IEQAS annual Participants' Conference

Creatinine Assays: fit for purpose?

subtitled: Yet more "Sausages"

Successfully Adopting UK NEQAS
Slope Adjusted GFR Estimate Systems

An update on the UK NEQAS angle on the Measurement of Creatinine

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UK NEQAS

Update

This is an update, so I will try to lead you to where we are now, based on where we came from. Hopefully no one will get lost on the journey, although I will pass through the history quite quickly

I will try and lead things, but I would like to think that we could come up with ideas that would have helped the eGFR initiative or which could help future initiatives.

The eGFR initiative has caused much debate. I have no particular axe to grind. My own opinion, for what it is worth, is that eGFR is 'better' than using creatinine alone and better than using creatinine clearances. There may be better estimates possible, for example using Cystatin C.

eGFR has put creatinine measurement on the Radar screen and for that I am grateful. I am unashamedly using this as a way of getting better creatinine methods. This may, or may mot be, enzymatic systems.

The data is not clear-cut and there are many people (rightly?) highlighting deficiencies in eGFR *per se*, as well the way it is currently being calculated.

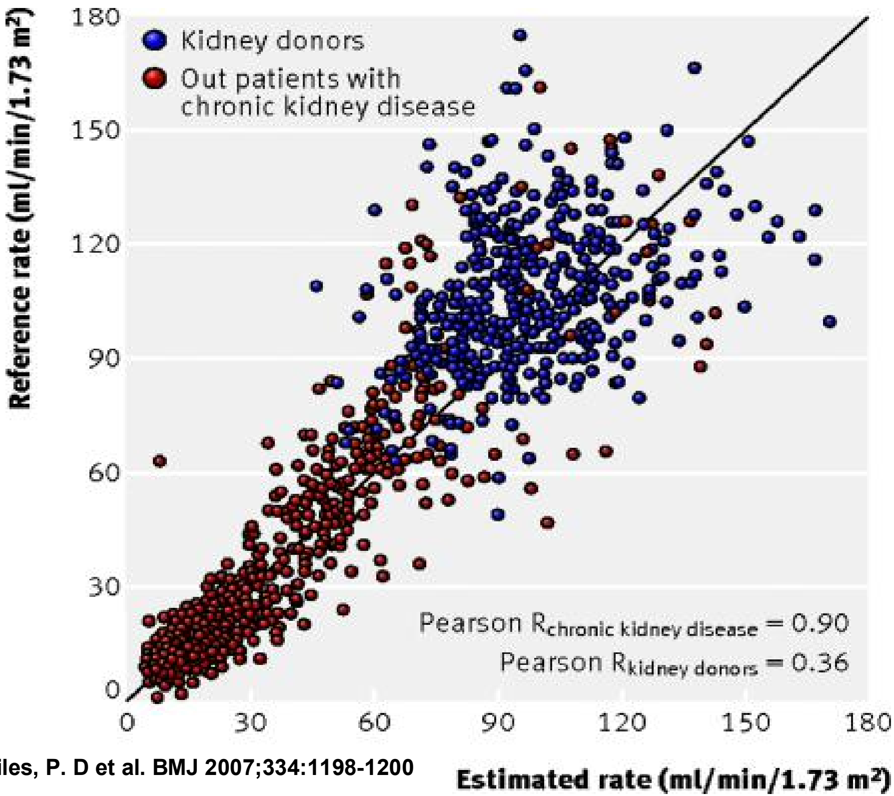


Fig 1 Association of estimated glomerular filtration rate (GFR) with GFR measured by an isotopic reference method. Below 60 ml/min/1.73 m2 the two methods are tightly associated, with limited scatter of the points. At higher filtration rates scatter becomes progressively worse, and in kidney donors estimated GFR underestimates renal function compared with reference measurements. Adapted from Poggio et al10

Giles, P. D et al. BMJ 2007;334:1198-1200

The data is not clear-cut and there are many people (rightly?) highlighting deficiencies in eGFR *per se*, as well the way it is currently being calculated.

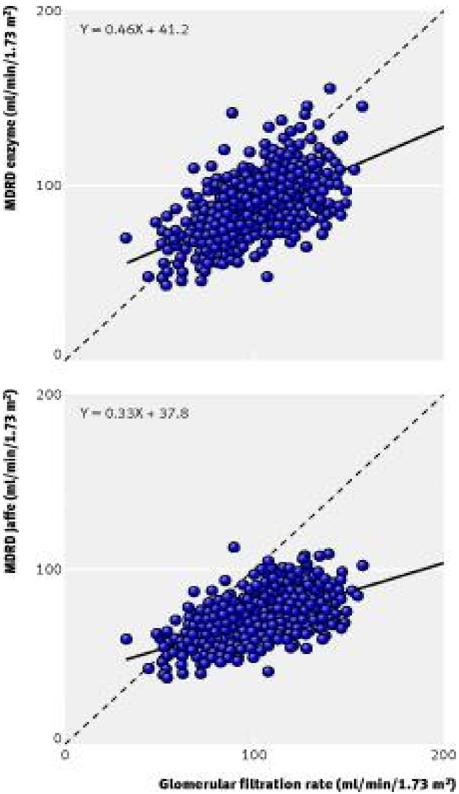


Fig 2 Scatter plot of estimated glomerular filtration rate (GFR) against isotopic reference GFR in subjects with normal serum creatinine using two different creatinine assays (enzymatic and Jaffe methods). Formula calculations underestimate GFR for both assays. The negative bias is less with the enzymatic assay, but the scatter of results is wide with both methods. Adapted from Verhave et al14

Giles, P. D et al. BMJ 2007;334:1198-1200

Finlay's recent Workshop at Focus 2007 Manchester

This workshop is intended to look at the practical consequences of trying to underpin clinical findings using the results of a poorly performed test, namely creatinine, in the area of estimating glomerular filtration rates. Laboratory medicine as a whole has singularly failed to address, or if being charitable, 'resolve', the shortcomings of specificity and calibration in this assay over the last 20 years. Though not actively excluding delegates over the age of 35, for whom this is perhaps already a lost cause, I am intending to present this to an audience which might just take issues like this a bit more seriously in the future.

The measurement of creatinine may not be as glamorous as looking at subtleties of DNA expression, genetic mutations and the like. However, until these tests are analysed in their thousands every day by hundreds of labs across the length and breadth of the UK, then there is still relevance for tired old analytes, such as creatinine, which are.

This workshop addresses the dilemma of underpinning never-to-be-repeated rafts of clinical evidence with results from a method giving potentially the 'wrong' results, when there were better methods available which could have given the 'right' answer.

Acknowledgements

Finlay MacKenzie (on behalf of UK NEQAS Birmingham) is part of the Department of Health's eGFR Advisory Group, which also includes Dr Ian Barnes [chair] , Dr Bill Bartlett, Dr Ed Lamb, Dr Paul Stevens and, from the DoH's Modernising Pathology Team, Deirdre Feehan and Monica Acheampong

This group's remit was more than just the measurement of creatinine

The Pilot initiative was supported by monies from UK NEQAS Birmingham, the DoH (England) and Clinical Pathology Accreditation (CPA).
The Scheme is now fully self-funding

Finlay MacKenzie (on behalf of UK NEQAS Birmingham) also worked with Dr Mark MacGregor's Scottish Creatinine Group

(as everyone knows Scottish creatinine is different and far superior to the Sassenach creatinine found south of the border where the turn-coats, like me, live. Is Welsh creatinine different, still? What about Irish Creatinine? Is it more green?)

In the beginning was GFR....

The Renal NSF recommended the use of an estimate of glomerular filtration rate (eGFR) - this was heavily based on data from the American MDRD study and further pronouncements from the NKDEP.

When the DoH wanted to encourage the roll-out of eGFR, then the Pathology Modernisation Group put together an advisory group of experts to try to ensure a trouble-free passage. Given that Ian Barnes, a former laboratory scientist, chaired the group, it was not a surprise that the 'accuracy' of the creatinine methods in use across the UK quickly became an issue. I am not going to talk to you today about the clinical aspects but I am going to discuss the laboratory and EQA quality angle of this undertaking.

Starting reference for the UK community

Estimating Kidney Function in Adults Using Formulae

Lamb E J *et al*

Ann Clin Biochem 2005; **42**: 321 - 345

Definitions

The GFR is a measure of the efficiency of which substances are cleared from the body by glomerular filtration, and is defined as 'the volume of plasma from which a given substance is completely cleared by glomerular filtration per unit time'. It is measured by quantitating the clearance of an exogenous or endogenous substance by the kidneys.

MDRD : Modification of Diet in Renal Diseases 4 variable
aka restricted formula (5, 6 and others also available!)

In the beginning was GFR....

Everyone knew, but no-one wanted to be the first to put their hand up and say that creatinine measurement, as assayed by routine field methods, was not performed very well.

Another example of *Emperor's Clothes,* a condition prevalent in laboratory medicine

(as is being *'Holier Than Thou'*

- a condition from which I suffer, chronically).

Introduction

The basic problem was this. In the good old days, you could clearly state if the creatinine was raised/elevated compared to normal and the Jaffe reaction, whether kinetic or endpoint, was capable of differentiating between these two states.

The issue came to a head when some bright sparks in the USA decided to try to tell the difference between 'normal' and 'normal-ish'.

You don't need expensive Mass Spec techniques to tell you that field methods <u>do</u> <u>not</u> measure creatinine.

Well field methods <u>do</u> measure creatinine, but the problem is they measure a whole load of other junk as well.

Introduction

The higher the levels of creatinine, the less the problem is. The thing about eGFR is that, if you try to simplify things, by thinking of eGFR as the proportion of your kidney function you have left, then at high creatinines, it is pretty clear-cut that you have low GFRs.

However, at those very eGFR levels where it is important to have 'accurate' readings, the creatinine measurements let you down.

Introduction

It was felt by the DoH Advisory group that it was more important to be traceable to the evidence base, rather than trying straight-away to move to the 'true' creatinine results.

The plan was to have UK NEQAS pools assayed by both IDMS values (to get the 'truth') and to get the values assayed by the Cleveland Medical lab in the USA (therefore allowing direct comparison with data used to construct the evidence base).

Introduction

The DoH Advisory group had to make many pragmatic decisions as unforeseen events, over which we had no control, were emerging. These had to be taken into consideration when any final recommendations were made.

It was felt by the DoH Advisory group that all labs should 'jump' at the same time and that all users of any given method should use the same 'slope adjustors' so that a free-for-all did not ensue.

eGFR - still the current 'big thing' in the UK*

In brief, implementation of routine eGFR reporting is recommended by 1st April 2006 to fit in with the Quality and Outcomes Framework coming into effect. The group is recommending that estimated GFR (eGFR) in adults ($\geq$18 years) should be calculated using the 4-variable (i.e. serum creatinine concentration, age, gender and ethnic origin) isotope dilution mass spectrometry (ID-MS) traceable version of the Modification of Diet in Renal Disease (MDRD) equation:

GFR (mL/min/1.73 m^2) =

$$175 \times [\text{serum creatinine (umol/L)} \times 0.011312]^{-1.154} \times [\text{age}]^{-0.203}$$

$$\times [1.212 \text{ if black}] \times [0.742 \text{ if female}]$$

Ed Lamb, March 2006

NB: The DoH recommended the use of this equation with a UK NEQAS derived slope adjustor. See later.

The Pilot EQA scheme

The Pilot Distributions of human serum from UK NEQAS Birmingham quantified the problems that were already known to the laboratory professionals, but which were less well understood by other Healthcare groups.

The UK NEQAS for eGFR Pilots probed, and the full Scheme continues to probe, the robustness and accuracy of creatinine measurements, particularly targeting key concentrations of creatinine.

The Pilot EQA scheme

The Pilot also asked for an estimate of GFR for a particular scenario for each specimen.

A range of method-specific eGFRs for a *range* of scenarios was reported back to Participants to put in a wider context the spread of data observed.

The data was reliable in that most hospital laboratories across the country took part. By the end of March 2006, 6 Pilot distributions had been performed and material suitable for the year 2006-2007 had been commissioned.

