Tables for estimating glomerular filtration rate from plasma creatinine

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SUMMARY

Chronic kidney disease (CKD) and its related complications have become an important health and social problem. Very expensive resources are required in end-stage renal disease, and both complications of CKD as well as the important associated cardiovascular risk demand for interventions long before renal substitution therapies are needed. Thus, early diagnosis of CKD is currently considered of paramount importance, and it is based essentially upon the estimation of the glomerular filtration rate by formulae such as the abbreviated equation of the MDRD study. Nevertheless, in spite of international published recommendations, an automatic calculation to estimate the glomerular filtration rate (GFR) from serum creatinine is not reported by most laboratories yet and the need for creatinine assay standardisation is far from being implemented. Thus, we have designed some tables to show the creatinine value corresponding to different GFR for ages between 20 and 90 y/o, at 5 years intervals and in both sexes with both the MDRD-4 and MDRD-IDMS equations (Modification of Diet in Renal Disease-Isotope Dilution Mass Spectrometry). Moreover, we have created a global table including an estimation of GFR from plasma creatinine, age and sex by the MDRD-IDMS formula, the recommended for those laboratories which measure serum creatinine with assays aligned to the reference method. These tables aim to increase the awareness of the different assays for serum creatinine and to facilitate the diagnosis of CKD converting serum creatinine into GFR. This action should allow not only the early detection but also the possibility to establish the appropriate medical actions recommended after CKD detection.

Key words: *Glomerular filtration rate. Creatinine. Tables. Chronic kidney disease. MDRD-4. MDRD-IDMS.*

RESUMEN

La enfermedad renal crónica (ERC) y las complicaciones que de ella se derivan se ha convertido en un importante problema social y sanitario, tanto por los recursos que se requieren en los estadios finales de la enfermedad como por las complicaciones secundarias a la propia ERC y a su elevado riesgo cardiovascular asociado. Hoy se considera de gran valor el diagnóstico precoz, basándose la definición y la clasificación actuales fundamentalmente en la estimación del filtrado glomerular (FG) por medio de fórmulas como la ecuación abreviada del estudio MDRD. No obstante, a pesar de las recomendaciones internacionales, no en todos los laboratorios es posible el cálculo automático del FG a partir de la creatinina plasmática ni se ha enfatizado la necesidad de estandarización de los métodos de medición de la misma. Es por ello que hemos diseñado unas tablas en las que se ha calculado el valor de creatinina correspondiente a los diferentes FG con significación clínica para cada una de las edades comprendidas entre 20 y 90 años y a intervalos de 5 años en ambos sexos con las fórmulas MDRD-4 y MDRD-IDMS (Modification of Diet in Renal Disease-Isotope Dilution Mass Spectrometry). Además hemos creado una tabla que integra de forma global una estimación del FG a partir de la creatinina plasmática por el método MDRD-IDMS que es el recomendado para aquellos laboratorios que utilizan un método de medición de la creatinina con trazabilidad respecto al método de referencia de espectrometría de masas por dilución isotópica. Estas tablas pretenden, no sólo incrementar la conciencia de la existencia de distintos ensayos en la medida de la creatinina sérica que influyen sobre la estimación del FG, sino también el facilitar el diagnóstico de la ERC a partir de la conversión de la creatinina plasmática en FG, para permitir así el diagnóstico precoz y el establecimiento de las acciones precisas que se recomiendan tras su detección.

Palabras clave: Filtrado glomerular. Creatinina. Tablas. Enfermedad renal crónica. MDRD-4. MDRD-IDMS.

