LABORATORY INVESTIGATION GUIDELINES FOR CHRONIC KIDNEY DISEASE AND UTILISATION OF eGFR IN ADULTS

OCTOBER 2012
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FOREWORD
The Clinical Practice Guideline (CPG) for the Chronic Kidney Disease (CKD) that was recently launched has clearly indicated the needs to standardize the formula to be adopted for eGFR (estimated Glomerular Filtration Rate) as well as to standardize reporting for eGFR (eGFR reporting format) for the whole country. The Pathology service had established a Working Group for The Standardization of eGFR in CKD for Adults from the Chemical Pathology technical group to achieve this.

Hopefully, the standardization and guidelines that has been developed will benefit the patients.

Dr. Shahnaz Murad
National Head of Pathology Services
Ministry of Health, Malaysia.
FOREWORD

The prevalence of chronic kidney disease (CKD) and end-stage renal disease (ESRD) is increasing worldwide. In Malaysia, the incidence and prevalence of patients with ESRD on dialysis had increased. As a consequence, the growing number of ESRD places an enormous human, economic and social burden on the healthcare system.

Early kidney disease is largely asymptomatic and patients often present late with complications of CKD. As such, targeted screening and early intervention will be necessary to reduce the burden of the disease. Primary care providers play a key role in the early identification, treatment and improving the outcome of patients with CKD. Awareness of CKD among primary care providers should be increased and they should be equipped to detect and to treat these patients, including referral to nephrologists for further management.

In the current Clinical Practice Guidelines (CPG) by the Ministry of Health (MOH), laboratory tests for detection and staging of CKD include estimated Glomerular Filtration Rate (eGFR) based on the Modification Diet of Renal Disease (MDRD) equation. Serum creatinine should be used in combination with eGFR in the assessment of renal function.

It is my hope that this guideline: “Laboratory Investigation Guidelines for Chronic Kidney Disease and Utilisation Of eGFR in Adults” will be used by MOH Pathology laboratory as a platform to help laboratorians to implement and use a standardised formula to calculate and, thus to report eGFR.

Hopefully, the reporting of eGFR by the MOH Pathology Service will further improve the detection and staging of CKD in Malaysia.

Dr. Muhammad Arif Mohd. Hashim
National Head of Chemical Pathology and
Head of Pathology Department
Hospital Kuala Lumpur
THE ARTICLES
INTRODUCTION

Chronic kidney disease (CKD) is an irreversible loss of renal function for at least three months and poses a major public health problem. The prevalence of CKD and end-stage renal disease (ESRD) is increasing worldwide. The estimated prevalence of CKD in the US was 16.8% while in Asia the prevalence ranged from 12.1% to 17.5%. In Malaysia, the incidence and prevalence of patients with ESRD on dialysis had increased from 88 and 325 per million population (pmp) respectively in 2001 to 170 and 762 pmp respectively in 2009. The increase in ESRD was largely driven by the increasing incidence of diabetic kidney disease (DKD) accounting for 58% of new patients accepted for dialysis. As a consequence, the growing number of ESRD places an enormous human, economic and social burden on the healthcare system.

Early kidney disease is largely asymptomatic and patients often present late with complications of CKD. As such, targeted screening and early intervention will be necessary to reduce the burden of the disease. Primary care providers play a key role in the early identification, treatment and improving the outcome of patients with CKD. Awareness of CKD among primary care providers should be increased and they should be equipped to detect and to treat these patients, including referral to nephrologists for further management.

The Clinical Practice Guidelines (CPG) was recently launched by the Ministry of Health (MOH) with the objectives to provide recommendations on the following:

a) Prevention and reduction in risk of developing chronic kidney disease (CKD)
b) Screening and early detection of CKD
c) Treatment of early CKD to prevent its progression to end-stage renal disease
d) Reduction in risk of cardiovascular disease

Patients with early stage of CKD are generally asymptomatic. Many of such cases remain undiagnosed and later progress to ESRD. To reduce the prevalence of ESRD, effective screening and treatment methods for CKD should be established. Early detection and intervention of high risk groups may prevent the development and progression of CKD. For instance, patients with diabetes mellitus and/or hypertension should be screened at least yearly for chronic kidney disease (CKD). Screening can also be considered for high risk patients with:

a) Age >65 years old
b) Family history of stage 5 CKD or hereditary kidney disease
c) Structural renal tract disease, renal calculi or prostatic hypertrophy
d) Opportunistic (incidental) detection of haematuria or proteinuria
e) Chronic use of non-steroidal anti-inflammatory drugs (NSAIDs) or other nephrotoxic drugs
f) Cardiovascular disease (CVD)
INTRODUCTION

g) Multisystem diseases with potential kidney involvement such as systemic lupus erythematosus.