The Pilot EQA scheme

A pragmatic way of bringing together the reported eGFRs obtained by different methods used across the country was proposed by the DoH group.

In order to be scientifically justifiable however, it was recognised that this would only be a short term measure which would have limitations.

It would allow the roll out of eGFRs in a common currency in the time-scales required.

The Pilot EQA scheme ~ semantics

There were two options that, on the surface, could produce the same common goal, namely harmonised eGFRs.

[1] The soft option was to fudge the creatinine assay and plug the modified result into one of the MDRD equations

[2] The option that we took was to keep the creatinine results *[warts and all]* but adjust the creatinine result only as part of the eGFR equation calculation process.

Both are fudges, but [2] does not pretend that the field creatinine results are the 'true' creatinine results

The Pilot EQA scheme

The UK NEQAS involvement was to be two-fold: an initial data gathering and mathematical analysis followed by an ongoing, but strictly necessary, monitoring process.

This would assess the impact of the new variables and ensure that the equations remained valid over time.

This second point is crucial. Because the creatinine results are now directly influencing treatment stratifications, it is anticipated that laboratories will want to move to better methodologies as they become available.

The Pilot EQA scheme

The data from the initial Pilot Distributions was to be used to harmonise the eGFR results by offering laboratories method-dependent parameters to include in their MDRD equations.

This would necessitate [1] the measurement of the sample pools by the laboratory in America whose method was used in the original study.

[2] This would also necessitate the measurement of the sample pools by truly 'gold standard' methods.

Now superseded following the Dec 2005 'new' NKDEP equation

The Pilot EQA scheme

The complicated part is that we need to ensure when we do get truly 'accurate' estimates of GFR that these can be used as part of patient care.

It is important that creatinine measurements do not become 'fossilised' to their current state-of-the-art position (which is not as good as it could be) in that measurements suffer from poor analytical specificity.

We knew that better methods and 'gold standard' methods did exist, but that moving to them was not possible within the time-scales of the initiative.

eGFR - *an update from UK NEQAS*
Distribution 1 Specimen Composition

Birmingham

UKNEQAS for GFR Estimations [Pilot]

Laboratory :

Distribution : 1 Date : 31-Aug-2005

Page 1 of 2

Analyte : Serum creatinine (umol/L)

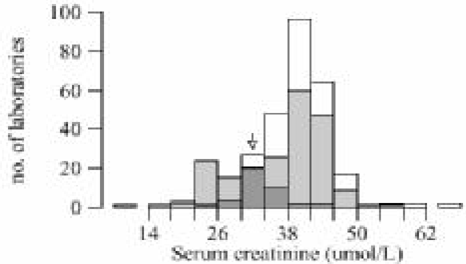
Spec.	Pool	Pool description / Treatments / Additions
1A	105	Pooled human serum diluted 1:1 with PBS
1B	101	Pooled human serum with no additions
1C	102	Pooled human serum with 40 umol/L added creatinine
1D	103	Pooled human serum with 80 umol/L added creatinine
1E	104	Pooled human serum with 800 umol/L added creatinine

☐ All methods
☐ Kinetic Jaffe
■ Beckman reagents [11BK]

Your A score is
Your B score is
Your C score is

Specimen : 1A

	n	Mean	SD	CV(%)
All methods	304	38.7	6.8	17.6
Dry slide	45	37.8	3.6	9.6
OCD (J&J) slides [1JJ]	45	37.8	3.6	9.6
Kinetic Jaffe	207	37.7	7.5	20.0
Beckman reagents [11BK]	39	33.7	3.6	10.8
Olympus reagents [11OL]	63	41.9	1.4	3.5
Roche Modular reagents [11BO]	45	32.5	11.2	34.3
O'Leary	31	42.5	3.5	8.2



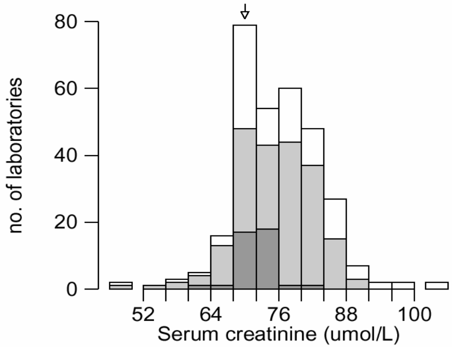
Your result	33
Target value (ALTM)	38.7
Your specimen: %bias	-14.6
Mass Spec value (Lab 1)	27.9
Mass Spec value (Lab 2)	30.5
Your method mean (Beckman reagents [11BK])	33.7

Human serum with added creatinine and also a diluted specimen

Neat specimen ~ the absolute spread of results ranges from 50 to 100

Specimen : 1B

	n	Mean	SD	CV(%)
All methods	308	76.4	7.2	9.4
Dry slide	45	71.5	3.0	4.2
OCD (J&J) slides [1JJ]	45	71.5	3.0	4.2
Kinetic Jaffe	211	76.1	6.6	8.6
Abbott reagents [11AB]	16	74.0	2.3	3.1
Beckman reagents [11BK]	39	72.5	2.7	3.7
Olympus reagents [11OL]	63	80.1	2.4	3.0
Roche Integra reagents [11RO]	14	67.6	7.2	10.6
Roche Modular reagents [11BO]	38	71.7	5.3	7.4
O'Leary	30	82.6	5.9	7.2
Endpoint Jaffe	18	82.7	10.8	13.1



Your result 70

Target value (ALTM) 76.4

Your specimen:
%bias -8.4
transformed bias -84
Accuracy Index 84

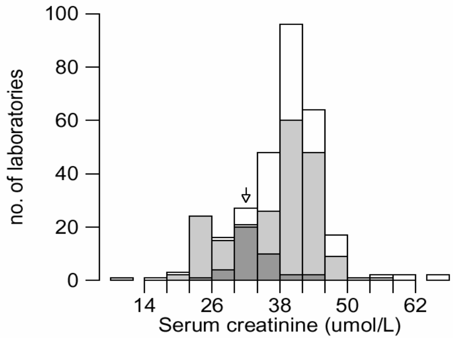
'True' value 64

Beckman reagents [11BK] (reagent) 72.5

Diluted specimen ~ a bimodal spread of data

Specimen : 1A

	n	Mean	SD	CV(%)
All methods	304	38.7	6.8	17.6
Dry slide	45	37.8	3.6	9.6
OCD (J&J) slides [1JJ]	45	37.8	3.6	9.6
Kinetic Jaffe	208	37.7	7.5	20.0
Abbott reagents [11AB]	16	38.6	2.3	5.9
Beckman reagents [11BK]	39	33.7	3.6	10.8
Olympus reagents [11OL]	63	41.9	1.5	3.5
Roche Integra reagents [11RO]	13	32.5	8.7	26.8
Roche Modular reagents [11BO]	36	29.1	7.6	26.1
O'Leary	30	42.5	3.6	8.4
Endpoint Jaffe	18	43.6	7.6	17.5



Your result 33

Target value (ALTM) 38.7

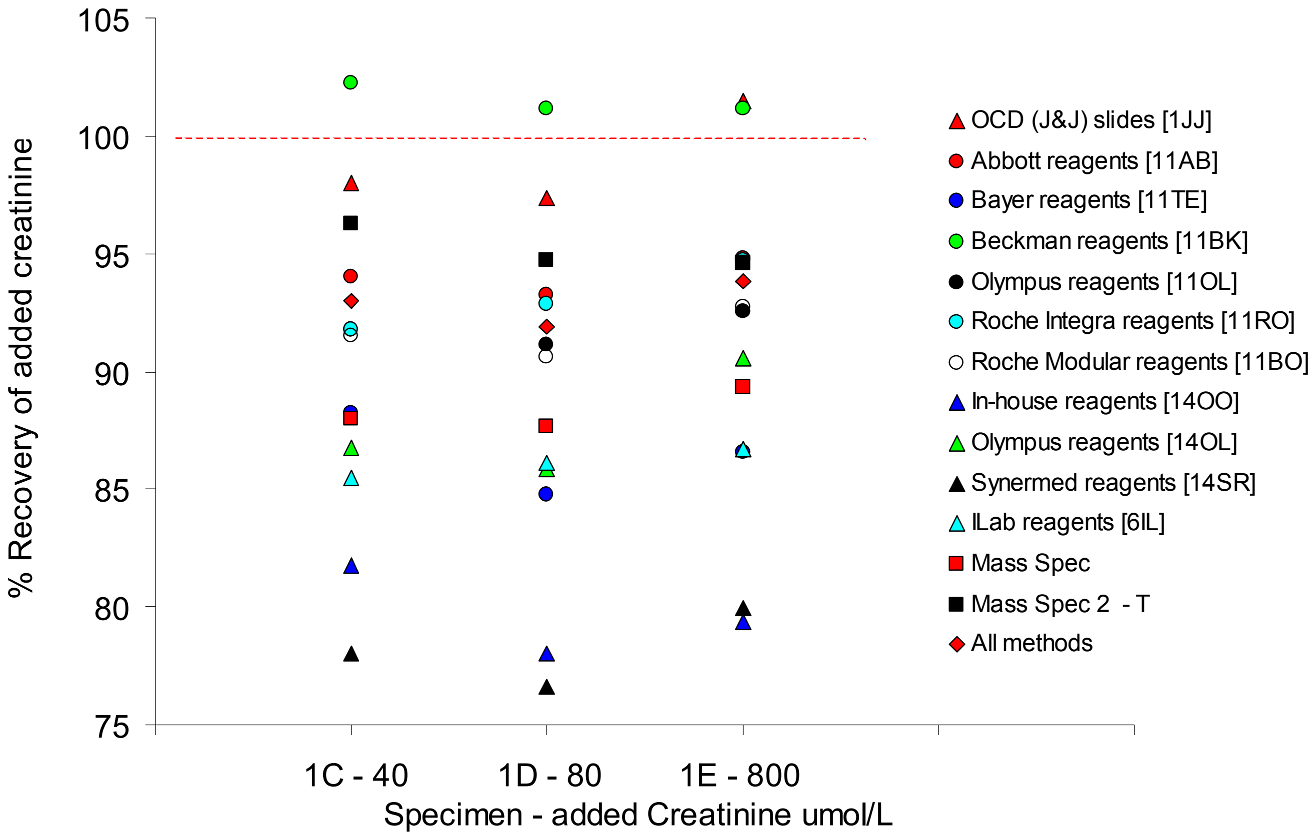
Your specimen:
%bias -14.6
transformed bias -146
Accuracy Index 146