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INTRODUCTION

Chronic kidney disease (CKD) is currently recognised as a leading health problem worldwide, not only because of the need for significant healthcare resources in patients reaching

end-stage CKD, requiring dialysis and transplant, but also because of the significant burden of cardiovascular disease, hospitalisation, and early death inherent to CKD diagnosis.[1]

There is increasing evidence that these adverse events may be prevented or, at least, delayed.[2] In 2002, the US National Kidney Foundation (NKF) Kidney Disease Outcome Quality Initiative (K/DOQI) published clinical guidelines to define and to classify CKD in different stages.[3] In 2005, another initiative, Kidney Disease: Improving Global Outcomes (KDIGO), international in character, accepted with minor clarifications the definition and classification initially proposed by the K/DOQI.[4]

There is currently general agreement in that CKD classification is based on the *estimated* glomerular filtration rate (GFR) as the parameter to measure kidney function, particularly at low GFR ranges. For GFR values > 60 mL/min/1.73 m^2, other renal «damage» markers (albuminuria, haematuria, changes in imaging tests, etc…) are required due to the imprecision of GFR estimation in higher values, amongst other reasons.[3,4] Despite the existence of some limitations, the abbreviated equation from the MDRD study (Modification of Diet in Renal Disease)[5] has been validated in multiple studies and conditions, and is now the formula to estimate GFR in adults most commonly recommended[4] not only by many nephrological societies,[3,6] but also in other clinical guidelines, such as those from the Joint National Committee 7 (JNC7)[7], the American Heart Association, and others.[8,9] We recently published, on behalf of a work group of the Spanish Society of Nephrology (SEN) and the Spanish Society of Clinical Chemistry (SEQC), a consensus document on «Recommendations about use of equations for estimating the glomerular filtration rate in adults» in which automatic calculation of GFR using the MDRD-4 formula is advised whenever plasma creatinine levels are requested.[6] On the other hand, for laboratories using a creatinine measuring procedure traceable to the reference method (isotopic dilution mass spectrophotometry), use of the MDRD-IDMS variant is recommended, as advised by the National Kidney Disease Education Program.[10]

However, these recommendations have not bee still implemented by all laboratories, and international recommendations have not been followed yet in many countries. There is thus a need for tools that allow for rapid translation of serum creatinine into an estimated GFR at different ages and for both sexes. We therefore calculated and designed numerical tables with different clinically significant cut-off points, as well as a table globally integrating an estimation of GFR from plasma creatinine levels, age and sex using the MDRD-IDMS method, emphasising the need for standardisation of plasma creatinine measurement at the different laboratories.

METHODS

Results shown in the tables were obtained using a spreadsheet prepared with Excel software (Microsoft, USA). The creatinine value corresponding to the different GFRs at each of the 5-year intervals between 20 and 90 years of age was calculated for both sexes by first finding serum creatinine raised to its exponent in each formula (MDRD-4/ MDRD- IDMS) (table I). Then, by fixing the GFR value, the spreadsheet is used to obtain the value of creatinine raised to its exponent for each of the ages of interest. By a linear estimation consisting of the practice of 100 iterations by the Newton method, with a precision of 0.000001, the serum creatinine value is finally obtained. Because of the characteristics of the average population in our country, the correction factor for the black race was obviated.

Data in table V were obtained by applying the MDRD-IDMS formula to each of the creatinine values and ages.

RESULTS

Table II shows the serum creatinine value corresponding to an estimated GFR of 60 mL/min/1.73 m^2 according to the MDRD-4 and IDMS formulas. The MDRD-IDMS formula should be used when creatinine was measured using a method with spectrophotometric traceability, as previously mentioned.[10] This GFR maintained for ≥ 3 months normally defines the presence of CKD without the need for kidney damage markers (stage 3).[3,4]

Table III shows the serum creatinine value corresponding to an estimated GFR of 30 mL/min/1.73 m^2 according to the MDRD-4 and IDMS formulas. This GFR maintained for ≥ 3 months normally defines the presence of stage 4 CKD without the need for kidney damage markers.[3,4] This stage is generally considered *per se,* among others, a criterion for referral to specialised care, although some divide stage 3 into two substages (3A and 3B) partially for this purpose.[11]

Table IV shows the serum creatinine value corresponding to an estimated GFR of 15 mL/min/1.73 m^2 according to the MDRD-4 and IDMS formulas. This GFR maintained for ≥ 3 months normally defines the presence of stage 5 CKD without the need for kidney damage markers.[3,4] This stage not only represents a criterion for mandatory (though late) referral to specialised care, but may in itself be an indication for early entry in a dialysis programme in some patients (i.e. CKD in diabetic patients, refractory heart failure, etc.).[12-14]

Table V shows the integrated estimation of GFR by plasma creatinine values, age and sex, using mean creatinine values and age for each interval and the MDRD-IDMS formula, stratified into the different CKD stages.

