kidney	0	0	16	24	8	1	2	2	0	1	0	0	0	0	0	0	0	54	31	85	5.40	3.07
(%)	(0.0)	(0.0)	(29.6)	(44.4)	(14.8)	(1.9)	(3.7)	(3.7)	(0.0)	(1.9)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(100.0)				
Renal failure due to congenital abnormal metabolism	0	1	4	9	2	0	0	0	0	0	0	0	0	0	0	0	0	16	19	35	4.30	1.37
(%)	(0.0)	(6.3)	(25.0)	(56.3)	(12.5)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(100.0)				
Kidney and urinary tract tuberculosis	0	0	3	6	1	0	1	0	1	0	0	0	0	0	0	0	0	12	4	16	5.97	3.70
(%)	(0.0)	(0.0)	(25.0)	(50.0)	(8.3)	(0.0)	(8.3)	(0.0)	(8.3)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(100.0)				
Kidney and urinary tract stone	0	4	11	10	3	0	1	0	0	1	0	0	0	0	0	0	0	30	24	54	4.63	2.99
(%)	(0.0)	(13.3)	(36.7)	(33.3)	(10.0)	(0.0)	(3.3)	(0.0)	(0.0)	(3.3)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(100.0)				
Kidney and urinary tract tumor	0	1	22	20	10	0	4	2	1	2	0	0	0	0	0	0	3	65	79	144	7.35	8.65
(%)	(0.0)	(1.5)	(33.8)	(30.8)	(15.4)	(0.0)	(6.2)	(3.1)	(1.5)	(3.1)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(4.6)	(100.0)				
Obstructive urinary tract difficulty	0	3	21	19	5	0	0	0	0	0	0	0	0	0	0	0	0	48	49	97	4.07	1.39
(%)	(0.0)	(6.3)	(43.8)	(39.6)	(10.4)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(100.0)				
Myeloma	0	4	24	26	3	2	1	0	0	0	0	0	0	0	0	0	0	60	79	139	4.25	1.78
(%)	(0.0)	(6.7)	(40.0)	(43.3)	(5.0)	(3.3)	(1.7)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(100.0)				
Hypoplastic kidney	0	4	10	6	1	2	1	1	0	0	1	0	0	0	0	0	0	26	21	47	5.24	4.00
(%)	(0.0)	(15.4)	(38.5)	(23.1)	(3.8)	(7.7)	(3.8)	(3.8)	(0.0)	(0.0)	(3.8)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(100.0)				
Unspecified	0	51	453	464	183	86	46	21	16	12	5	4	1	1	0	1	1	1 345	1 680	3 025	5.45	3.60
(%)	(0.0)	(3.8)	(33.7)	(34.5)	(13.6)	(6.4)	(3.4)	(1.6)	(1.2)	(0.9)	(0.4)	(0.3)	(0.1)	(0.1)	(0.0)	(0.1)	(0.1)	(100.0)				
Reintroduction after transplantation	0	0	10	20	6	6	2	0	0	0	0	0	0	0	0	0	0	44	47	91	5.45	2.23
(%)	(0.0)	(0.0)	(22.7)	(45.5)	(13.6)	(13.6)	(4.5)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(100.0)				
Others	0	6	103	111	60	29	15	9	11	4	2	2	0	2	2	2	5	363	403	766	6.85	5.45
(%)	(0.0)	(1.7)	(28.4)	(30.6)	(16.5)	(8.0)	(4.1)	(2.5)	(3.0)	(1.1)	(0.6)	(0.6)	(0.0)	(0.6)	(0.6)	(0.6)	(1.4)	(100.0)				
Subtotal	23	347	4910	5884	2286	904	393	216	111	94	50	29	14	16	15	7	32	15 331	15 078	30 409	5.43	3.43
(%)	(0.2)	(2.3)	(32.0)	(38.4)	(14.9)	(5.9)	(2.6)	(1.4)	(0.7)	(0.6)	(0.3)	(0.2)	(0.1)	(0.1)	(0.1)	(0.0)	(0.2)	(100.0)				
No information available	0	0	2	2	0	1	0	0	0	0	0	0	0	0	0	0	0	5	96	101	5.31	2.45
Total	23	347	4912	5886	2286	905	393	216	111	94	50	29	14	16	15	7	32	15 336	15 174	30 510	5.43	3.43
(%)	(0.1)	(2.3)	(32.0)	(38.4)	(14.9)	(5.9)	(2.6)	(1.4)	(0.7)	(0.6)	(0.3)	(0.2)	(0.1)	(0.1)	(0.1)	(0.0)	(0.2)	(100.0)				

Values in parentheses below each figure represent the percentage relative to the total of each row.

eGFR of male patients = 186 × (serum creatinine concentration prior to first dialysis$^{(-1.154)}$) × (age at introduction into dialysis$^{(-0.203)}$) × 0.881

When the serum creatinine concentration was determined by the enzyme method, the following equation was used:

eGFR of male patients = 175 × (serum creatinine concentration prior to first dialysis$^{(-1.154)}$) × (age at introduction to dialysis$^{(-0.203)}$) × 0.741

The eGFR of female patients was calculated by multiplying the value obtained using the above equations, that is, the eGFR of male patients, by 0.742.

a. Treatment method at the end of year of introduction into dialysis. Table 57 shows the relationship between eGFR at the introduction to dialysis and the treatment method at the end of the year of introduction (2007). The mean eGFR at the introduction to dialysis of patients who underwent home hemodialysis was as low as 3.25 (±0.25) mL/min, which was difficult to evaluate accurately because the number of patients evaluated was only two. No significant difference in eGFR was found among the patients who were treated by other methods.

b. Gender. Table 58 shows the relationship between eGFR at the introduction to dialysis and gender. Similarly to the result of the 2006 survey, the eGFR of female patients was lower than that of male patients, despite the fact that the serum creatinine concentration at the introduction to dialysis of the female patients was lower than that of the male patients.

c. Age. Table 59 shows the relationship between eGFR at the introduction to dialysis and age. The eGFR of the patients tended to increase with age, which was similar to that in the 2006 survey.

d. Primary disease. Table 60 shows the relationship between eGFR at the introduction to dialysis and primary disease. The eGFR tended to be high for patients with renal or urinary tract tumors, amyloid nephropathy, SLE nephritis, and diabetic nephropathy as the primary diseases.