'True' value 32

Beckman reagents [11BK] (reagent) 33.7

eGFR - *an update from UK NEQAS*

Recovery of added creatinine



Dilution studies

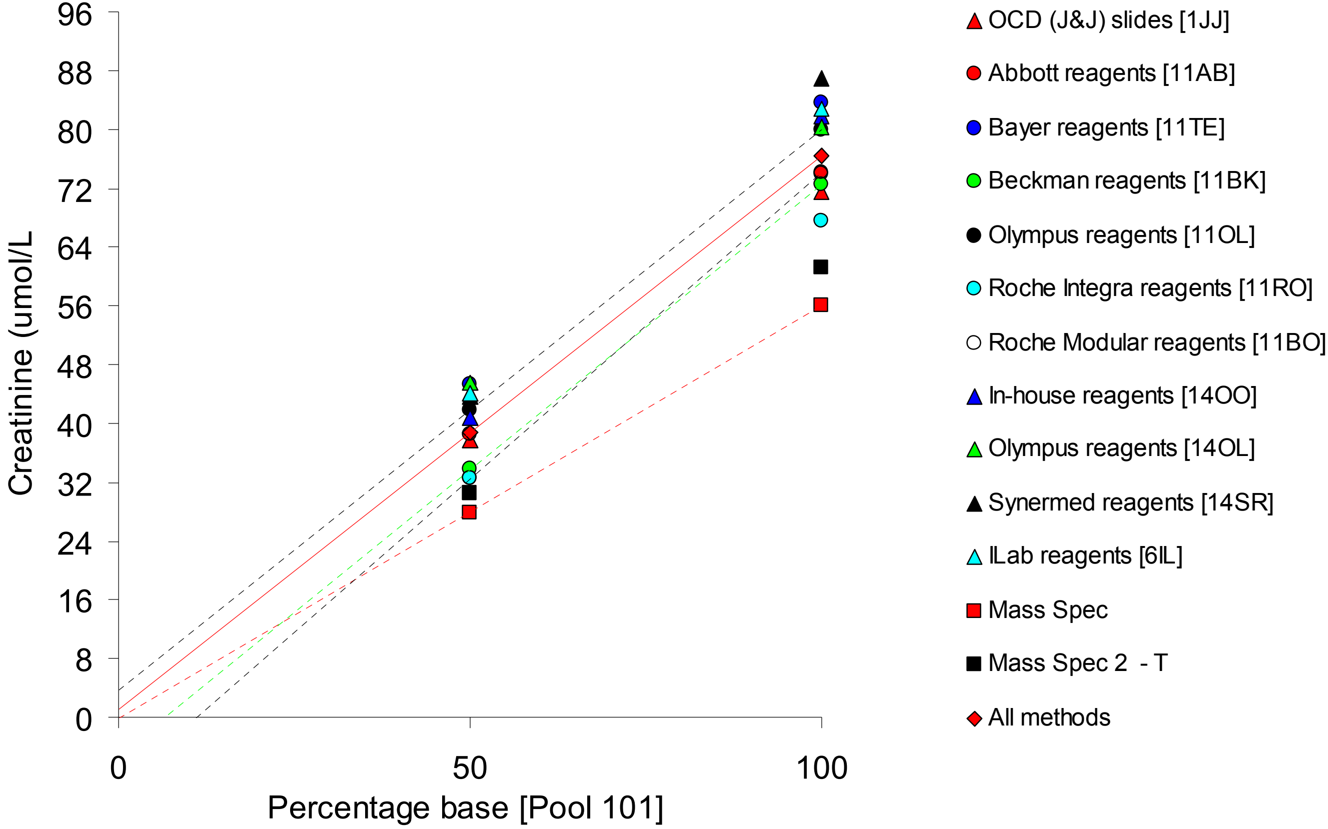
What happens when sample is diluted in buffer?

Any assay algorithm that expects a fixed, significant, interference from non-creatinine chromogens will tend to give extrapolated results of ‘less than zero’ (*ie* a negative y-axis intercept) on dilution plots.

This means that that the reported creatinine in a diluted sample will be less than anticipated because it will contain a reduced amount of interferent compared to the ‘neat’ sample.

eGFR - *an update from UK NEQAS*

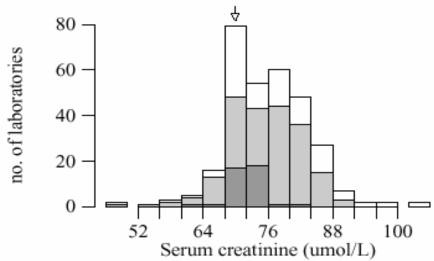
Dilution of serum to assess low level 'specificity'



eGFR- *an update from UK NEQAS*

Specimen : 1B

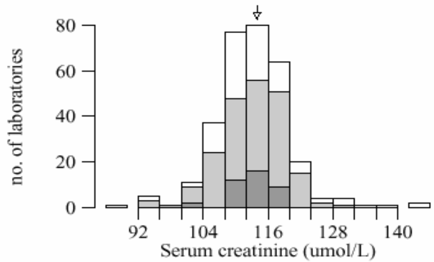
	n	Mean	SD	CV(%)
All methods	308	76.4	7.2	9.4
Dry slide	45	71.5	3.0	4.2
OCD (J&J) slides [1JJ]	45	71.5	3.0	4.2
Kinetic Jaffe	210	76.0	6.5	8.6
Beckman reagents [11BK]	39	72.5	2.7	3.7
Olympus reagents [11OL]	63	80.0	2.3	2.9
Roche Modular reagents [11BO]	47	74.2	8.0	10.8
O'Leary	31	82.7	5.8	7.0



Your result	70
Target value (ALTM)	76.4
Your specimen: %bias	-8.4
Mass Spec value (Lab 1)	56.0
Mass Spec value (Lab 2)	61.2
Your method mean (Beckman reagents [11BK])	72.5

Specimen : 1C

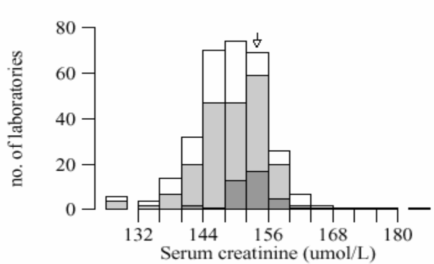
	n	Mean	SD	CV(%)
All methods	308	113.6	5.6	4.9
Dry slide	45	110.7	3.0	2.7
OCD (J&J) slides [1JJ]	45	110.7	3.0	2.7
Kinetic Jaffe	210	113.6	5.5	4.9
Beckman reagents [11BK]	39	113.4	3.3	2.9
Olympus reagents [11OL]	63	116.7	3.2	2.8
Roche Modular reagents [11BO]	47	110.8	4.9	4.4
O'Leary	31	115.4	7.3	6.3



Your result	114
Target value (ALTM)	113.6
Your specimen: %bias	+0.4
Mass Spec value (Lab 1)	91.2
Mass Spec value (Lab 2)	99.7
Your method mean (Beckman reagents [11BK])	113.4

Specimen : 1D

	n	Mean	SD	CV(%)
All methods	308	149.9	6.1	4.1
Dry slide	45	149.4	3.9	2.6
OCD (J&J) slides [1JJ]	45	149.4	3.9	2.6
Kinetic Jaffe	210	150.3	5.8	3.8
Beckman reagents [11BK]	39	153.4	3.4	2.2
Olympus reagents [11OL]	63	152.9	3.8	2.5
Roche Modular reagents [11BO]	47	146.7	4.4	3.0
O'Leary	31	145.7	6.5	4.4

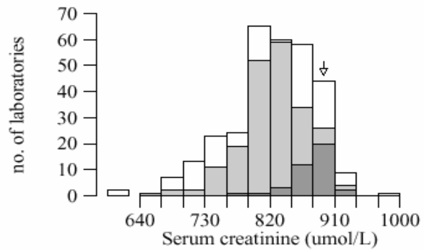


Your result	154
Target value (ALTM)	149.9
Your specimen: %bias	+2.8
Mass Spec value (Lab 1)	126.1
Mass Spec value (Lab 2)	137.0
Your method mean (Beckman reagents [11BK])	153.4

eGFR ~ *an update from UK NEQAS*

Specimen : 1E

	n	Mean	SD	CV(%)
All methods	307	827.0	58.3	7.0
Dry slide	45	883.3	18.7	2.1
OCD (J&J) slides [1JJ]	45	883.3	18.7	2.1
Kinetic Jaffe	210	830.0	43.6	5.2
Beckman reagents [11BK]	39	881.6	24.8	2.8
Olympus reagents [11OL]	63	820.4	17.9	2.2
Roche Modular reagents [11BO]	47	816.2	53.5	6.6
O'Leary	31	736.6	50.0	6.8



Your result	884
Target value (ALTM)	827.0
Your specimen: %bias	+6.9
Mass Spec value (Lab 1)	770.8
Mass Spec value (Lab 2)	818.1
Your method mean (Beckman reagents [11BK])	881.6

For any laboratory, all the results were from a single method. Where a laboratory used a second method for the diluted specimen, only the result for the primary method was processed.

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eGFR- *an update from UK NEQAS*

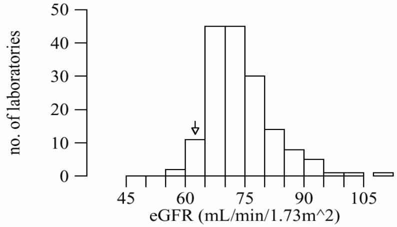
data from Distribution 2

Spec.	Pool	Pool description
2A	106	25 year old 'whi
2B	107	55 year old 'white male
2C	108	55 year old 'white' male

Specimen : 2A

	n	Mean	SD	CV(%)
All methods	163	73.8	7.1	9.6

white female 25y

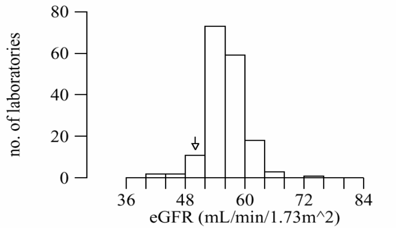


Your result	62
Target value (ALTM)	73.8
Your specimen: %bias	-16.0
Mass Spec value (Lab 1)	
Mass Spec value (Lab 2)	
Your method mean ()	

Specimen : 2B

	n	Mean	SD	CV(%)
All methods	169	56.8	3.4	5.9

white male 55y

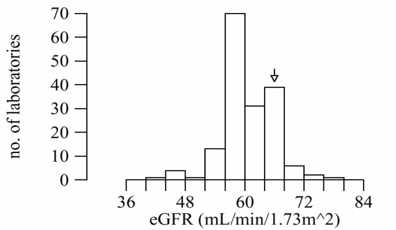


Your result	52
Target value (ALTM)	56.8
Your specimen: %bias	-8.4
Mass Spec value (Lab 1)	
Mass Spec value (Lab 2)	
Your method mean ()	

Specimen : 2C

	n	Mean	SD	CV(%)
All methods	168	61.2	4.6	7.5

white male 55y



Your result	66
Target value (ALTM)	61.2
Your specimen: %bias	+7.8
Mass Spec value (Lab 1)	
Mass Spec value (Lab 2)	
Your method mean ()	

eGFRs and CKD stages

Tabulated scenario data for 2B

Specimen 2B	creatinine umol/L	35 y 'white' male	45 y 'white' male	55 y 'white' male	65 y 'white' male	75 y 'white' male
All methods	122.9	62	59	56	54	53
Dry slide	119.5	64	61	58	56	55
OCD (J&J) slides [1JJ]	119.5	64	61	58	56	55
Kinetic Jaffe	123.5	61	58	56	54	53
Abbott reagents [11AB]	121.0	63	60	57	55	54
Bayer reagents [11TE]	120.0	64	60	58	56	54
Beckman reagents [11BK]	127.9	59	56	54	52	51
Olympus reagents [11OL]	125.8	60	57	55	53	52
Roche Integra reagents [11RO]	115.8	66	63	60	58	57
Roche Modular reagents [11BO]	120.0	64	60	58	56	54
O'Leary	124.4	61	58	56	54	52
In-house reagents [14OO]	125.5	60	57	55	53	52
Synermed reagents [14SR]	126.4	60	57	55	53	51
Endpoint Jaffe	129.9	58	55	53	51	50
ILab reagents [6IL]	130.5	58	55	53	51	49

Because of the variety of equations that could be being used, the utility of this type of analysis has not yet been pushed to its full potential

Bilirubin

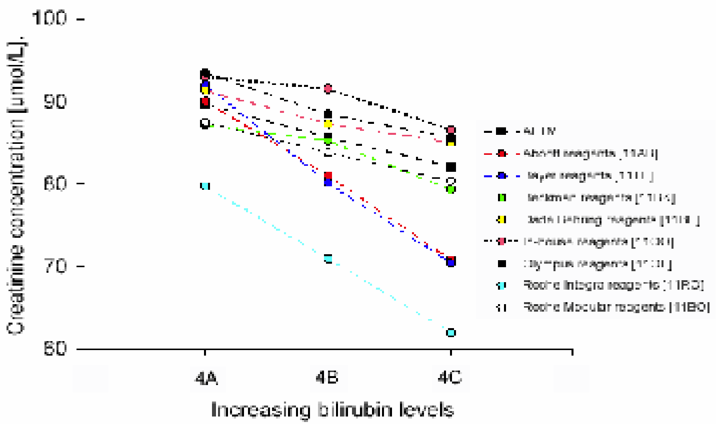
The interference study.