Table I. Equation for estimation of glomerular filtration rate (International System of Units)

MDRD - 4

Estimated GFR (mL/min/1.73 m^2) = 186 x (creatinine/88.4)$^{-1.154}$ x (age)$^{-0.203}$ x (0.742 if female) x (1.210 if black)

MDRD - IDMS

Estimated GFR (mL/min/1.73 m^2) = 175 x (creatinine/88.4)$^{-1.154}$ x (age)$^{-0.203}$ x (0.742 if female) x (1.210 if black)

Abbreviations and units: MDRD: Modification of Diet in Renal Disease. IDMS: Isotopic dilution mass spectrometry. Age (years). Creatinine: serum creatinine levels (µmol/L). If mg/dL is used as unit, division by the correction factor, 88.4, is not required.

Table II. Serum creatinine corresponding to a GFR of 60 mL/min/1.73 m² (stage 3 CKD) according to the MDRD-IDMS and MDRD-4 formulas

	Glomerular filtration rate (MDRD-IDMS) (60 mL/min/1.73 m²)				Glomerular filtration rate (MDRD-4) (60 mL/min/1.73 m²)			
	Female		Male		Female		Male	
Age	mg/dL	µmol/L	mg/dL	µmol/L	mg/dL	µmol/L	mg/dL	µmol/L
20	1.15	102	1.49	132	1.22	107	1.57	139
25	1.11	98	1.44	127	1.17	103	1.51	134
30	1.07	95	1.39	123	1.13	100	1.47	130
35	1.04	92	1.35	120	1.10	97	1.43	126
40	1.02	90	1.32	117	1.08	95	1.39	123
45	1.00	88	1.29	114	1.05	93	1.36	121
50	0.98	87	1.27	112	1.03	91	1.34	118
55	0.96	85	1.25	110	1.02	90	1.32	116
60	0.95	84	1.23	109	1.00	89	1.30	115
65	0.94	83	1.21	107	0.99	87	1.28	113
70	0.92	82	1.20	106	0.97	86	1.26	112
75	0.91	81	1.18	105	0.96	85	1.25	110
80	0.90	80	1.17	103	0.95	84	1.23	109
85	0.89	79	1.16	102	0.94	83	1.22	108
90	0.88	78	1.15	101	0.93	82	1.21	107

Table III. Serum creatinine corresponding to a GFR of 30 mL/min/1.73 m² (stage 4 CKD) according to the MDRD-IDMS and MDRD-4 formulas

	Glomerular filtration rate (MDRD-IDMS) (30 mL/min/1.73 m²)				Glomerular filtration rate (MDRD-4) (30 mL/min/1.73 m²)			
	Female		Male		Female		Male	
Age	mg/dL	µmol/L	mg/dL	µmol/L	mg/dL	µmol/L	mg/dL	µmol/L
20	2.10	186	2.72	241	2.22	196	2.86	253
25	2.02	179	2.61	231	2.13	188	2.75	243
30	1.96	173	2.54	224	2.06	182	2.67	236
35	1.91	168	2.47	218	2.01	177	2.59	229
40	1.86	165	2.41	213	1.96	173	2.53	224
45	1.82	161	2.36	209	1.92	170	2.48	219
50	1.79	158	2.32	205	1.89	167	2.44	215
55	1.76	155	2.28	202	1.85	164	2.40	212
60	1.73	153	2.25	198	1.83	161	2.36	209
65	1.71	151	2.21	195	1.80	159	2.33	206
70	1.69	149	2.19	193	1.78	157	2.30	203
75	1.67	147	2.16	191	1.76	155	2.27	201
80	1.65	146	2.13	189	1.74	153	2.25	199
85	1.63	144	2.11	187	1.72	152	2.22	197
90	1.61	143	2.09	185	1.70	150	2.20	195