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Revised Equations for Estimated GFR From Serum Creatinine in Japan

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Background: Estimation of glomerular filtration rate (GFR) is limited by differences in creatinine generation among ethnicities. Our previously reported GFR-estimating equations for Japanese had limitations because all participants had a GFR less than 90 mL/min/1.73 m^2 and serum creatinine was assayed in different laboratories.

Study Design: Diagnostic test study using a prospective cross-sectional design. New equations were developed in 413 participants and validated in 350 participants. All samples were assayed in a central laboratory.

Setting & Participants: Hospitalized Japanese patients in 80 medical centers. Patients had not participated in the previous study.

Reference Test: Measured GFR (mGFR) computed from inulin clearance.

Index Test: Estimated GFR (eGFR) by using the modified isotope dilution mass spectrometry (IDMS)-traceable 4-variable Modification of Diet in Renal Disease (MDRD) Study equation using the previous Japanese Society of Nephrology Chronic Kidney Disease Initiative (JSN-CKDI) coefficient of 0.741 (equation 1), the previous JSN-CKDI equation (equation 2), and new equations derived in the development data set: modified MDRD Study using a new Japanese coefficient (equation 3), and a 3-variable Japanese equation (equation 4).

Measurements: Performance of equations was assessed by means of bias (eGFR − mGFR), accuracy (percentage of estimates within 15% or 30% of mGFR), root mean squared error, and correlation coefficient.

Results: In the development data set, the new Japanese coefficient was 0.808 (95% confidence interval, 0.728 to 0.829) for the IDMS–MDRD Study equation (equation 3), and the 3-variable Japanese equation (equation 4) was eGFR (mL/min/1.73 m^2) = 194 × Serum creatinine$^{-1.094}$ × Age$^{-0.287}$ × 0.739 (if female). In the validation data set, bias was −1.3 ± 19.4 versus −5.9 ± 19.0 mL/min/1.73 m^2 (P = 0.002), and accuracy within 30% of mGFR was 73% versus 72% (P = 0.6) for equation 3 versus equation 1 and −2.1 ± 19.0 versus −7.9 ± 18.7 mL/min/1.73 m^2 (P < 0.001) and 75% versus 73% (P = 0.06) for equation 4 versus equation 2 (P = 0.06), respectively.

Limitation: Most study participants had chronic kidney disease, and some may have had changing GFRs.

Conclusion: The new Japanese coefficient for the modified IDMS–MDRD Study equation and the new Japanese equation are more accurate for the Japanese population than the previously reported equations.
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INDEX WORDS: Glomerular filtration rate; Japanese; inulin clearance; serum creatinine.

Editorial, p. 932

Glomerular filtration rate (GFR) is the most accurate index for assessing overall kidney function and an important tool for making diagnostic decisions in clinical practice.[1] GFR may be measured by using the clearance of an exogenous marker; inulin is the gold standard, but the method is not applicable to daily practice because it is time consuming, labor intensive, and expensive. Kidney function usually is assessed from serum creatinine (SCr) concentration alone, but SCr is affected by creatinine generation, including muscle mass and dietary intake, in addition to GFR.[2] GFR can be estimated from SCr level by using equations that include age, sex, race, and serum urea nitrogen (SUN) and albumin levels, as surrogates for creatinine generation, and are more accurate than estimates based on SCr level alone.[1,3,4]

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A list of the investigators who helped develop the Japanese equation for estimated GFR appears at the end of the article.

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The Modification of Diet in Renal Disease (MDRD) Study equation[5] and Cockcroft-Gault (CG) equation[6] are most commonly used for GFR estimation worldwide. Recently, the 4-variable MDRD Study equation was reexpressed by Levey et al[7] for use with isotope dilution mass spectrometry (IDMS)-standardized SCr values (the IDMS–MDRD Study equation). Several studies have validated the MDRD Study equation in whites and blacks.[8-14] In studies of more than 5,500 participants, Stevens et al[15,16] reported that GFR estimates using the IDMS–MDRD Study equation were unbiased and accurate for interpretations of GFR less than 60 mL/min/1.73 m^2, but warned that estimates just less than 60 mL/min/1.73 m^2 must be interpreted with caution to prevent misclassification of chronic kidney disease. The equation is less accurate for Asians, with greater bias at estimated GFR (eGFR) less than 60 mL/min/1.73 m^2.[17-19] Accordingly, both Ma et al[17] and our investigators[18,19] modified the MDRD Study equation by using separate "correction coefficients" for Chinese and Japanese. In both studies, the new equations were more accurate than the MDRD Study equation, but the correction coefficients were considerably different, with a Chinese coefficient of 1.233[17] and Japanese coefficient of 0.741.[19]

The difference in correction coefficients between Japanese and Chinese has not been explained. In our previous study, there may have been nonuniformity of creatinine assays because study samples for SCr were assayed in multiple laboratories and during different periods. Furthermore, data from participants with GFR greater than 90 mL/min/1.73 m^2 were not used for deriving the equation in the study. To verify results of our previous study, a new project was launched by the Japanese Society of Nephrology (JSN) with cooperation of nephrologists nationwide. The new study was conducted in 763 individuals to measure GFR and SCr by using inulin clearance (Cin) and standardized assays. A new Japanese correction coefficient was derived, as were new 3- and 5-variable Japanese equations.

METHODS

Inclusion and Exclusion Criteria

Inclusion criteria were: (1) age 18 years and older; (2) relatively stable kidney function, assessed by using SCr level; and (3) patient's agreement to have urinary Cin measured using a continuous infusion.

Exclusion criteria were: (1) acute kidney injury, (2) apparent malignancy, (3) problems in micturition, (4) pregnancy, (5) inulin allergy, (6) amputation, and (7) individuals for whom the investigator judged that measuring Cin was inappropriate. Although some study participants were hospitalized for diagnosis of rapidly progressive or acute glomerulonephritis, renal biopsies and Cin measurements were performed after their conditions became relatively stable. We did not record data for day-to-day SCr level changes.