Even before many of us became involved in clinical chemistry there have been well documented papers highlighting interferences in some creatinine assays due to the presence of non-creatinine chromagens, for example with haemolysis, hyperbilirubinaemia and the presence of ketones.

This simple experiment was just to raise the profile of this interference phenomenon again, as I believe specificity to be fundamental to the estimation of creatinine. This is especially important when we are being bombarded with claims of assays being 'Mass Spec traceable' and being so-called 'Zero bias assays', which can be confusing to the non-expert.

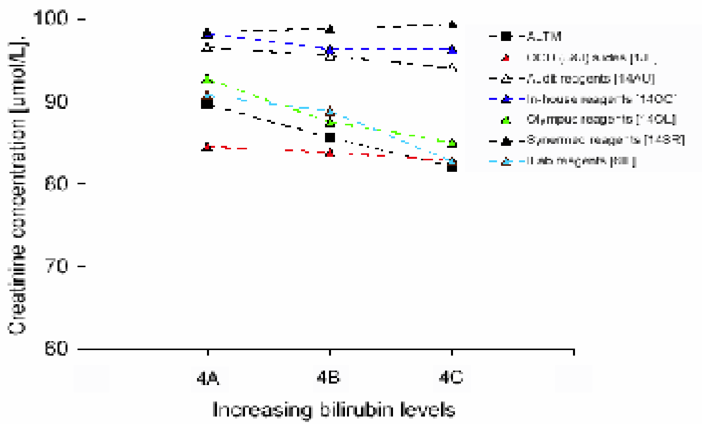
Dist 4 fig 1 - ALTM and kinetic Jaffe methods

Effect of addition of 75 umol/L and 150 umol/L bilirubin on the measurement of serum creatinine.



Dist 4 fig 2 - ALTM and other methods

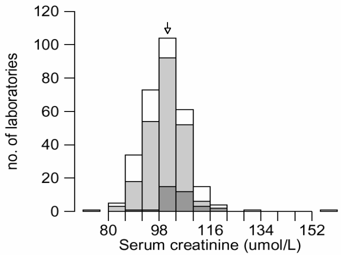
Effect of addition of 75 umol/L and 150 umol/L bilirubin on the measurement of serum creatinine.

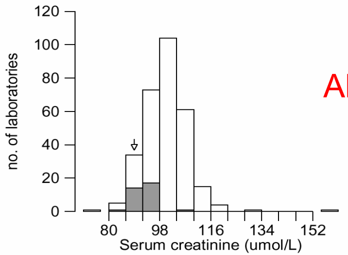


Effect of Ketones on measured Creatinine
Distribution 13, October 2006

0

Specimen : 13A	n	Mean	SD	CV(%)
All methods	299	100.5	7.0	7.0
Dry slide	33	92.9	3.1	3.4
OCD (J&J) slides [1JJ]	33	92.9	3.1	3.4
Kinetic Jaffe	228	100.8	6.0	6.0
Abbott reagents [11AB]	30	103.2	3.5	3.4
Beckman reagents [11BK]	34	105.0	4.6	4.4
Olympus reagents [11OL]	63	103.3	3.1	3.0
Roche Integra reagents [11RO]	13	93.6	8.3	8.9
Roche Modular reagents [11BO]	67	95.8	4.1	4.2
O'Leary	26	105.7	5.0	4.7
In-house reagents [14OO]	9	106.3	4.9	4.6

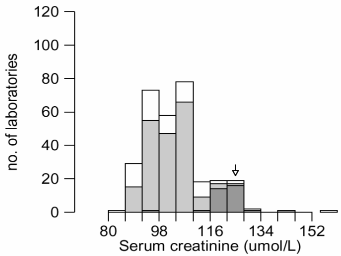


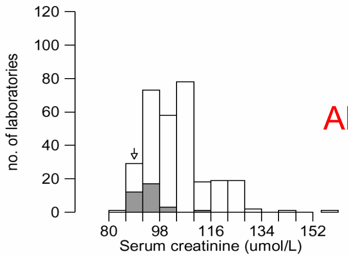


Abbott 103

5

Specimen : 13B	n	Mean	SD	CV(%)
All methods	299	103.7	10.3	9.9
Dry slide	33	93.3	2.7	2.9
OCD (J&J) slides [1JJ]	33	93.3	2.7	2.9
Kinetic Jaffe	228	104.5	9.9	9.4
Abbott reagents [11AB]	30	107.0	3.9	3.6
Beckman reagents [11BK]	34	122.5	4.2	3.4
Olympus reagents [11OL]	63	104.7	2.9	2.8
Roche Integra reagents [11RO]	13	95.5	7.3	7.6
Roche Modular reagents [11BO]	67	96.2	3.9	4.0
O'Leary	26	106.9	4.6	4.3
In-house reagents [14OO]	9	108.4	4.5	4.2

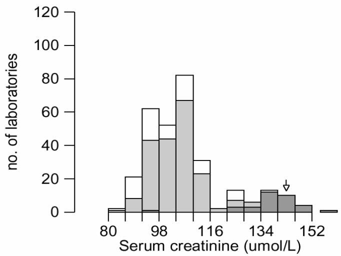


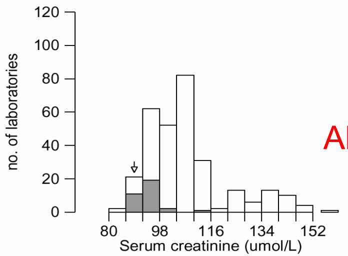


Abbott 107

10
mmol/L

Specimen : 13C	n	Mean	SD	CV(%)
All methods	299	106.7	12.9	12.1
Dry slide	33	93.8	3.4	3.7
OCD (J&J) slides [1JJ]	33	93.8	3.4	3.7
Kinetic Jaffe	228	108.3	13.3	12.3
Abbott reagents [11AB]	30	110.7	3.3	3.0
Beckman reagents [11BK]	34	138.9	7.0	5.1
Olympus reagents [11OL]	63	106.3	2.7	2.6
Roche Integra reagents [11RO]	13	96.9	8.9	9.1
Roche Modular reagents [11BO]	67	98.2	4.4	4.5
O'Leary	26	107.3	3.9	3.6
In-house reagents [14OO]	9	109.1	3.7	3.4