Table IV. Serum creatinine corresponding to a GFR of 15 mL/min/1.73 m² (stage 5 CKD) according to the MDRD-IDMS and MDRD-4 formulas

	Glomerular filtration rate (MDRD-IDMS) (15 mL/min/1.73 m²)				Glomerular filtration rate (MDRD-4) (15 mL/min/1.73 m²)			
	Female		Male		Female		Male	
Age	mg/dL	µmol/L	mg/dL	µmol/L	mg/dL	µmol/L	mg/dL	µmol/L
20	3.83	339	4.96	439	4.03	356	5.22	461
25	3.69	326	4.78	422	3.88	343	5.02	444
30	3.57	315	4.62	409	3.75	332	4.86	430
35	3.47	307	4.49	397	3.65	323	4.73	418
40	3.39	300	4.39	388	3.57	315	4.62	408
45	3.32	294	4.31	381	3.49	309	4.53	400
50	3.26	288	4.22	373	3.43	303	4.44	393
55	3.22	284	4.16	368	3.37	298	4.37	386
60	3.16	279	4.09	362	3.32	294	4.30	380
65	3.11	275	4.05	358	3.28	290	4.24	375
70	3.07	272	3.98	352	3.23	286	4.19	370
75	3.04	269	3.94	348	3.19	282	4.14	366
80	3.00	265	3.89	344	3.16	279	4.09	362
85	2.97	263	3.85	340	3.12	276	4.05	358
90	2.94	260	3.81	337	3.09	273	4.01	354

DISCUSSION

Current recommendations by different national and international societies to estimate GFR using formulas have not still been automatically implemented by some laboratories, and such initiative has not been taken in many countries because of a lack of leadership or willingness. As a result, there is a need for tools permitting rapid translation of serum creatinine into an estimated GFR for the different ages and weights, thus adapting clinical practice to current guidelines. Plasma creatinine levels have been used as a measure of kidney function because they are simply tested, but are affected by many other parameters that go beyond the GFR itself. Hence, a same plasma creatinine value does not reflect the same grade of kidney function in all patients. Thus, the tables shown allow for converting a parameter as little sensitive and precise as plasma creatinine into an estimated GFR that, being inaccurate, is currently considered to be the most practical parameter for assessing kidney function without requiring 24-hour urine collection with their attendant inaccuracies.[15,16] In addition, early detection of CKD also allows for detection of the associated complications (anaemia, secondary hyperparathyroidism, etc.),[17] modification of treatments or therapeutic objectives[18,19] (e.g. blood pressure values, start of angiotensin converting inhibitors or angiotensin II receptor blockers, plasma cholesterol or LDL goals, among others) for preventing progression and the associated cardiovascular complications,[20] or awareness that once CKD is detected, nephrotoxics or dangerous drugs in this setting should be avoided (i.e. potassium sparing agents).

The tables provided therefore not only allow for seeing that methodological differences exist in creatinine measurement with use of both formulas, but also very visually show (e.g. Table II) that plasma creatinine values as low as 0.88 to 1.15 mg/dL (78 to 102 µmol/L) may correspond to a diagnosis of CKD in women at various ages. On the other hand, at the other side of the spectrum, plasma creatinine levels of 3 mg/dL (270 µmol/L) could indicate a GFR of 15 mL/min/1.73 m² in a 70-year old woman, suggesting the nephrogenic origin of a potential associated anaemia, or the need to start dialysis in a diabetic patient.

While any formula (i.e. the Cockcroft-Gault formula) is probably better than serum creatinine, the formulas derived from the MDRD study are the ones currently recommended by most clinical guidelines and societies.[3,4,11,21-23] However, if they are not automatically reported by the clinical laboratories, they cannot be calculated without use of programmed computers. This is one of the reasons why the Cockcroft and Gault formula[24] continues to be the most widely used in clinical practice because of its simplicity. However, it is well known that this formula is highly imprecise, particularly as the GFR decreases, and only reports creatinine clearance (mL/min), not GFR (mL/min/1.73 m²). While this latter aspect is controversial,[25,26] the European Best Practice Guidelines (EBPG), for instance, do not consider the Cockcroft-Gault equation as an adequate method for