Study Population of the Data Set

The study recruited participants from 80 medical centers throughout Japan between December 2006 and July 2007. Participants included mostly nephrology inpatients. Hospitalization of 5 to 14 days for kidney biopsy or education about lifestyle change was commonly practiced in Japan. Data for Cin and SCr were collected from 878 participants, mostly those with chronic kidney disease and a small number of healthy kidney donors. A total of 115 participants were excluded for the following reasons: 36 lacked data for urine volume, 11 were 17 years and younger, 2 had high serum inulin concentrations, 4 had lack of data for inulin blank, 51 had high values for inulin blank, 9 had a low volume of voided urine (<10 mL), and 2 had extraordinarily high GFRs. The final study population included 763 participants. Data collected from December 1, 2006, to April 20, 2007 (n = 413), were used as the development data set, and those obtained from April 21, 2007, to July 31, 2007 (n = 350), were used as the validation data set. The institutional review board at all the study institutions approved anonymous use of data for the present study. All patients signed written informed consent.

Cin and Creatinine Renal Clearance

Cin and creatinine clearance (Ccr) were measured simultaneously in 757 participants. In 6 participants, only Cin was measured. The method for measuring renal Cin was described elsewhere.[18] Briefly, Cin and Ccr were calculated from serum and urine concentrations and urine flow rate. Inulin (1%) was administered by means of a continuous intravenous infusion for 2 hours under overnight fasting, but hydrated, conditions. During the inulin infusion, serum samples were collected 4 times at 0 (blank), 45, 75, and 105 minutes for creatinine and inulin, and urine samples were collected between 30 and 60, 60 and 90, and 90 and 120 minutes for inulin and creatinine after completely emptying the bladder at 30 minutes from the start of the inulin infusion. Inulin samples were assayed by means of an enzymatic method using a kit (Diacolor Inulin; Toyobo Co, Osaka, Japan). The mean value of 3 measurements was used for the Cin and Ccr study.

SCr Measurement

Serum samples were assayed for creatinine in a central laboratory (Central Laboratory; SRL Co, Hachioji, Japan) by means of the enzymatic creatinine assay method using an

Table 1. Participant Characteristics

	Development Data Set	Validation Data Set
No. of participants (men/women)	413 (262/151)	350 (203/147)
Age (y)	51.4 ± 16.5 (18-88)	53.9 ± 17.5 (19-91)
Serum creatinine (mg/dL)	1.62 ± 1.59 (0.41-10.75)	1.57 ± 1.38 (0.34-10.28)
Albumin (g/dL)	3.80 ± 0.64 (1.70-5.20)	3.91 ± 0.56 (1.70-5.10)
Serum urea nitrogen (mg/dL)	22.0 ± 15.5 (5.0-107.3)	22.4 ± 14.2 (6.1-81.2)
GFR (mL/min/1.73 m^2)	59.1 ± 35.4 (3.0-199.3)	57.2 ± 34.7 (2.6-228.7)
0-29	108 (26%)	93 (27%)
30-59	115 (28%)	113 (32%)
60-89	102 (25%)	73 (21%)
>90	88 (21%)	71 (20%)
Creatinine clearance (mL/min/1.73 m^2)	81.2 ± 47.2 (3.1-274.1)	79.7 ± 44.9 (5.3-268.5)
Height (cm)	163.3 ± 8.8	161.6 ± 9.5
Weight (kg)	61.0 ± 12.9	60.4 ± 12.7
Body surface area (m^2)	1.65 ± 0.19	1.63 ± 0.19
Diagnosis		
Chronic glomerulonephritis	219	173
Acute glomerulonephritis	4	3
RPGN	10	4
Interstitial nephritis	6	3
Diabetes mellitus	46	44
Polycystic kidney disease	2	0
Nephrosclerosis	25	30
Lupus	10	3
Kidney donor	1	10
Kidney recipient	9	2
Hereditary nephritis	3	1
Hypoplasia	3	0
Unilateral nephrectomy	6	3
Miscellaneous	69	74

Note: Conversion factors for units: serum creatinine in mg/dL to μmol/L, ×88.4; urinary albumin in g/dL to g/L, ×10; serum urea nitrogen in mg/dL to mmol/L, ×0.357; GFR in mL/min/1.73 m^2 to mL/s/1.73 m^2, ×0.01667.

Abbreviations: GFR, glomerular filtration rate; RPGN, .

Hitachi creatinine auto-analyzer, model 7170 (Hitachi, Tokyo, Japan) and enzyme solution (Preauto-SCrE-N; Daiichi Pure Chemicals Co, Tokyo, Japan). SCr values obtained in the central laboratory were compared with those of the Cleveland Clinic (Cleveland, OH) by using a calibration panel of 40 samples, provided by Dr Frederick Van Lente, Cleveland Clinic.

Comparison of Measured Versus Expected Creatinine Excretion

Creatinine excretion was measured in 90-minute urine samples obtained during Cin measurements and predicted based on previously published formulas.

Creatinine excretion rates were based on published equations for Japenese[20] and whites[21] and are given in the notes to Table 2.

Development of the Correction Coefficient for the IDMS–MDRD Study Equation

The new Japanese coefficient to modify the IDMS–MDRD Study equation[7] for Japanese was calculated from the development data set of 413 participants. The coefficient was derived by minimizing the root mean squared error (RMSE) of the estimate calculated as the square root of (sum of squared errors of the estimate/[N]).

Development of the New Equations for Japanese

The new 3- and 5-variable Japanese equations were derived in the development data set by using a multiple linear regression model and the variables age, sex, and SCr, SUN, and serum albumin levels in relation to measured GFR (mGFR). All variables were log transformed.

Development of the Correction Coefficient for the CG Equation

The CG equation was modified by a Japanese CG coefficient that was calculated in the development data set. The correction coefficient was determined by minimizing the RMSEs of the estimate.