Abbott 111

Affected method

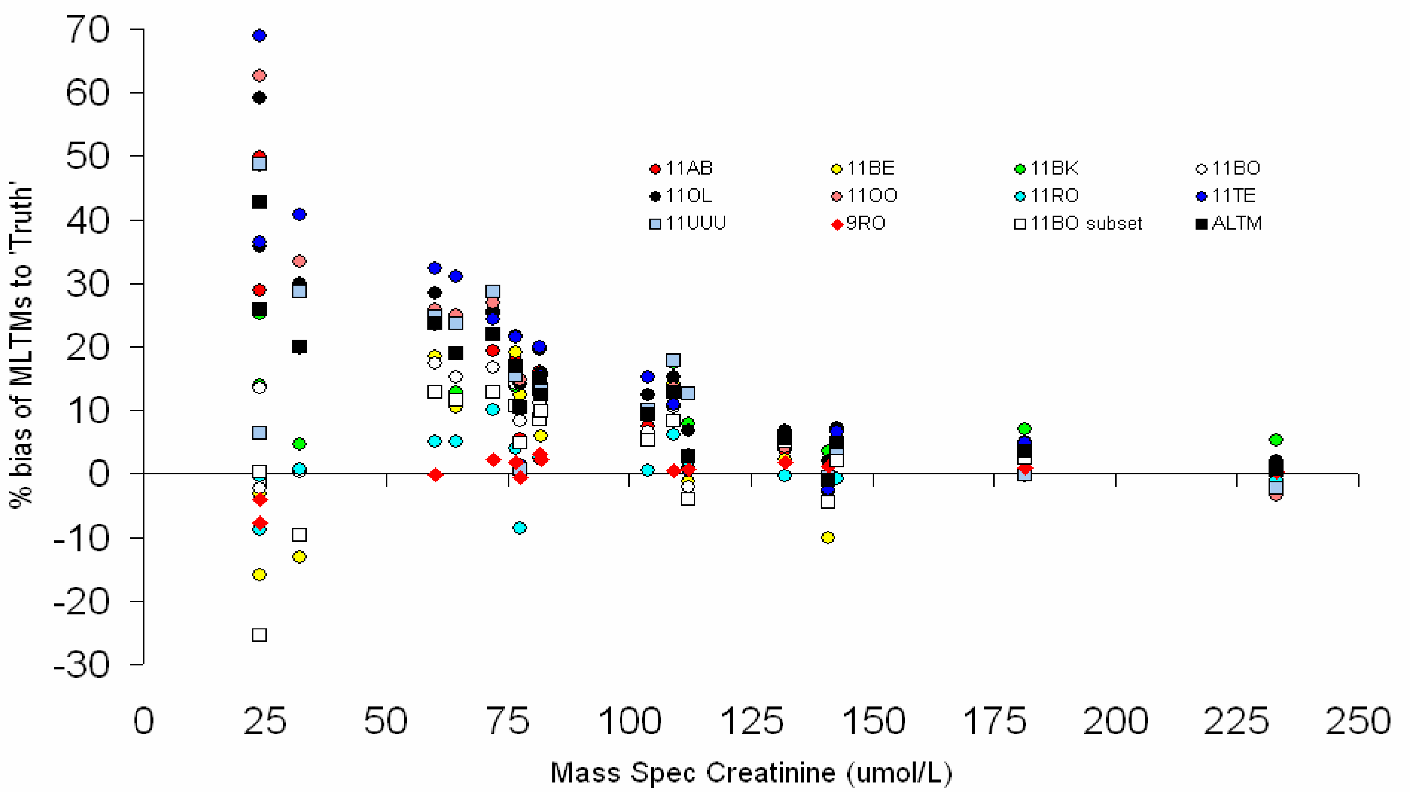
Un-affected method

Derivation of UK NEQAS-derived Slope Adjustors ~ Mass Spectrometry values

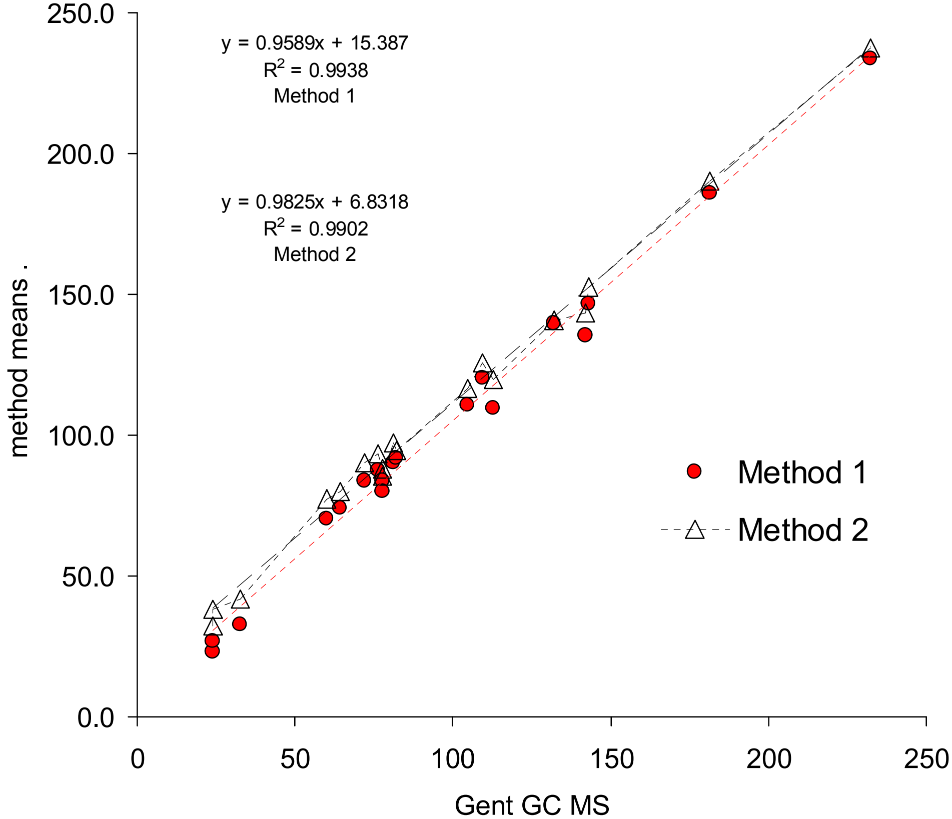
	Pool	Description	Consensus mean	Gent ID-MS	*Recovery*		London MS-MS
1A	105	Pool 101 diluted 1:1 with PBS	39	32.2			32.7
1B	101	base serum	76	64.3			65.9
1C	102	Pool 101 + 40 umol/L creatinine	114	103.9	*98.9*		105.5
1D	103	Pool 101 + 80 umol/L creatinine	150	142.9	*98.2*		141.8
1E	104	Pool 101 + 800 umol/L creatinine	827	861.0	*99.6*		822.8
2A	106	base serum	88	71.9			73.1
2B	107	Pool 106 + 38 umol/L creatinine	123	109.0	*97.8*		110.3
2C	108	Pool 106 diluted 1:1 with PBS then + 76 umol/L	115	112.2			112.8
3A	109	base serum	92	81.7			83.5
3B	110	Pool 109 + 50 umol/L creatinine	139	132.0	*100.5*		131.8
3C	111	Pool 109 diluted 1:1 with PBS then + 100 umol/L	140	140.9			139.8
4A	112	base serum	90	76.7			77.8
4B	114	base serum + 75 umol/L bilirubin	86	77.5			77.6
4C	113	base serum + 150 umol/L bilirubin	82	78.0			77.6
5A	115	base serum	92	81.4			82.1
5B	116	Pool 115 + 100 umol/L creatinine	189	181.4	*100.0*		180.5
5C	117	Pool 115 + 150 umol/L creatinine	236	233.1	*101.1*		227.5
6A	118	base serum	73	60.1			59.8
6B	119	Pool 118 diluted 2:3 with PBS	28	23.8			24.2
6C	120	Pool 118 diluted 2:3 with HSA	31	24.0			24.3

Gent %Recovery *99.5*

Method bias (%) for all Specimens distributed in the Pilot



Derivation of UK NEQAS-derived Slope Adjustors



For information only, I have also provided a UK NEQAS ALTM, overall, slope adjustor.

If you have 'fudged' your creatinine results then only you know how and why this was done and what it was trying to achieve, so the applicability of using any of the provided slopes is not straight-forward and cannot readily be advised.

slopes and intercepts to use		
method/category	intercept	slope
All methods	12.73	0.959
Dry slide	7.71	0.968
OCD (J&J) slides [1JJ]	7.71	0.968
Kinetic Jaffe	11.60	0.970
Abbott reagents [11AB]	13.21	0.940
Bayer reagents [11TE]	17.78	0.927
Beckman reagents [11BK]	5.92	0.994
Dade Behring reagents [11BF]	6.78	1.030
Olympus reagents [11OL]	16.14	0.955
Roche Integra reagents [11RO]	2.03	0.966
Roche Modular reagents [11BO]	3.08	1.004
O'Leary	24.66	0.864
Endpoint Jaffe	22.02	0.910
ILab reagents [6IL]	21.77	0.906
Enzymatic	0.26	1.011

These are the calculated slopes and intercepts

Derivation of UK NEQAS-derived Slope Adjustors ~New Methods

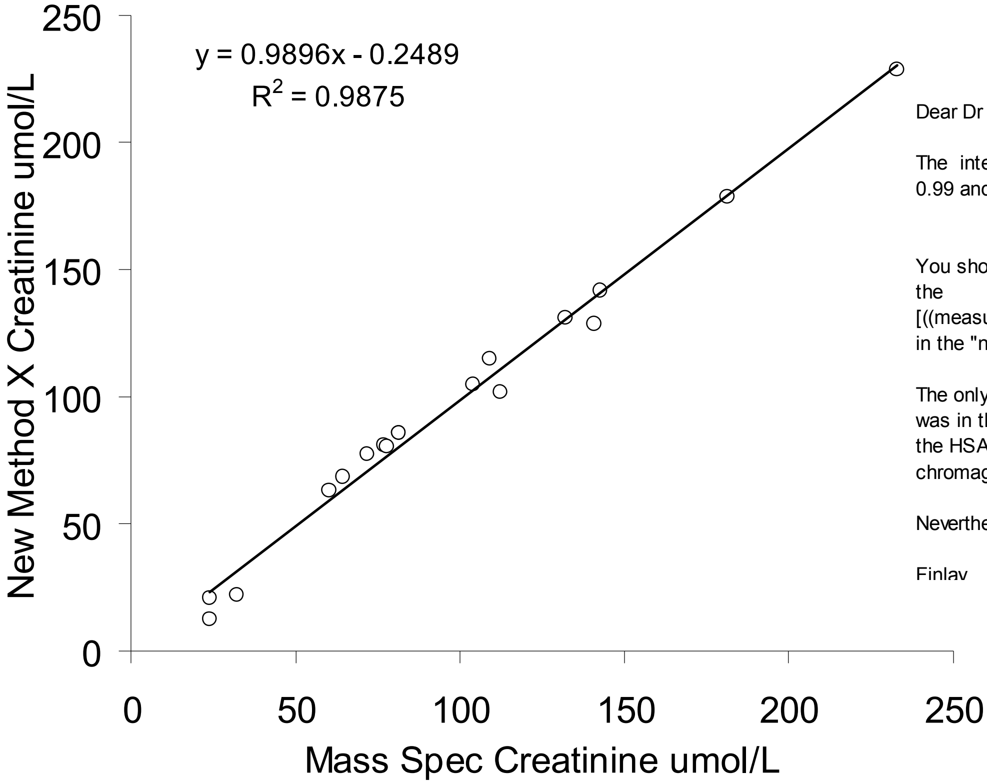
original pools		DAY 1	DAY 1			DAY 2	DAY 2			
				GSCR	GSCR					
SPEC	**POOL**	new method X - 1	new method X - 2	**ALTM**	**XALTM**	new method X - 1	new method X - 2	new method X	new method average	bias
6B	119	13	14.5	30	23.82	11.5	12	12.75	12.8	-46.5
6C	120	20.7	21.1	34	23.98	19.5	22	20.83	20.8	-13.2
1A	105	21.5	20.2	39	32.24	23.8	23.7	22.30	22.3	-30.8
6A	118	62.2	63	74	60.11	60.6	65.8	62.90	62.9	4.6
1B	101	67.9	65.8	76	64.28	69.7	69.9	68.33	68.3	6.3
2A	106	76.5	77.7	88	71.88	77.1	78.2	77.38	77.4	7.6
4A	112	80	79.8	90	76.68	81	82.5	80.83	80.8	5.4
4C	113	79.6	78.9	82	78	80.9	81.7	80.28	80.3	2.9
5A	115	87.1	81.7	94	81.45	83.6	89.9	85.58	85.6	5.1
3A	109	83.9	82.4	92	81.72	88.6	88	85.73	85.7	4.9
1C	102	103.3	106.5	114	103.9	103.1	106.7	104.90	104.9	1.0
2B	107	113.1	114.8	123	109	114.8	116.1	114.70	114.7	5.2
2C	108	100	103.7	115	112.2	100.6	103.6	101.98	102.0	-9.1
3B	110	133.4	130	139	132	130	129.9	130.83	130.8	-0.9
3C	111	125	131.7	140	140.9	128.3	130.2	128.80	128.8	-8.6
1D	103	139.3	140	150	142.9	143	145.2	141.88	141.9	-0.7
5B	116	179.7	178.7	188	181.4	178.2	178	178.65	178.7	-1.5
5C	117	224.9	227.4	235	233.1	231	229.8	228.28	228.3	-2.1

This is data for Method X, a new 'compensated' Jaffe

This is the approach we are taking for all new methods,
including the new Abbott and Bayer 'compensated' Jaffe assays

Derivation of UK NEQAS-derived Slope Adjustors ~New Methods

This is the approach we are taking for <u>all</u> new methods, including the new Abbott and Bayer 'compensated' Jaffe assays



Dear Dr X

The intercept and slope to use are:
0.99 and -0.249

You should replace the [serum creatinine] variable with the [((measured serum creatinine - intercept)/slope)] variable in the "new 175" formula.

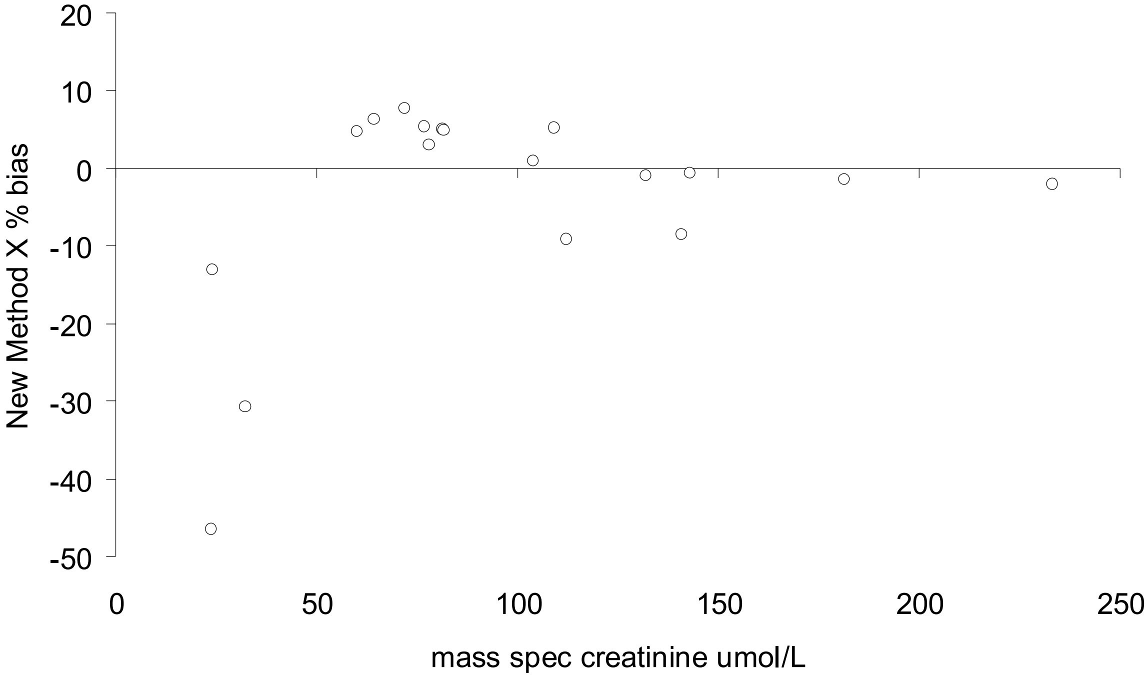
The only specimens where the assay was challenged was in those which had been diluted in PBS (but not in the HSA dilutions] as there was less non-creatinine chromagen present than 'expected'.

Nevertheless, it looks pretty good.

Finlay

This is data for Method X,

Derivation of UK NEQAS-derived Slope Adjustors ~New Methods



This is data for Method X

eGFR - the current 'big thing'

The problem is that routine kinetic Jaffe field assays for creatinine are non-specific.

No amount of 'traceability' is going to overcome this plain fact.

What is "conventional calibration"?

Will "IDMS-traceable calibration" suddenly transmogrify the sow's ear that is the Jaffe reaction, whether or not "compensated", into a delicate silk purse of unquestioning accuracy?

FM March 2006,

Cynic of the Year 2 years running [2004 and 2005]

As Lothan Siekman (Bonn) *[doesn't he do Mass Spec work?]* said in

http://www.ifcc.org/ejifcc/vol13no3/130301002n.htm

"An inevitable precondition for the establishing of traceable results to calibrators and control materials is the specificity of the measurement procedures applied.