Table Va. Estimation of glomerular filtration rate as a function of plasma creatinine (μmol/L) and age using the MDRD-IDMS formula

Plasma creatinine (μmol/L)	Male								Female							
	Age (years)								Age (years)							
	20-29	30-39	40-49	50-59	60-69	70-79	80-89	> 89	20-29	20-30	20-31	50-59	60-69	70-79	80-89	> 89
60-69	130	121	115	111	107	104	101	99	96	90	85	82	79	77	75	73
70-79	110	103	98	94	91	88	86	84	82	76	72	70	67	65	64	62
80-89	95	89	85	81	78	76	74	73	71	66	63	60	58	57	55	54
90-99	84	78	74	71	69	67	65	64	62	58	55	53	51	50	48	47
100-109	75	70	66	64	61	60	58	57	55	52	49	47	46	44	43	42
110-119	67	63	60	57	55	54	52	51	50	47	44	42	41	40	39	38
120-129	61	57	54	52	50	49	48	47	45	42	40	39	37	36	35	35
130-139	56	52	50	48	46	45	44	43	41	39	37	35	34	33	32	32
140-149	51	48	46	44	42	41	40	39	38	36	34	33	31	31	30	29
150-159	48	44	42	41	39	38	37	36	35	33	31	30	29	28	28	27
160-169	44	41	39	38	36	35	35	34	33	31	29	28	27	26	26	25
170-179	41	39	37	35	34	33	32	32	31	29	27	26	25	25	24	23
180-189	39	36	34	33	32	31	30	30	29	27	26	25	24	23	22	22
190-199	37	34	32	31	30	29	29	28	27	25	24	23	22	22	21	21
200-209	34	32	31	29	28	28	27	26	26	24	23	22	21	20	20	20
210-219	33	30	29	28	27	26	25	25	24	23	21	21	20	19	19	18
220-229	31	29	27	26	26	25	24	24	23	21	20	20	19	18	18	18
230-239	29	28	26	25	24	24	23	22	22	20	19	19	18	17	17	17
240-249	28	26	25	24	23	22	22	21	21	19	18	18	17	17	16	16
250-259	27	25	24	23	22	21	21	20	20	19	18	17	16	16	16	15
260-269	26	24	23	22	21	21	20	20	19	18	17	16	16	15	15	15
270-279	25	23	22	21	20	20	19	19	18	17	16	16	15	15	14	14
280-289	24	22	21	20	19	19	18	18	17	16	16	15	14	14	14	13
290-299	23	21	20	19	19	18	18	17	17	16	15	14	14	13	13	13
300-309	22	20	19	19	18	17	17	17	16	15	14	14	13	13	13	12
310-319	21	20	19	18	17	17	16	16	16	15	14	13	13	12	12	12
320-329	20	19	18	17	17	16	16	15	15	14	13	13	12	12	12	11
330-339	20	18	17	17	16	16	15	15	15	14	13	12	12	12	11	11
340-349	19	18	17	16	16	15	15	14	14	13	12	12	12	11	11	11
350-359	18	17	16	16	15	15	14	14	14	13	12	12	11	11	11	10
360-369	18	17	16	15	15	14	14	14	13	12	12	11	11	11	10	10
370-379	17	16	15	15	14	14	13	13	13	12	11	11	11	10	10	10
380-389	17	16	15	14	14	13	13	13	12	12	11	11	10	10	10	9
390-399	16	15	14	14	13	13	13	12	12	11	11	10	10	10	9	9
400-409	16	15	14	13	13	13	12	12	12	11	10	10	10	9	9	9
410-419	15	14	14	13	13	12	12	12	11	11	10	10	9	9	9	9
420-429	15	14	13	13	12	12	12	11	11	10	10	9	9	9	9	8
430-439	14	14	13	12	12	12	11	11	11	10	10	9	9	9	8	8
440-449	14	13	13	12	12	11	11	11	10	10	9	9	9	8	8	8
450-459	14	13	12	12	11	11	11	10	10	10	9	9	8	8	8	8
460-469	13	13	12	11	11	11	10	10	10	9	9	8	8	8	8	8
470-479	13	12	12	11	11	10	10	10	10	9	9	8	8	8	8	7
480-489	13	12	11	11	11	10	10	10	9	9	8	8	8	8	7	7
490-499	12	12	11	11	10	10	10	10	9	9	8	8	8	7	7	7
500-509	12	11	11	10	10	10	10	9	9	8	8	8	7	7	7	7