Validation of Equations

GFR was estimated by using all equations and compared with mGFR in the development and validation data

Table 2. Participant Characteristics

	Men (n = 462)	Women (n = 296)
Age (y)	53.7 ± 17.1	50.8 ± 16.8
Height (cm)	167.4 ± 7.1	154.9 ± 6.3
Weight (kg)	65.7 ± 11.9	52.7 ± 9.5
Body surface area (m^2)	1.74 ± 0.16	1.49 ± 0.13
Body mass index (kg/m^2)	23.4 ± 3.7	22.0 ± 3.8
Measured creatinine excretion (mg/kg/d)	20.2 ± 0.8	16.7 ± 4.6
Estimated creatinine excretion (for Japanese)	18.4 ± 1.2	14.3 ± 1.0
Estimated creatinine excretion (for whites)	19.0 ± 2.9	16.1 ± 1.9

Note: Data expressed as mean ± SD. Measured creatinine excretion was obtained during the measurement of inulin clearance. Expected creatinine excretion for Japanese was calculated by using the following equations: Creatinine excretion rate (mg/kg/d) = 22.1 − 0.068 × Age (in men) or 17.2 − 0.057 × Age (in women). Estimated creatinine excretion for whites was calculated by the following equations: Creatinine excretion rate (mg/kg/d) = 28.2 − 0.172 × Age (in men) or 21.9 − 0.115 × Age (in women).

sets. We compared all equations, but specifically focused on the comparison in the validation data set of the IDMS–MDRD Study equations modified by the previously published JSN Chronic Kidney Disease Initiative (JSN-CKDI) coefficient and the new Japanese coefficient, as well as the JSN-CKDI equation and new Japanese equations. Metrics for comparison were RMSE, bias, accuracy, and r^2. The RMSE of GFR estimated by using the equation was calculated as the square root of (sum of squared errors of the estimate/[N]). Bias of the equations was expressed as the mean difference between eGFR and mGFR (eGFR − mGFR). Accuracy was expressed as percentage of participants with eGFR less than 15% and 30% from mGFR. RMSE and correlation coefficients were computed on the raw scale. Data sets were combined for correlation between eGFR and mGFR. Intercepts and slopes were evaluated in a linear regression model.

Statistical Analysis

Data are expressed as mean ± SD. Measured versus predicted creatinine excretion was compared by using Student *t*-test. Creatinine values were calibrated by using the calibration panel and evaluated by means of linear regression. Differences in accuracy of eGFR were evaluated between equations by means of χ^2 tests. Differences in bias of eGFR were evaluated between equations by using Student *t*-test. A difference with *P* less than 0.05 was considered statistically significant. Statview, version 4.02 (SAS Institute, Cary, NC), and JMP, version 6.02 (SAS Institute), were used for statistical analysis and calculation of correction factors and confidence intervals (CIs).

RESULTS

Patient Characteristics in the Development and Validation Populations

Characteristics of the development population (n = 413) and validation population (n = 350) are listed in Table 1. Distributions of participant numbers by cause of kidney disease and mean age, SCr level, albumin level, SUN level, height, weight, and body surface area were similar between the 2 populations. Mean Cin was also similar between them at 59.1 ± 35.4 mL/min/1.73 m^2 in the development population and 57.2 ± 34.7 mL/min/1.73 m^2 in the validation population. Proportions of participants with mGFR less than 60 mL/min/1.73 m^2 were 54% in the development population and 60% in the validation population.

Body Size and Creatinine Excretion

Body size and creatinine excretion in the combined development and validation data sets are listed separately for men and women in Table 2. The creatinine excretion rate was greater in men than women (20.2 versus 16.7 mg/kg/d). Measured values were significantly, but not substantially, greater than expected values for both Japanese ($P < 0.001$) and whites ($P < 0.001$).

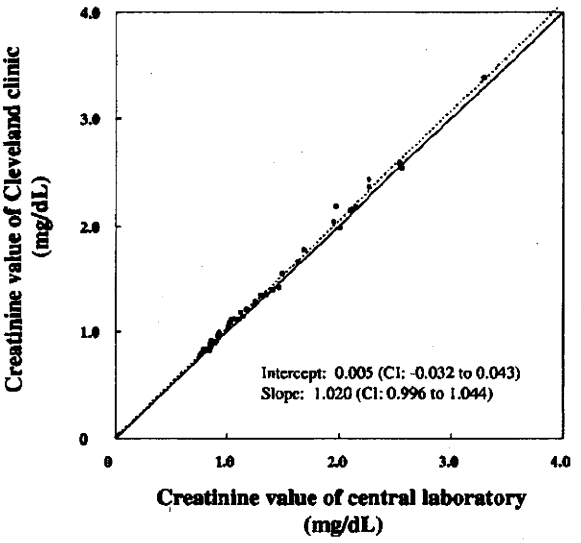

Figure 1. Correlation between creatinine values of the Cleveland Clinic and a central laboratory. Y = X (solid line), and regression line (dotted line). Abbreviation: CI, confidence interval.

Table 3. Intercepts and Coefficients for GFR-Estimating Equations in the Development Population

Equation	Exponent-Transformed Intercept (95% CI)	Coefficient of Continuous Parameters (95% CI)				Exponent-Transformed Coefficient Of Dichotomous Variables (95% CI)
		SCr	Age	SUN	Alb	
IDMS–MDRD Study	175	−1.154	−0.203	–	–	0.742 if female 1.01 if white 1.212 if black
1	175	−1.154	−0.203	–	–	0.742 if female 0.741 if Japanese
2	171	−1.004	−0.287	–	–	0.782 if female
3	175	−1.154	−0.203	–	–	0.742 if female 0.808 if Japanese (0.728 to 0.829)
4	194 (143 to 262)	−1.094 (−1.139 to −1.048)	−0.287 (−0.366 to −0.208)	–	–	0.739 if female (0.695 to 0.786)
5	142 (93 to 217)	−0.923 (−0.997 to −0.849)	−0.185 (−0.263 to −0.108)	−0.233 (−0.319 to −0.148)	0.414 (0.272 to 0.557)	0.772 if female (0.728 to 0.818)
6	–	–	–	–	–	0.85 if female (0.769 to 0.810)

Equation 1: IDMS–MDRD Study equation with previously reported JSN-CKDI coefficient: $eGFR = 0.741 \times 175 \times SCr^{-1.154} \times Age^{-0.203} \times 0.742$ (if female).

Equation 2: Previously reported JSN-CKDI equation: $eGFR = 171 \times SCr^{-1.004} \times Age^{-0.287} \times 0.782$ (if female).

Equation 3: IDMS–MDRD Study equation with new Japanese coefficient: $eGFR = 0.808 \times 175 \times SCr^{-1.154} \times Age^{-0.203} \times 0.742$ (if female).

Equation 4: New 3-variable Japanese equation: $eGFR = 194 \times SCr^{-1.094} \times Age^{-0.287} \times 0.739$ (if female).