Results of measurement cannot be traceable when the procedure applied partially detects components which are not consistent with the definition of the measurand."

In our case the 'measurand' is creatinine, so if the method is non-specific then it is <u>not</u> traceable.

- The up-shot of what I am suggesting you should do

You should replace the [serum creatinine] variable with the [((measured serum creatinine - intercept)/slope)] variable in the "new 175" formula.

You should be aware that the equations are often written in two (both correct!) formats.

One says Serum creatinine multiplied by 0.011312, the other says Serum creatinine divided by 88.4. They both give the same answer!

So for a white male of 70 years old, where the measured creatinine on an Abbott system was 90 umol/L

GFR (mL/min/1.73 m^2) =

$175 \times [\text{serum creatinine} \times 0.011312]^{-1.154} \times [\text{age}]^{-0.203}$

$175 \times [90 \times 0.011312]^{-1.154} \times [70]^{-0.203}$ is the non-adjusted form, but I suggest you use the following instead

$175 \times [((90-\text{intercept})/\text{slope}) \times 0.011312]^{-1.154} \times [70]^{-0.203}$

and from the look-up table below we see that the Abbott intercept and slope are 13.21 and 0.940 respectively, so we get

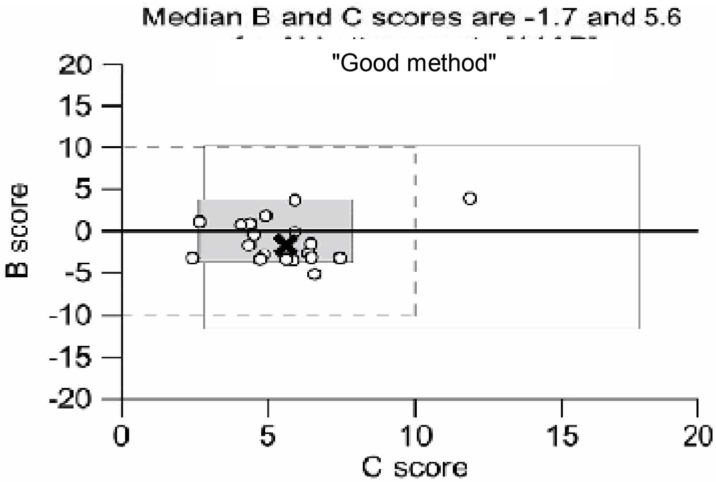
$175 \times [(90-13.21)/0.940)) \times 0.011312]^{-1.154} \times [70]^{-0.203}$

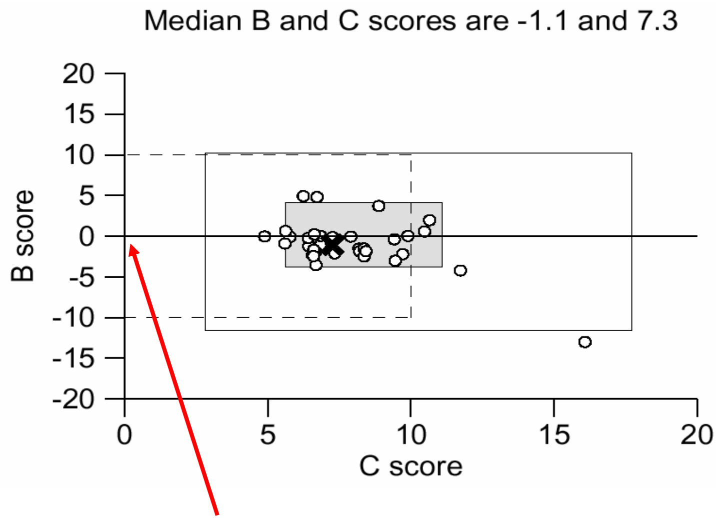
which is an eGFR of 81

[So for interest, but <u>not</u> for reporting to clinicians, the true creatinine was probably close to 82 umol/L and the "old 186" formula would have given an eGFR of 77, while the "new 175" formula would have produced an eGFR of 72. I will be carrying out more of these off-line what-if calculations as part of the Scheme.]

What do the Penalty Box Plots tell us?

Creatinine from eGFR scheme

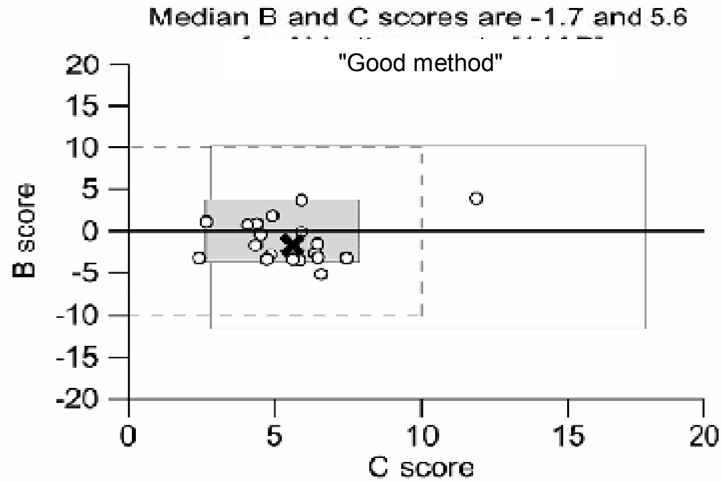


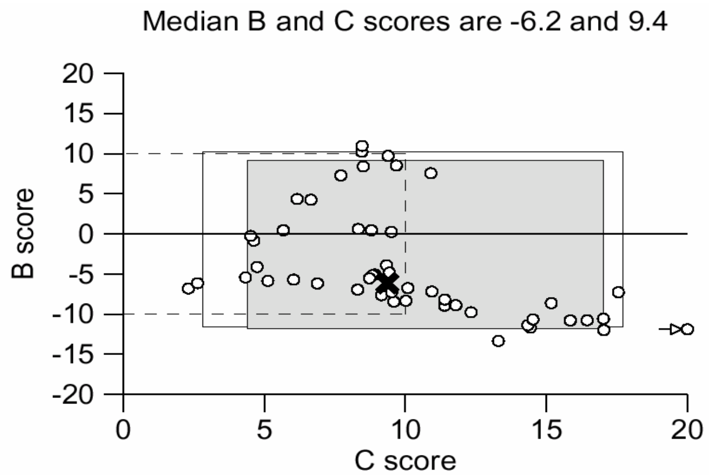


where you want to be

What do the Penalty Box Plots tell us?

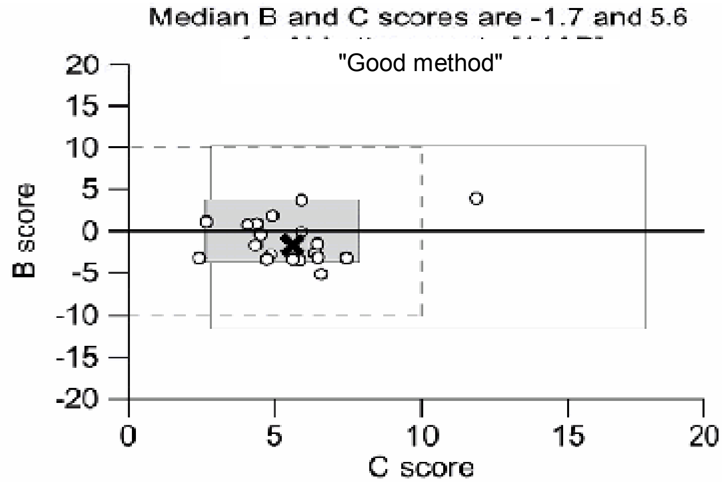
Creatinine from eGFR scheme

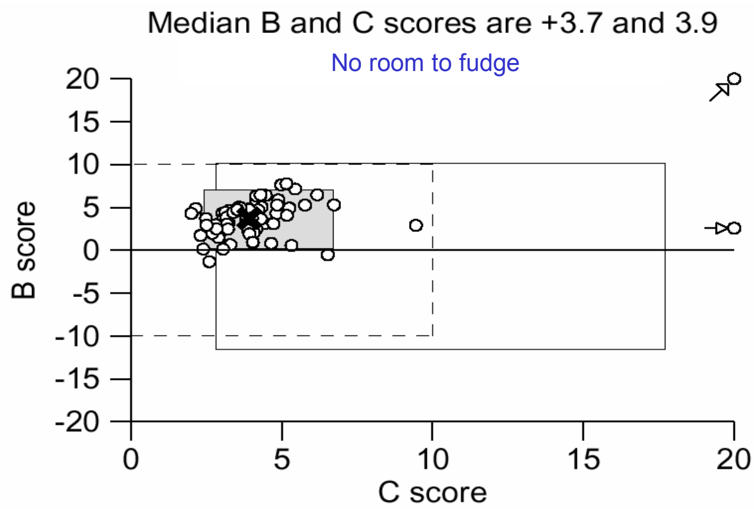




What do the Penalty Box Plots tell us?

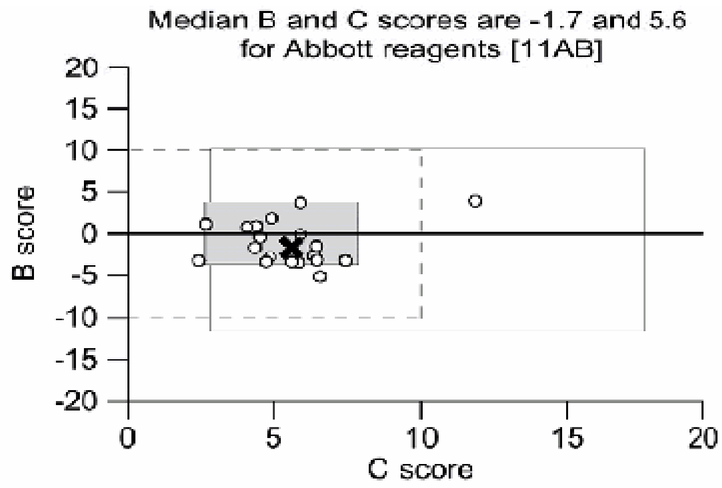
Creatinine from eGFR scheme





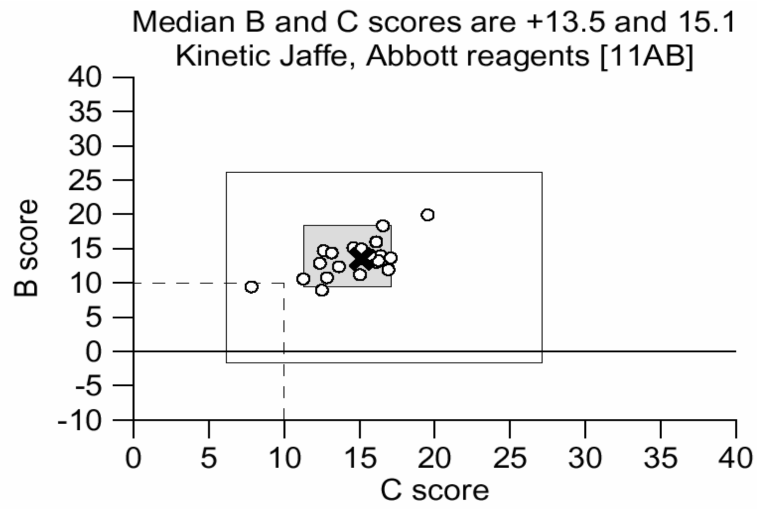
What do the Penalty Box Plots tell us?