deciding entry of a patient into a dialysis programme.[12] In fact, many studies comparing both equations in different population groups have been published in recent years. Results reported by the different studies have varied, depending not only on the characteristics of the populations analysed and their mean GFRs, but especially on the gold standard used to assess GFR, and particularly on the creatinine measurement method, which makes comparison of the results obtained difficult.[6] Moreover, the Cockcroft-Gault equation has not been re-expressed for use with standardised creatinine tests, and is therefore likely to routinely overestimate the actual GFR and be even less useful in the future.[27]

Our comprehensive review of international guidelines found that only the CARI guidelines (Caring for Australasians with Renal Impairment) recommend use of the Cockcroft-Gault formula for calculating kidney function in patients with CKD. The Australian organisation published similar tables based in this other formula.[28] On the other hand, the British Columbia Health Service recently published tables based on the MDRD-4 equation only where the age range for which the GFR for each creatinine value is analysed is wider, and which are therefore less precise.[29] In this study, however, Table V overall shows the GFRs as a function of serum creatinine and age, using mean creatinine values and age for each of the intervals according to the

Table Vb. Estimation of glomerular filtration rate as a function of plasma creatinine (mg/dL) and age using the MDRD-IDMS formula

Plasma creatinine (mg/dL)	Male								Female							
	Age (years)								Age (years)							
	20-29	30-39	40-49	50-59	60-69	70-79	80-89	> 89	20-29	30-39	40-49	50-59	60-69	70-79	80-89	> 89
0,7	137	128	122	117	113	110	107	105	102	95	90	87	84	82	80	78
0,8	118	110	105	100	97	94	92	90	87	82	78	74	72	70	68	67
0,9	103	96	91	88	85	82	80	78	76	71	68	65	63	61	60	58
1	91	85	81	78	75	73	71	69	68	63	60	58	56	54	53	52
1,1	82	76	72	69	67	65	64	62	61	57	54	52	50	48	47	46
1,2	74	69	65	63	61	59	58	56	55	51	49	47	45	44	43	42
1,3	67	63	60	57	55	54	52	51	50	47	44	43	41	40	39	38
1,4	62	58	55	53	51	49	48	47	46	43	41	39	38	37	36	35
1,5	57	53	51	49	47	46	44	43	42	40	38	36	35	34	33	32
1,6	53	49	47	45	44	42	41	40	39	37	35	33	32	31	31	30
1,7	49	46	44	42	41	39	38	38	37	34	33	31	30	29	29	28
1,8	46	43	41	39	38	37	36	35	34	32	30	29	28	27	27	26
1,9	43	41	39	37	36	35	34	33	32	30	29	27	27	26	25	25
2	41	38	36	35	34	33	32	31	30	28	27	26	25	24	24	23
2,1	39	36	34	33	32	31	30	29	29	27	25	24	24	23	22	22
2,2	37	34	33	31	30	29	29	28	27	25	24	23	22	22	21	21
2,3	35	33	31	30	29	28	27	27	26	24	23	22	21	21	20	20
2,4	33	31	29	28	27	27	26	25	25	23	22	21	20	20	19	19
2,5	32	30	28	27	26	25	25	24	23	22	21	20	19	19	18	18
2,6	30	28	27	26	25	24	24	23	22	21	20	19	18	18	17	17
2,7	29	27	26	25	24	23	23	22	21	20	19	18	18	17	17	16
2,8	28	26	25	24	23	22	22	21	21	19	18	18	17	16	16	16
2,9	27	25	24	23	22	21	21	20	20	18	18	17	16	16	15	15
3	26	24	23	22	21	21	20	20	19	18	17	16	16	15	15	14
3,1	25	23	22	21	20	20	19	19	18	17	16	16	15	15	14	14