In the current CPG, laboratory tests for detection and staging of CKD include estimated Glomerular Filtration Rate (eGFR) based on the Modification Diet of Renal Disease (MDRD) equation. Serum creatinine should be used in combination with eGFR in the assessment of renal function.

For many years, serum creatinine has been routinely used in clinical practice to estimate renal function. However, it is affected by many other variables (such as age, gender, ethnicity, muscle mass and protein meal) and should not be used as an independent marker of kidney function. Furthermore, serum creatinine is not a sensitive marker of early CKD as it will rise only after a reduction of renal function by at least 50%.

Due to this limitation, other formula to estimate renal function was developed including the MDRD equation. The MDRD equation has been shown to be better than Cockcroft-Gault equation in estimating renal function. However, these equations are still dependent on serum creatinine level and thus may over-estimate (such as in amputees) or under-estimate (such as in bodybuilders) renal function when muscle mass is abnormal.

With the launching of the CPG, National Pathology Service will implement the eGFR reporting from the clinician request using the standardized request form. Hopefully, the request and reporting of eGFR will improve the detection and staging of CKD and will help with the management of the patients.

In conclusion, through the link with laboratories, the public health issues of CKD detection and management will be implemented in a uniform manner. Renal experts (such as nephrologists and pathologists) will provide the interpretive expertise to allow optimal use of the laboratory results by the users of the laboratory services. The collaborative approach can provide a template for future activities where consensus approaches driven by informed experts are preferable to patchwork local implementations at the laboratory or laboratory network level. The consistent approach optimizes the use of pathology reporting services to disseminate pathology-related health interventions as widely as possible such as this eGFR reporting.
AIM OF THE GUIDELINES

The aims of these guidelines are to provide:

1. Guideline for request of eGFR
2. Guideline for collection of specimen for tests to support CKD
3. Recommended method and method interferences
4. Guideline for calculation and unit to be adopted for tests that support CKD
5. Guideline for reporting of eGFR (format).
GUIDELINES FOR REQUESTING AND REPORTING OF eGFR

1. Request form
   1.1. All manual request shall use PER. PAT 301 form
   1.2. Information needed
       • Relevant clinical history
       • Previous creatinine result, if available
       • Previous Creatinine Clearance, if available
       • Previous calculated eGFR result, if available

2. Only serum or plasma creatinine sample sent along with PER. PAT 301 form shall have its eGFR calculated.

3. Calculation of eGFR using previous creatinine result shall not be allowed. This is because previous eGFR result could lead to misinterpretation of the test result correlating to the current patient status.

4. Manual calculation of eGFR
   4.1. eGFR can be calculated using CKD and eGFR Laboratory Tools (CELT) software.
   4.2. Transcription check shall be done.

5. Automatic calculation of eGFR via LIS
   5.1. Use the adopted eGFR formula and reporting format. The formula and reporting format should be verified by the Chemical Pathologist or designated officer prior to first time usage.

6. eGFR reporting format
   6.1 The MDRD eGFR Formula is calculated in ml/min/1.73m²

$$175 \times \left(\frac{S_{cr}}{88.4}\right)^{1.154} \times (\text{Age})^{-0.203} \times (0.742 \text{ if female})$$

   • The equation does not require weight measurement because the results are reported normalized to 1.73 m² body surface area, which is an accepted average adult surface area.
   • This equation is not applicable for African Black.

6.2 Disclaimer below shall be included in the eGFR report

LIMITATIONS OF THE MDRD eGFR
The MDRD equation should not be used in some populations where it has not been specifically validated, including:
• Paediatric patients (<18 years)
• Elderly patients (>70 years)
• Dialysed patients
• Pregnant mothers
GUIDELINES FOR REQUESTING AND REPORTING OF eGFR

- Extremes of body habitus ie malnutrition, paraplegia, quadriplegia
- Patients with skeletal muscle disorders
- Vegetarians
- Patients with very rapidly changing kidney function
- Patients on renally excreted drugs that have significant toxicity
- Severe dehydration
- Patients on medications that might interfere with the creatinine measurement
- Not suitable for drugs dosing
- Incomplete essential information (age, gender, race)
### 4.1 Serum/Plasma Creatinine