Equation 5: New 5-variable Japanese equation: $eGFR = 142 \times SCr^{-0.923} \times Age^{-0.185} \times Alb^{0.414} \times SUN^{-0.233} \times 0.772$ (if female).

Equation 6: 0.789 × CG equation: $eGFR = 0.789 \times (140 - Age) \times BW/SCr/72 \times 1.73/BSA \times 0.85$ (if female).

Abbreviations: Alb, albumin; BSA, body surface area; BW, body weight; CG, Cockcroft-Gault; CI, confidence interval; CKDI, Chronic Kidney Disease Initiative; eGFR, estimated glomerular filtration rate; IDMS, isotope dilution mass spectrometry; JSN, Japanese Society of Nephrology; MDRD, Modification of Diet in Renal Disease; SCr, serum creatinine; SUN, serum urea nitrogen.

Calibration of Creatinine Assays

Creatinine values for the calibration panel assigned in our laboratory were compared with values assigned by Cleveland Clinic Laboratory (Fig 1). Mean SCr level was 1.415 ± 0.100 (SEM) versus 1.449 ± 0.102 mg/dL. Creatinine values correlated highly with values assigned by the Cleveland Clinic as judged by the intercept of 0.005 (95% CI, −0.0032 to 0.043), close to zero, and the slope of 1.020 (95% CI, 0.996 to 1.044), close to 1.0. Because there was no significant systemic bias, creatinine values were not adjusted in the present study.

Cin and Ccr

Cin and Ccr were measured simultaneously in 757 patients. Mean serum inulin concentrations were 18.4 ± 4.9, 18.3 ± 5.1, and 19.3 ± 5.9 mg/dL at 45, 75, and 105 minutes, respectively. The median coefficient of variation for Cin was 10.9% (95% CI, 5.8 to 20.4) during the 90-minute renal Cin test. The median coefficient of variation for Ccr was 13.3%. Cin and Ccr significantly correlated ($r = 0.889$; $r^2 = 0.790$). The slope was 0.698 (95% CI, 0.672 to 0.724) and the intercept was 2.339 (95% CI, 0.143 to 4.622). Ccr was significantly greater than Cin, and the correction coefficient for the bias was determined to be 0.715 (95% CI, 0.703 to 0.726).

eGFR Equations

All equations are listed in the notes to Table 3.

The new Japanese correction coefficient calculated for modification of the IDMS–MDRD Study equation was 0.808 (95% CI, 0.728 to 0.829; equation 3) in the development population, whereas the previously reported coefficient was 0.741 (equation 1), as listed in Table 3.

Using the development data set, we derived a new 3-variable Japanese equation (equation 4) and a new 5-variable Japanese equation (equation 5; Table 3).

Table 4. Performance of GFR-Estimating Equations in the Development Population

Equation	RMSE (mL/min/1.73 m²)	Accuracy	
		Within 15% of mGFR (95% CI)	Within 30% of mGFR (95% CI)
IDMS–MDRD Study equation	23.6	36 (32-41)	59 (55-64)
Equation 1	18.4	38 (34-43)	73 (69-77)
Equation 2	19.2	39 (35-44)	73 (68-77)
Equation 3	17.6	44 (39-48)	77 (72-81)
Equation 4	17.3	44 (39-48)	78 (74-82)
Equation 5	16.4	52 (47-57)	83 (79-86)
Equation 6	17.7	44 (39-49)	76 (72-80)

P

15% Accuracy Level	IDMS	Eq 1	Eq 2	Eq 3	Eq 4	Eq 5
IDMS						
Eq 1	0.6					
Eq 2	0.4	0.7				
Eq 3	0.03	0.1	0.2			
Eq 4	0.03	0.1	0.2	0.9		
Eq 5	<0.001	<0.001	<0.001	0.01	0.01	
Eq 6	0.03	0.1	0.2	0.9	0.9	0.02

30% Accuracy Level	IDMS	Eq 1	Eq 2	Eq 3	Eq 4	Eq 5
IDMS						
Eq 1	<0.001					
Eq 2	<0.001	0.9				
Eq 3	<0.001	0.2	0.2			
Eq 4	<0.001	0.09	0.06	0.6		
Eq 5	<0.001	<0.001	<0.001	0.03	0.1	
Eq 6	<0.001	0.3	0.3	0.8	0.5	0.02

Note: Accuracy given as percentage of participants whose estimated GFR was within 15% or 30% of measured GFR.

Abbreviations: CI, confidence interval; Eq, equation; GFR, glomerular filtration rate; IDMS, isotope dilution mass spectrometry; MDRD, Modification of Diet in Renal Disease; RMSE, root mean squared error.

The CG equation was modified with a correction coefficient. The Japanese coefficient of 0.789 (95% CI, 0.769 to 0.810) was obtained from the development data set and is provided as equation 6 in Table 3.

Comparison of Performance of the Equations

Performance in GFR estimation was evaluated among equations by using the development and validation data sets based on RMSE, bias, and accuracy of eGFR in reference to mGFR.

Accuracy in the Development Data Set

Performance of each derived equation was evaluated by using the development data set, as listed in Table 4. Bias is not compared because it is expected to be approximately zero for equations developed in the development data set. There were no significant differences in accuracy within 15% or 30% between equations 3 and 1 or between equations 4 and 2, reflecting no significant different in precision.

Bias and Accuracy in the Validation Data Set

Performance of each derived equation was evaluated by using the validation data set, as listed in Table 5. Bias was significantly less in equation 3 than in equation 1 ($P = 0.002$) and in equation 4 than in equation 2 ($P < 0.001$). Equation 3 provided GFR with significantly better accuracy within 15% than equation 1 ($P = 0.02$), but no significant difference in accuracy within 30% deviation ($P = 0.6$) between the 2 equations. There was a trend toward improved accuracy within 15% and 30% between equations 4 and 2 ($P = 0.06$). Equation 5 performed similarly to equation 4.

Correlation Between eGFR and mGFR

The correlation between eGFR and mGFR was evaluated in the combined population as shown for each equation in Fig 2. Intercepts and slopes for equations are listed in Table 6.