3,2	24	22	21	20	20	19	19	18	18	16	16	15	15	14	14	13
3,3	23	21	20	20	19	18	18	18	17	16	15	15	14	14	13	13
3,4	22	21	20	19	18	18	17	17	16	15	15	14	14	13	13	13
3,5	21	20	19	18	18	17	17	16	16	15	14	14	13	13	12	12
3,6	21	19	18	18	17	17	16	16	15	14	14	13	13	12	12	12
3,7	20	19	18	17	17	16	16	15	15	14	13	13	12	12	12	11
3,8	20	18	17	17	16	16	15	15	14	14	13	12	12	12	11	11
3,9	19	18	17	16	16	15	15	14	14	13	12	12	12	11	11	11
4	18	17	16	16	15	15	14	14	14	13	12	12	11	11	11	10
4,1	18	17	16	15	15	14	14	14	13	12	12	11	11	11	10	10
4,2	17	16	15	15	14	14	14	13	13	12	11	11	11	10	10	10
4,3	17	16	15	14	14	14	13	13	13	12	11	11	10	10	10	10
4,4	16	15	15	14	14	13	13	13	12	11	11	10	10	10	10	9
4,5	16	15	14	14	13	13	13	12	12	11	11	10	10	10	9	9
4,6	16	15	14	13	13	13	12	12	12	11	10	10	10	9	9	9
4,7	15	14	14	13	13	12	12	12	11	11	10	10	9	9	9	9
4,8	15	14	13	13	12	12	12	11	11	10	10	9	9	9	9	8
4,9	15	14	13	12	12	12	11	11	11	10	10	9	9	9	8	8
5	14	13	13	12	12	11	11	11	11	10	9	9	9	8	8	8
5,1	14	13	12	12	11	11	11	11	10	10	9	9	8	8	8	8
5,2	14	13	12	12	11	11	11	10	10	9	9	9	8	8	8	8
5,3	13	12	12	11	11	11	10	10	10	9	9	8	8	8	8	8
5,4	13	12	12	11	11	10	10	10	10	9	9	8	8	8	8	7
5,5	13	12	11	11	10	10	10	10	9	9	8	8	8	8	7	7
5,6	12	12	11	11	10	10	10	10	9	9	8	8	8	7	7	7
5,7	12	11	11	10	10	10	10	9	9	8	8	8	7	7	7	7

Stage 1 ≥ = 90 mL/min/1.73 m² with kidney damage markers (albuminuria, haematuria, changes in imaging tests).

Stage 2 = 60-89 mL/min/1.73 m² with kidney damage markers (albuminuria, haematuria, changes in imaging tests).

Stage 3A = 45-59 mL/min/1.73 m².

Stage 3B = 30-44 mL/min/1.73 m².

Stage 4= 16-29 mL/min/1.73 m².

Stage 5 = < 15 mL/mi/1.73 m².

MDRD-IDMS formula. It should be noted that the main limitation for use of estimating equations stems from the lack of standardisation of methods to measure serum creatinine and their different degrees of inaccuracy, imprecision, and susceptibility to interference. Use of calibration materials with traceability to the accepted reference method

(isotopic dilution mass spectrophotometry or IDMS) is therefore currently recommended.[6,10] This is why this study provides tables corrected by the MDRD-IDMS formula and integrates GFRs in a single table in accordance with these recommendations, thus calling clinician attention to this significant aspect of methodology. In fact, diagnostic laboratories are revising their tests to be in line with this method, that also appears to have a greater precision in different ranges.[21,30]

To summarise, while the procedure currently recommended for estimating GFR would be automatic calculation using the MDRD-IDMS formula, with adequate creatinine measurement by a method with traceabililty, the availability of tables with the MDRD-4 and MDRD-IDMS formulas allows clinicians for visualisation and conversion of plasma creatinine, not only to detect the presence of CKD with creatinine values even in the normal range, but also to rapidly and simply transform plasma creatinine into a more clinically significant parameter such as GFR.

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