Abbott versus Consensus and Abbott versus the 'Truth'



Consensus mean as target

last year



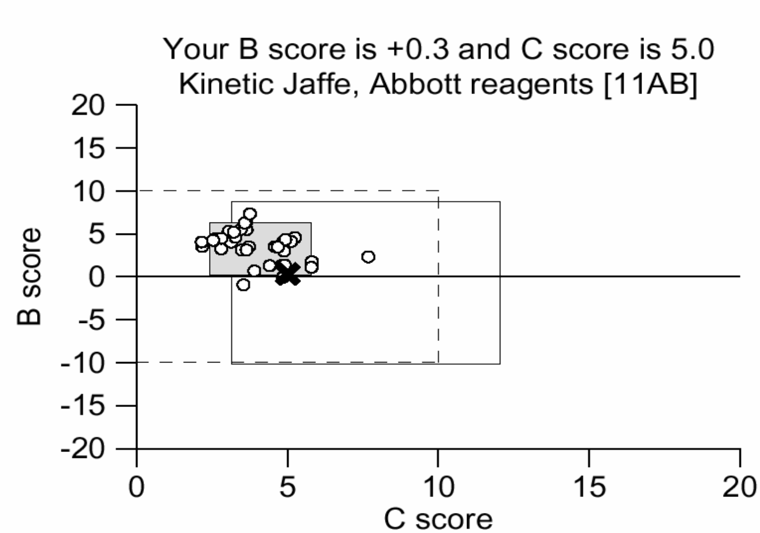
'Truth' as target

last year

Note different x-axis and y-axis scales

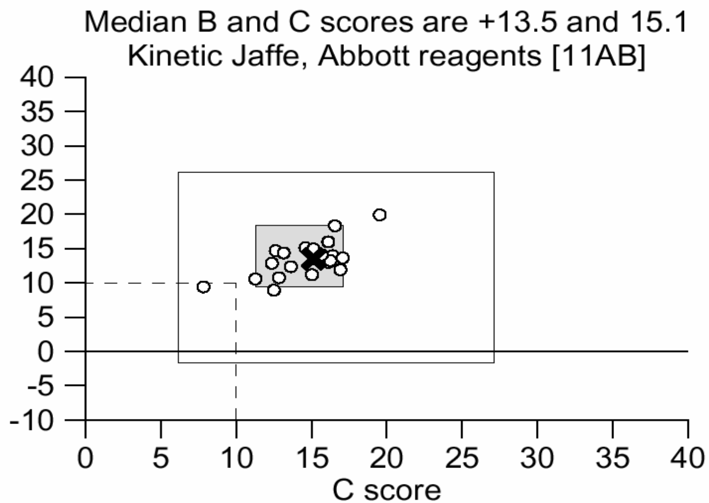
What do the Penalty Box Plots tell us?

Abbott versus Consensus and Abbott versus the 'Truth'



Consensus mean as target

As of May 2007 year



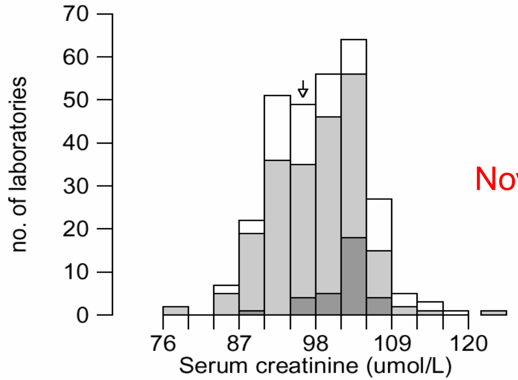
'Truth' as target

last year

Note different x-axis and y-axis scales

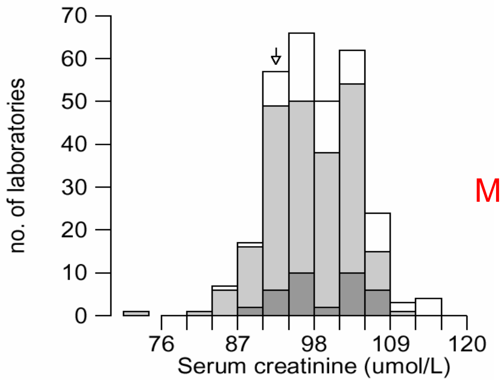
What do the Histograms tell us?

Specimen : 14A	n	Mean	SD	CV(%)
All methods	288	98.6	6.4	6.5
Dry slide	32	94.4	3.4	3.6
OCD (J&J) slides [1JJ]	32	94.4	3.4	3.6
Kinetic Jaffe	218	98.4	6.2	6.3
→ Abbott reagents [11AB]	32	102.3	2.8	2.8
Beckman reagents [11BK]	33	100.5	4.6	4.6
Olympus reagents [11OL]	61	100.9	3.4	3.4
Roche Integra reagents [11RO]	13	90.4	6.2	6.9
Roche Modular reagents [11BO]	59	93.5	4.0	4.2
O'Leary	24	103.2	3.8	3.7
Endpoint Jaffe	10	109.9	5.2	4.7



Nov 2006

Specimen : 19A	n	Mean	SD	CV(%)
All methods	292	98.2	6.0	6.1
Dry slide	26	96.5	3.2	3.4
OCD (J&J) slides [1JJ]	26	96.5	3.2	3.4
Kinetic Jaffe	231	97.8	6.0	6.1
→ Abbott reagents [11AB]	36	99.4	6.0	6.0
Beckman reagents [11BK]	33	99.0	3.0	3.1
Olympus reagents [11OL]	61	102.1	2.5	2.4
Roche Integra reagents [11RO]	11	92.4	6.8	7.3
Roche Modular reagents [11BO]	67	93.0	3.2	3.4
O'Leary	24	101.8	4.6	4.5
In-house reagents [14OO]	10	103.1	4.1	3.9



May 2007

Slight upward shift in method mean (*with hint of bi-modality?)*

Where are we now ? *[Autumn 2007]* :

23 Distributions completed, now a full UK NEQAS Scheme
6 month post-April launch review at DoH January 2007

What I said to participants.

UK NEQAS for GFR Estimations [Pilot]

GFR\Rep7\April 2006

UK NEQAS for eGFR - *A personal view from Finlay MacKenzie*, UK NEQAS Birmingham, April 2006.

- Distribution 7 ~ new analytes

The question you are all asking is this, *"Well then, Finlay, was your SAUSAGE initiative a success?"*
The simple answer is a guarded 'yes'. It does appear to have 'worked', but since the aim of the endeavour is to maintain the long-term harmony, we will have to continue to monitor things very closely over time.

I will try to explain what new approaches I have introduced to allow me to monitor progress.

Please find as part of your report some additional 'analytes' that I have created to assist you in seeing how your own calculation of an eGFR compares with what else is going on across the UK.

Just to spell it out and to try to minimise confusion, the scheme now contains 5 analytes

Serum creatinine
eGFR
eGFR 'slope adjusted'
eGFR 'new 175'
eGFR 'old 186'

(Note: only the first two will <u>always</u> be reported back to you, the others will usually remain in the background for periodic summaries.)

You will report only *Serum creatinine* and *eGFR as normal*, but I will additionally calculate on your behalf *eGFR 'slope adjusted'*, *eGFR 'new 175'* and *eGFR 'old 186'*.

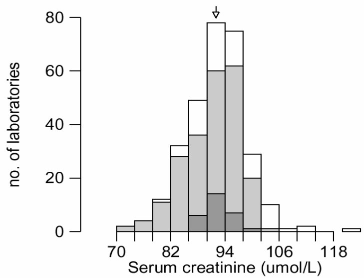
What are the analytes?

- *Serum creatinine* is your raw, unadulterated creatinine that comes off your analyser
- *eGFR* is the eGFR that you have calculated *[sometimes written for clarity as (reported) eGFR]* in whatever way you have calculated it *(which could be the right way, the wrong way or whatever. see later...)*
- *eGFR 'slope adjusted'* is the eGFR that I would have expected you to have obtained had you used the suggested UK NEQAS slope and intercept adjustments to the 'new 175' equation
- *eGFR 'new 175'* is the eGFR that I would have expected you to have obtained had you used the NKDEP new formula <u>without</u> any factors. According to the NKDEP guidelines *(please note my concerns, later)* you would use this equation if your method has been calibrated to be traceable to IDMS
- *eGFR 'old 186'* is the eGFR that I would have expected you to have obtained had you used the NKDEP old formula <u>without</u> any factors. According to the NKDEP guidelines *(please note my concerns, later)* you would use this equation if your method has not been re-calibrated to be traceable to IDMS

Has it been a success?

9B 115 40 year old 'white' female; [previously 5A]

Specimen : 9B	n	Mean	SD	CV(%)
All methods	295	92.7	6.2	6.7
Dry slide	32	90.1	3.4	3.7
OCD (J&J) slides [1JJ]	32	90.1	3.4	3.7
Kinetic Jaffe	224	92.1	6.0	6.5
Abbott reagents [11AB]	28	92.9	2.8	3.0
Beckman reagents [11BK]	34	91.3	3.6	3.9
Olympus reagents [11OL]	63	96.4	2.5	2.6
Roche Integra reagents [11RO]	14	84.8	7.7	9.1
Roche Modular reagents [11BO]	66	89.0	5.3	5.9
O'Leary	24	98.8	4.3	4.3
Endpoint Jaffe	11	105.0	6.2	5.9



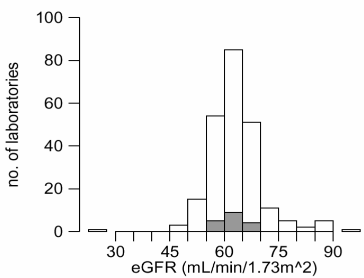
Your result	91
Target value (ALTM)	92.7
Your specimen:	
%bias	-1.8
transformed bias	-18
Accuracy Index	18
'True' value	81
Abbott reagents [11AB] (reagent)	92.9

Creatinine

consensus 93

Truth 81

Specimen : 9B	n	Mean	SD	CV(%)
All methods	233	63.1	5.4	8.5
Abbott reagents [11AB]	18	63.1	3.5	5.5
Bayer reagents [11TE]	5	67.0		
Beckman reagents [11BK]	29	63.0	2.0	3.2
Dade Behring reagents [11BE]	5	68.0		
ILab reagents [6IL]	8	56.3	6.1	10.8
In-house reagents [14OO]	6	59.0	0.0	0.0
OCD (J&J) slides [1JJ]	25	64.5	3.4	5.3
Olympus reagents [11OL]	48	62.8	4.6	7.4
Roche Integra reagents [11RO]	13	65.7	7.1	10.9
Roche Modular reagents [11BO]	54	64.4	6.3	9.8
Synermed reagents [14SR]	9	58.5	4.6	7.9



Your result	>60
Target value (ALTM)	63.1
Your specimen:	
%bias	
transformed bias	
Accuracy Index	
'True' value	67
Abbott reagents [11AB] (reagent)	63.1

eGFR

'as reported'

[~mixture]

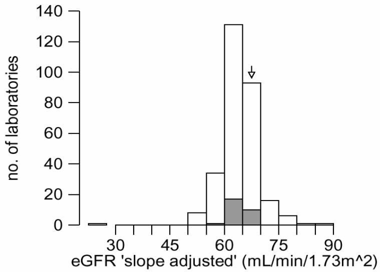
The consensus **creatinine** was 93 umol/L, but the MS 'Truth' was **81** umol/L

The consensus **eGFR** was 63, but if the 'true' creatinine was used, it would be **67** mL/min/1.73m^{2}.

Has it been a success?