DISCUSSION

We previously reported that eGFR calculated using either the IDMS–MDRD Study equation modified by using the JSN–CKDI coefficient (0.741; equation 1) or the JSN–CKDI equation (equation 2) was more accurate than the unmodified MDRD Study equation in Japanese individu-

Table 5. Performance of GFR-Estimating Equations in the Validation Population

Equations	RMSE (mL/min/1.73 m²)	Bias (mL/min/1.73 m²)	Accuracy	
			Within 15% of mGFR (95% CI)	Within 30% of mGFR (95% CI)
IDMS–MDRD Study equation	25.2	12.0 ± 22.2	39 (34-45)	59 (54-64)
Equation 1	19.9	−5.9 ± 19.0	34 (29-39)	72 (67-76)
Equation 2	20.3	−7.9 ± 18.7	36 (31-41)	73 (69-78)
Equation 3	19.4	−1.3 ± 19.4*	43 (38-48)	73 (59-78)
Equation 4	19.1	−2.1 ± 19.0†	43 (38-48)	75 (70-79)
Equation 5	17.7	−1.2 ± 17.6	49 (44-54)	79 (75-83)
Equation 6	19.4	−1.7 ± 19.6	45 (40-50)	75 (70-79)

P

	15% Accuracy Level							30% Accuracy Level					
	IDMS	Eq 1	Eq 2	Eq 3	Eq 4	Eq 5		IDMS	Eq 1	Eq 2	Eq 3	Eq 4	Eq 5
IDMS							IDMS						
Eq 1	0.1						Eq 1	<0.001					
Eq 2	0.4	0.5					Eq 2	<0.001	0.6				
Eq 3	0.4	0.02	0.08				Eq 3	<0.001	0.6	0.9			
Eq 4	0.3	0.01	0.06	0.9			Eq 4	<0.001	0.3	0.06	0.6		
Eq 5	0.01	<0.001	<0.001	0.1	0.1		Eq 5	<0.001	0.02	0.08	0.08	0.2	
Eq 6	0.1	0.003	0.02	0.5	0.6	0.3	Eq 6	<0.001	0.3	0.7	0.7	0.9	0.2

Note: Accuracy given as percentage of participants whose estimated GFR was within 15% or 30% of measured GFR.

Abbreviations: CI, confidence interval; Eq, equation; GFR, glomerular filtration rate; IDMS, isotope dilution mass spectrometry; MDRD, Modification of Diet in Renal Disease; RMSE, root mean squared error.

als.[19] The present study verifies our previous results, and accuracy of GFR estimation is improved further by means of newly derived equations, the modified IDMS–MDRD Study equation with the new Japanese coefficient (0.808; 95% CI, 0.728 to 0.829; equation 3) and the new 3-variable equation (equation 4). Bias was significantly reduced in equation 3 and 4 from that in equations 1 and 2 in the validation population. We also developed a 5-variable equation (equation 5). The new Japanese equations and the new Japanese coefficient for the IDMS–MDRD Study equation provided more reliable eGFRs in Japanese individuals. The present study had a larger number of participants than the previous study, and all samples were assayed for inulin and creatinine in a central laboratory.

In both the previous[18,19] and present studies, the original IDMS–MDRD Study equation overestimated GFR in comparison to mGFR by using Cin in Japanese patients with CKD (Fig 2). The correction coefficient less than 1.0 indicates lower SCr levels in Japanese than in whites in the MDRD Study for equivalent levels of GFR.

SCr level is affected by 3 major factors: level of kidney function, skeletal muscle mass,[2] and amount of protein intake.[22] In the steady state, creatinine excretion is a measure of creatinine generation from muscle or protein intake. Our data suggest that creatinine excretion was slightly greater than expected per kilogram of body weight, but less than observed in the MDRD Study because of lower body weight. Mean creatinine excretion values were 20.2 and 16.7 mg/kg/d in men and women in our study compared with 19.2 and 15.8 mg/kg/d in the MDRD Study, respectively.[23] Mean body weight was 60 kg in our study compared with 79 kg in the MDRD Study. Mean body mass index (BMI) was 23 kg/m² in the present study and 27 kg/m² in the MDRD Study.[23]

Differences in creatinine excretion, body weight, and BMI between participants in our study and the MDRD Study are consistent with studies that have shown a mean skeletal muscle mass assessed by means of magnetic resonance imaging data significantly less in Japanese (men, 24.8 ± 3.5 kg; women, 14.7 ± 2.3 kg)[24] than in North Americans (men, 33.0 ± 5.3 kg; women,

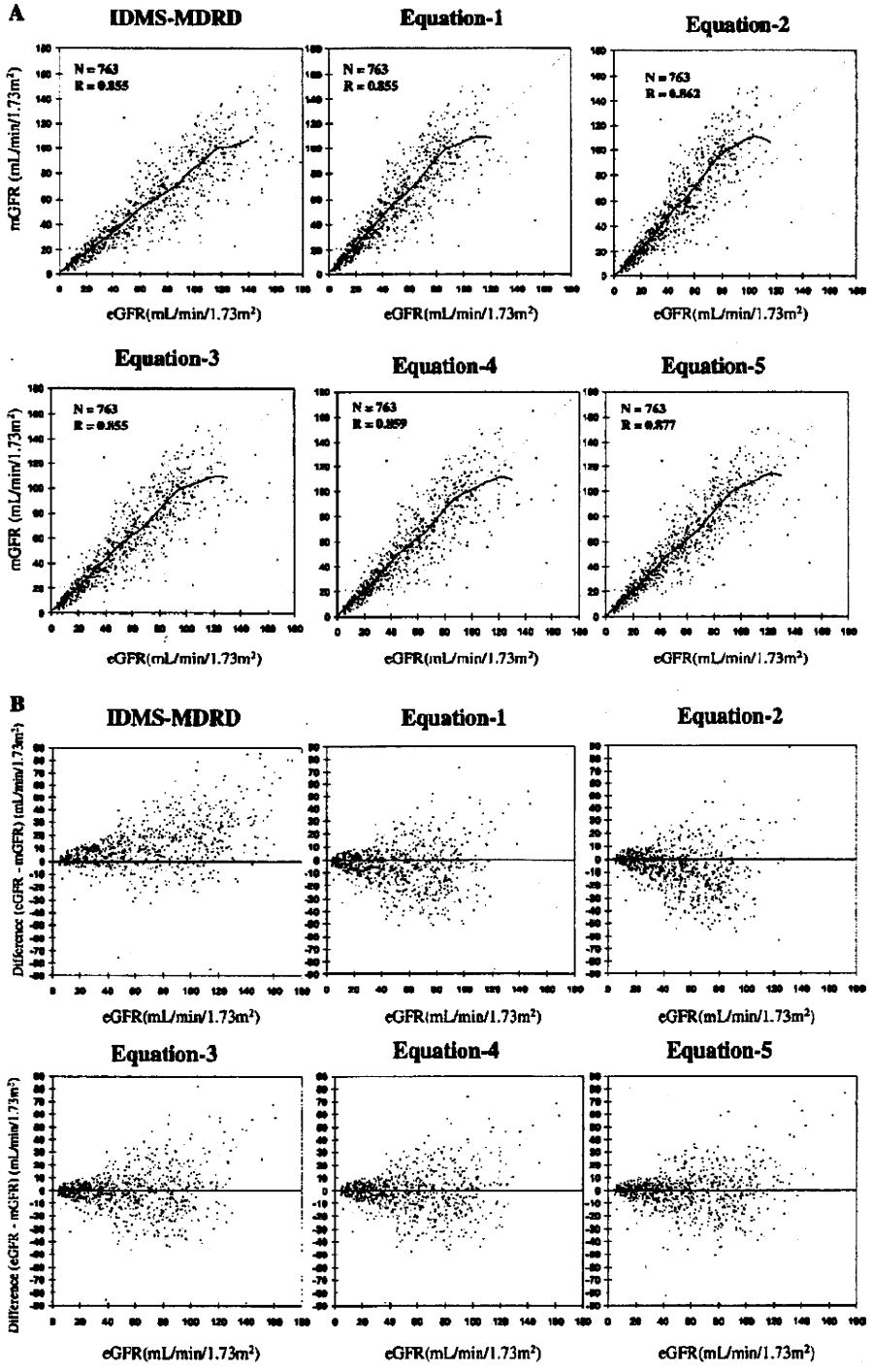

Figure 2. Correlation between estimated glomerular filtration rate (eGFR) using each equation and measured GFR (mGFR) in the combined population. (A) mGFR versus eGFR and (B) eGFR minus mGFR versus eGFR. Smoothed lines show the fit of the data. Abbreviations: IDMS-MDRD, isotope dilution mass spectrometry Modification of Diet in Renal Disease.

21.0 ± 3.8 kg; study population included whites [67%], blacks [17%], Asians [8%], and Hispanics [7%]).[25]

These differences in muscle mass are reflected as differences in SCr levels between Japanese and North American populations. Muscle mass significantly decreases with aging in Japanese men,[24] but does not significantly change in North American men.[25] SCr values were lower and remained constant until age 70 years in Japanese for both men and women,[26] whereas values were greater and increased after age 40 years in whites and blacks[27]: 0.831 mg/dL at age 20 to 39 years, 0.822 mg/dL at age 40 to 59 years, and 0.868 mg/dL at age 60 to 79 years in Japanese men versus 0.865 mg/dL at age 20 to 39 years, 0.883

Table 6. Intercepts and Slopes for GFR-Estimating Equations

Equations	Intercept (95% CI)	Slope (95% CI)	R^2
IDMS–MDRD Study equation	6.1 (3.5 to 8.6)	0.740 (0.708 to 0.771)	0.731
Equation 1	6.1 (3.5 to 8.6)	0.998 (0.955 to 1.041)	0.731
Equation 2	1.8 (−0.9 to 4.5)	1.123 (1.076 to 1.170)	0.743
Equation 3	6.1 (3.5 to 8.6)	0.915 (0.876 to 0.955)	0.731
Equation 4	5.1 (2.5 to 7.7)	0.943 (0.903 to 0.983)	0.738
Equation 5	4.5 (2.1 to 6.9)	0.944 (0.907 to 0.980)	0.770
Equation 6	6.7 (4.1 to 9.3)	0.908 (0.869 to 0.948)	0.730

Abbreviations: CI, confidence interval; GFR, glomerular filtration rate; IDMS, isotope dilution mass spectrometry; MDRD, Modification of Diet in Renal Disease.

mg/dL at age 40 to 59 years, and 0.998 mg/dL at 60 years and older as calibrated to IDMS-traceable creatinine in white men. Mean noncalibrated SCr values in the Third National Health and Nutrition Examination Survey (NHANES III) were 1.14 mg/dL at age 20 to 39 years, 1.16 mg/dL at age 40 to 59 years, and 1.28 mg/dL at 60 years and older[28] in white men (calibrated SCr = [SCr − 0.23] × 0.95).[29,30] After age 50 years, urinary creatinine excretion decreases as body weight decreases in Japanese men. However, in whites body weight is not as good a marker to estimate urinary creatinine excretion as muscle mass. Lean body mass, not body weight, correlates with urinary creatinine excretion and muscle mass in whites.[31]

Differences in muscle mass are parallel to differences in obesity. The obese population (BMI > 25 kg/m^2) increases with age in white Americans: 61% at age 20 to 39 years, 70% at age 40 to 59 years, and 74% at 60 years and older.[32] However, obesity decreases after age 50 years in Japanese men: BMI greater than 25 kg/m^2 is 20% at age 20 to 29 years, 28.9% at age 30 to 39 years, 32.7% at age 40 to 49 years, 30.8% at age 50 to 59 years, 29.7% at age 60 to 69 years, and 26% at 70 years and older (Japanese Ministry of Health, Labor, and Welfare). It was reported that an increase of 5 kg/m^2 in BMI resulted in increase of 1.1% in SCr level.[33] With aging, skeletal muscle mass and protein intake decrease at a greater rate in Japanese than in whites, whereas the prevalence of obesity increases in whites, but not Japanese.

Altogether, these data are consistent with a correction coefficient less than 1.0 for modification of the MDRD Study equation for Japanese. In contrast, the correction coefficient for Chinese is 1.233. Possible explanations for the large difference in correction coefficients between Japanese and Chinese studies may be differences in muscle mass in the study populations, creatinine assays, or GFR measurement methods. Additional study is required to understand the difference in GFR-estimating equations between Chinese and Japanese.

In the present study, no significant systemic bias was observed in SCr values used for the development of new equations by the panel of the Cleveland Clinic Laboratory. SCr values assayed using the enzymatic method were more accurate and had greater precision than other methods.[2] Although 95% of laboratories in Japan have switched to the enzymatic method from the Jaffé method, creatinine values must be standardized for use of the new equations.