Specimen : 9B

	n	Mean	SD	CV(%)
All methods	291	64.6	3.9	6.0
Abbott reagents [11AB]	28	64.4	2.3	3.6
Bayer reagents [11TE]	7	67.4	13.0	19.2
Beckman reagents [11BK]	34	63.6	3.1	4.9
Dade Behring reagents [11BE]	6	71.3	8.3	11.6
ILab reagents [6IL]	9	60.4	3.2	5.4
In-house reagents [14OO]	8	62.0	3.3	5.3
OCD (J&J) slides [1JJ]	32	65.9	3.3	5.0
Olympus reagents [11OL]	63	65.3	2.1	3.2
Roche Integra reagents [11RO]	14	65.8	6.7	10.1
Roche Modular reagents [11BO]	66	63.8	4.2	6.6
Synermed reagents [14SR]	10	60.8	3.5	5.8

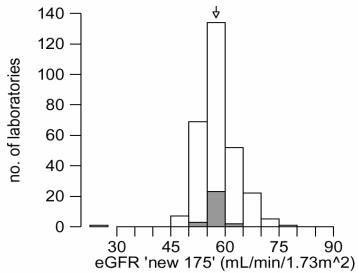


Your result	66
Target value (XALTM)	67.0
Your specimen:	
%bias	-1.5
transformed bias	-15
Accuracy Index	15
'True' value	67
Abbott reagents [11AB] (reagent)	64.4

eGFR 'Slope adjusted'

Specimen : 9B

	n	Mean	SD	CV(%)
All methods	291	58.4	4.4	7.6
Abbott reagents [11AB]	28	58.0	1.8	3.1
Bayer reagents [11TE]	7	57.6	8.6	15.0
Beckman reagents [11BK]	34	59.2	2.6	4.4
Dade Behring reagents [11BE]	6	62.8	6.8	10.9
ILab reagents [6IL]	9	51.4	2.5	4.9
In-house reagents [14OO]	8	53.7	2.6	4.8
OCD (J&J) slides [1JJ]	32	60.1	2.7	4.4
Olympus reagents [11OL]	63	55.8	1.7	3.0
Roche Integra reagents [11RO]	14	64.9	6.3	9.7
Roche Modular reagents [11BO]	66	61.1	3.9	6.5
Synermed reagents [14SR]	10	52.9	2.7	5.0

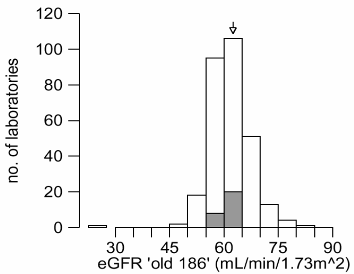


Your result	59
Target value (XALTM)	67.0
Your specimen:	
%bias	-11.9
transformed bias	-119
Accuracy Index	119
'True' value	67
Abbott reagents [11AB] (reagent)	58.0

eGFR 'New 175'

Specimen : 9B

	n	Mean	SD	CV(%)
All methods	291	62.0	4.8	7.7
Abbott reagents [11AB]	28	61.8	2.1	3.4
Bayer reagents [11TE]	7	61.2	8.9	14.6
Beckman reagents [11BK]	34	62.9	2.8	4.4
Dade Behring reagents [11BE]	6	66.5	7.6	11.4
ILab reagents [6IL]	9	54.7	2.2	3.9
In-house reagents [14OO]	8	57.2	2.9	5.0
OCD (J&J) slides [1JJ]	32	63.9	2.6	4.1
Olympus reagents [11OL]	63	59.1	1.8	3.1
Roche Integra reagents [11RO]	14	68.8	6.7	9.7
Roche Modular reagents [11BO]	66	64.9	4.2	6.4
Synermed reagents [14SR]	10	56.0	2.4	4.2



Your result	63
Target value (XALTM)	67.0
Your specimen:	
%bias	-6.0
transformed bias	-60
Accuracy Index	60
'True' value	67
Abbott reagents [11AB] (reagent)	61.8

eGFR 'Old 186'

- *Distribution 7.* What do I expect to see happen in the future?

If everyone moves towards using the suggested UK NEQAS slope adjustors, then (reported) eGFR and eGFR 'slope adjusted' will converge and be super-imposable. If the methods have not changed their performance characteristics and the original production of the slopes was 'error free' and the pools used in the scheme were truly representative, then this convergence would be to the best estimate of the eGFR. This would be the best short-term outcome scenario.

If everyone changed to using specific and sensitive methods that were IDMS traceable, then all three analytes (reported) eGFR, eGFR 'slope adjusted' and eGFR 'new 175' would be super-imposable and be 'correct'. This would be the ideal scenario and should be seen as a long-term goal. It is achievable.

If nobody adopted the suggested UK NEQAS slope adjustors, then (reported) eGFR and eGFR 'old 186' would be super-imposable, but both would possibly be 'wrong', especially at lower creatinine concentrations! It was to avoid this position that the DoH eGFR group was set up in the first place.

We need better agreement of eGFRs which are clinically traceable back to the evidence base. Harmonising to the wrong target would be a mistake!

Challenges for the eGFR initiative

- What about new methods?

- How frequently are the slopes updated?

- What is the 'uncertainty' of the eGFR, and of the factors?

- Will manufacturers' hype bamboozle the laboratories and the clinicians?

- What about other parameters such as ACR and PCR?

- Do points still make prizes?

Challenges for the eGFR initiative ~ ACR and PCR

One of the perennial problems I have in keeping tabs on UK [and Ireland] laboratory and clinical practice is one of units.

For example in the UK NEQAS for Urine Chemistries,
for Urinary Albumin 340 labs report in mg/L, but 2 report in g/L. for Urinary Total Protein 389 labs report in g/L, but 12 in mg/L. for Urinary Creatinine 400 labs report in mmol/L, but 19 in umol/L.

Why oh why oh why can't we get our act together on this?

Should the guidelines quote limits to reflect what currently happens (ie g/mmol, rather than mg/mmol), or will there suddenly be a seismic shift in the way labs report UTP?

There is no agreement for any analyte (as they differ by manufacturer' dipsticks) as to the value of ++ or 'trace'.

Maybe (following on from the reports from Focus in The Biomedical Scientist and MLW) I should take personal responsibility for this, too!

If there is a committee of the Great and Good out there that I don't know about, please co-opt me.

Cheers, Finlay

Birmingham

UK NEQAS Birmingham Dipstick Pilot

Laboratory :

Distribution : **16** Date : 02-Mar-2007

Dipstick Summary

Specimen : 16A

You use : Bayer Multistix 10SG

Your result			Consensus response			On this specimen you were...
Leucocytes	neg		Leucocytes	neg		Spot on
Nitrite	neg		Nitrite	neg		Spot on
Urobilinogen	normal	3.2 umol/L	Urobilinogen	normal	3.2 umol/L	Spot on
Protein	+++	3 g/L	Protein	++	1 g/L	High
pH		7.0	pH		6.5	High
non-haem Blood*	trace	10 Ery/uL	non-haem Blood*	neg		High
haem Blood*						
Specific Gravity		1.010	Specific Gravity		1.010	Spot on
Ketones	neg		Ketones	neg		Spot on
Bilirubin	neg		Bilirubin	neg		Spot on
Glucose	neg		Glucose	neg		Spot on

VLo Lo Spot on Hi VHi

If the 'gateway' to further testing is via a Dipstick result, then this raises big issues. Are dipsticks full-proof ? ~ No

Will UK NEQAS ensure dipstick 'accuracy' ? ~ you bet!

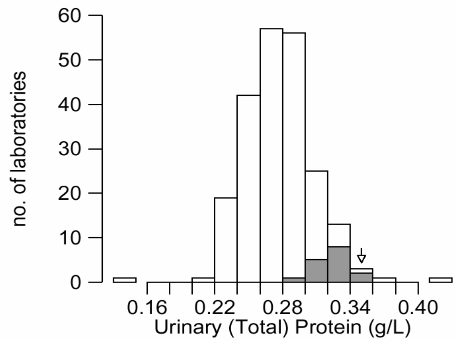
Specimen : 16B

You use : Bayer Multistix 10SG

Your result				Consensus response				On this specimen you were...
Leucocytes	neg			Leucocytes	neg			Leucocytes	Spot on
Nitrite	neg			Nitrite	neg			Nitrite	Spot on
Urobilinogen	normal	3.2 umol/L		Urobilinogen	normal	3.2 umol/L		Urobilinogen	Spot on
Protein	+	0.3 g/L		Protein	+	0.3 g/L		Protein	Spot on
pH		6.0		pH		6.0		pH	Spot on
non-haem Blood*	neg			non-haem Blood*	neg			non-haem Blood*	Spot on
haem Blood*									
Specific Gravity		1.010		Specific Gravity		1.010		Specific Gravity	Spot on
Ketones	neg			Ketones	neg			Ketones	Spot on
Bilirubin	neg			Bilirubin	neg			Bilirubin	Spot on
Glucose	+	14 mmol/L		Glucose	+	14 mmol/L		Glucose	Spot on

VLo Lo Spot on Hi VHi

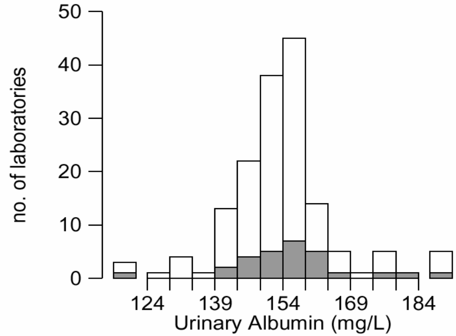
Specimen : 16B	n	Mean	SD	CV(%)
All methods	219	0.28	0.03	10.6
Dry slide	16	0.33	0.01	3.7
OCD (J&J) slides [1JJ]	16	0.33	0.01	3.7
Turbidimetry	58	0.27	0.02	7.1
Abbott reagents [5AB]	27	0.28	0.02	6.4
Roche Modular reagents [5BO]	29	0.26	0.01	5.4
Colorimetric	93	0.28	0.03	9.8
Beckman reagents [6BK]	24	0.26	0.01	4.3
Olympus reagents [6OL]	34	0.30	0.01	3.0
Randox reagents [6RX]	10	0.28	0.02	7.8
Not stated please specify	49	0.28	0.03	10.3



Common Specimen for Analysers and for Dipsticks

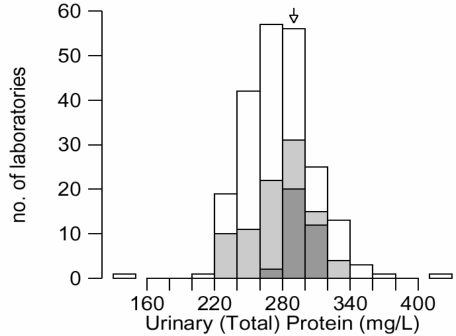
Specimen : 16B

	n	Mean	SD	CV(%)
All methods	158	153.6	8.7	5.6
Nephelometry	12	164.7	13.3	8.1
Turbidimetry	110	152.7	6.9	4.5
Abbott reagents [5AB]	19	155.9	4.7	3.0
Bayer reagents [5TE]	7	151.1	13.9	9.2
Beckman reagents [5BK]	9	155.2	6.2	4.0
Olympus reagents [5OL]	19	153.6	3.6	2.4
Randox reagents [5RX]	14	144.7	4.9	3.4
Roche Integra reagents [5RO]	7	146.8	5.9	4.0
Roche Modular reagents [5BO]	31	153.7	4.7	3.0
Not stated please specify	28	155.5	9.7	6.3



Specimen : 16B

	n	Mean	SD	CV(%)
All methods	219	281	30	10.6
Dry slide	16	330	12	3.7
OCD (J&J) slides [1JJ]	16	330	12	3.7
Turbidimetry	58	267	19	7.1
Abbott reagents [5AB]	27	277	18	6.4
Roche Modular reagents [5BO]	29	259	14	5.4
Colorimetric	93	283	28	9.8
Beckman reagents [6BK]	24	264	11	4.3
Olympus reagents [6OL]	34	300	9	3.0
Randox reagents [6RX]	10	280	22	7.8
Not stated please specify	49	280	29	10.3



We are looking at units and ratios and performance

eGFR - the current 'big thing'

Seeking
Agreement
Using
Slope
Adjusted
GFR
Estimates

Successfully
Adopting
UK NEQAS
Slope
Adjusted
GFR
Estimate
Systems

You would be disappointed if UK NEQAS didn't have some acronyms for this!

We wanted SAUSAGE but got SAUSAGES . . .

eGFR - SAUSAGES and MASH

Successfully
Adopting
UK NEQAS
Slope
Adjusted
GFR
Estimate
Systems

Maintaining
Agreement of
Slope
Harmonisation

eGFR - SAUSAGES and MASH or Wurst?

Successfully
Adopting
UK NEQAS
Slope
Adjusted
GFR
Estimate
Systems

Maintaining
Agreement of
Slope
Harmonisation

When I was in Germany giving this talk, I went for:

Weighted Unified Renal Slope Transformations

I don't know, it could be worse!