Limitations of the present study are as follows. (1) The new Japanese GFR-estimating equations may not be applicable to the healthy population because they were derived mostly from patients with chronic kidney disease. Rule et al[10] also suggested that the MDRD Study equation might systematically underestimate GFR in the normal healthy population. (2) Equations were derived from data for inpatients and outpatients. Some participants were hospitalized for renal biopsy as is customary practice in Japan, although some inpatient participants may have had clinical conditions related to creatinine metabolism.[14] (3) About 15% of patients had diabetes, and GFR was estimated accurately for patients with diabetes with our new equations. However, GFRs calculated by using the MDRD Study equation and CG equations were underestimated in patients with diabetes over the range of eGFR of 90 mL/min/1.73 m^2 or greater.[34] We must further

study the accuracy of eGFR in Japanese patients with diabetes.

In conclusion, according to Cin data, the newly derived creatinine-based GFR-estimating equations accurately estimate GFR for Japanese. Although the 5-variable Japanese equation estimates GFR more accurately than other equations, SUN and albumin are not routinely measured in Japan. Because the new 3-variable Japanese equation provided reasonably accurate eGFRs, we recommend using the new 3-variable Japanese equation for GFR estimation from SCr level and age in clinical practice and for epidemiological study.

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ORIGINAL ARTICLE

Report of the Asian Forum of Chronic Kidney Disease Initiative (AFCKDI) 2007. "Current status and perspective of CKD in Asia": diversity and specificity among Asian countries

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Abstract The Japanese Society of Nephrology (JSN) sponsored the Asian Forum of CKD Initiative (AFCKDI) 2007 with the support of the International Society of Nephrology-Commission for Global Advancement in Nephrology (ISN-COMGAN), Asian Pacific Society of Nephrology (APSN), the Kidney Disease: Improving Global Outcome (KDIGO) and other national societies of nephrology in the Asian Pacific region on 27–28 May 2007 in Hamamatsu City, Japan. An international organising committee was established by leading experts of the CKD initiative. The main objective of this forum was to clarify the current status and perspectives of CKD and to promote coordination, collaboration and integration of initiatives in the Asian Pacific region. The forum received 56 papers

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from 16 countries; it began with the symposium "A Challenge to CKD in the world" and was followed by the ISN-COMGAN affiliated workshop "Current status and perspective of CKD in Asia". The second day was dedicated to discussion on the evaluation, surveillance and intervention in CKD in this area. At the end of the forum, we decided on the future plan as follows: (1) The AFCKDI will provide opportunities annually or biannually for every person who promotes CKD initiatives in the Asian Pacific region to join together and build consensus for action; (2) the second forum will be held in Kuala Lumpur on 4 May 2008 at the time of the 11th Asian Pacific Congress of Nephrology (APCN). Zaki Morad, President of the 11th APCN, will host the second forum; (3) the International Organising Committee (IOC) of the 1st AFCKDI will continue its function by adding other experts, including the organisers of the APCN; (4) the AFCKDI is not an organisation by itself, nor does it belong to any society, but is organised by each host national society of nephrology. The IOC will assist the domestic committee for the success of the forum and will assure the continuation of the mission; (5) in order to organise the forum and promote CKD initiatives in the Asia Pacific region, the AFCKDI will look for support by both national and international societies. The AFCKDI will keep an intimate and mutual relation with the ISN, APSN and KDIGO.

Keywords Chronic kidney disease · AFCKDI · Asia · APSN · KDIGO · ISN COMGAN · Japan

Introduction

Nearly 50% of the global population lives in the Asian Pacific region, including the world's two large and most populous countries, China and India, which together account for over 35%, and are the two countries with the highest incidence and prevalence of chronic kidney disease (CKD) dialysis patients (CKD 5-D). Recognising the need for a coordinated regional approach, the Japanese Society of Nephrology, as part of its 50th anniversary celebrations, established the Asian Forum on Chronic Kidney Disease Initiative (AFCKDI) in 2007. Aided by the International Society of Nephrology (ISN), Kidney Disease: Improving Global Outcomes (KDIGO), the Asian Pacific Society of Nephrology, the Australian and New Zealand Society of Nephrology and the Malaysian Society of Nephrology, two regional meetings have now been held: in Hamamatsu, Japan, in 2007 and in Kuala Lumpur, Malaysia, in 2008. The tasks facing AFCKDI are formidable, with enormous economic, cultural and geographic differences characterising the region. However, regional and international interest and support have been overwhelming. At very short notice, in Hamamatsu 16 countries submitted 56 abstracts, from which many were chosen to supplement the invited speakers, allowing representation of a very wide range of nations.

In Hamamatsu the agreed aims were to clarify the current state of CKD in the Asian Pacific region and to promote coordination, collaboration and integration of initiatives to combat this disease burden. As host chair, Dr. Seichi Matsuo introduced the three main topics for discussion: (1) CKD screening and early detection, (2) clinical practice guidelines (CPGs) and their implementation, and (3) education, implementation and international and regional cooperation and support.

Screening for CKD

Japan (S. Matsuo)

Statutory urinalysis has been carried out on industrial workers since 1972, school children since 1973 and persons aged over 40 years since 1982 [1]. Despite this, Japan unfortunately still ranks among the highest in the world for CKD-5D prevalence and incidence, with particularly a rising incidence of diabetic patients [2]. Clearly screening alone has made little impact, hence the Japanese Association of CKD has now been established and government funded to pursue a strategic research project aimed at prevention of CKD, or reducing CKD-5D.

Hong Kong (P. KT. Li)

In 2004 the ISN held a Consensus Workshop on Prevention of Progression of Renal Disease in Hong Kong [3]. The consensus was that screening for CKD was worthwhile in diabetic and hypertensive patients and in the relatives of patients with CKD due to diabetes, hypertension and glomerulonephritis, and that CKD was more common in individuals over 60–65. This consensus meeting published recommendations for prevention of progression once CKD was detected [4].

Clinical practice guidelines and international collaboration

KDIGO (N. Lameire)

A non-profit foundation governed by an international board of directors (six currently from our region), KDIGO aims to improve global CKD care by promoting, integrating and