<table>
<thead>
<tr>
<th>TEST / CLINICAL SIGNIFICANCE</th>
<th>SPECIMEN COLLECTION &amp; PREANALYTICAL REQUIREMENTS</th>
<th>RECOMMENDED METHOD</th>
<th>CALCULATION &amp; UNIT</th>
<th>COMMENT</th>
</tr>
</thead>
</table>
| **Creatinine** *(Serum/Plasma)* | Collection tube:  
• Heparin tube (plasma)  
• Plain tube (serum)  
  
Avoid factors that may affect creatinine generation (REFER TABLE 1)  
  
Avoid icteric, haemolysis and lipaemic samples  
  
Stability:  
• 2–8 °C : stable up to 1 day  
• Freeze for longer storage. | Methods include:  
• Enzymatic method that has calibration traceable to an IDMS reference measurement procedure  
• Kinetic Jaffe method that has calibration traceable to an IDMS reference measurement procedure. | Creatinine value is expressed in µmol/L (no decimal point)  
  
* Serum/Plasma Creatinine  
  
  * mg/dl multiply with 88.4 → µmol/L  
  
  * mmol/L multiply with 1000 → µmol/L | Jaffe method  
False elevation of creatinine (positive interference) by Kinetic Jaffe method can occur in the presence of  
• Proteins  
• Glucose  
• Ketoacid  
• Ascorbic acid  
  
Enzymatic method  
Possible interference in enzymatic method by bilirubin and monoclonal IgG |
### 4.2 URINE ALBUMIN CREATININE RATIO (UACR)

<table>
<thead>
<tr>
<th>TEST/CLINICAL SIGNIFICANCE</th>
<th>SPECIMEN COLLECTION &amp; PREANALYTICAL REQUIREMENT</th>
<th>METHOD</th>
<th>CALCULATION &amp; UNIT</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>URINE ALBUMIN CREATININE RATIO (UACR)</strong></td>
<td>Correlates with 24-hour albumin excretion&lt;br&gt;First morning urine specimen is preferred&lt;br&gt;A random urine specimen is acceptable if a first-morning urine specimen is not available.&lt;br&gt;Stability of urine albumin:&lt;br&gt;  * 2–8 °C : stable up to 1 month&lt;br&gt;  * Frozen at -20°C : stable up to 6 months&lt;br&gt;  * Frozen at -70°C : stable up to 1 year&lt;br&gt;Preferably analyse on fresh sample&lt;br&gt;Stability of urine creatinine:&lt;br&gt;  * 2–8 °C : stable up to 4 days&lt;br&gt;  * Freeze for longer storage&lt;br&gt;Preferably analyse on fresh sample</td>
<td><strong>Urine Albumin</strong>&lt;br&gt;Imunoassay methods include:&lt;br&gt;  * Turbidimetric&lt;br&gt;  * Nephelometric</td>
<td><strong>Urine Albumin Creatinine Ratio</strong>&lt;br&gt;(UACR) is expressed in mg/mmol (1 decimal point)&lt;br&gt;To calculate, follow these steps:&lt;br&gt;  1. Measure urine albumin in mg/L&lt;br&gt;  2. Measure urine Creatinine in mmol/L&lt;br&gt;  3. Calculate UACR&lt;br&gt;  * Urine Albumin (mg/L) = _mg/mmol (1 decimal point)&lt;br&gt;  * Urine Creatinine (mmol/L)</td>
<td>• Interpretation of Urine Albumin to Creatinine Ratio (REFER TABLE 2)&lt;br&gt;• An elevated UACR should be confirmed in the absence of urinary tract infection with two (2) additional first-void specimens collected during the next 3 to 6 months&lt;br&gt;• Activity/condition that may increase urinary albumin excretion over baseline values&lt;br&gt;  * Exercise&lt;br&gt;  * Fever&lt;br&gt;  * Haematuria&lt;br&gt;  * Pregnancy&lt;br&gt;  * Postural proteinuria&lt;br&gt;  * Urinary tract infection</td>
</tr>
<tr>
<td></td>
<td>Urine Creatinine Methods include:&lt;br&gt;  * Enzymatic method&lt;br&gt;  * Kinetic Jaffe method&lt;br&gt;Due to lack of certified secondary reference material for urine creatinine, calibration of routine methods of urine measurement is often performed with serum based reference material.</td>
<td>UACR</td>
<td><strong>Urine Albumin</strong>&lt;br&gt;* g/L multiply with 1000 → mg/L&lt;br&gt;* μg/ml is equal to mg/L</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Urine Creatinine</strong>&lt;br&gt;* mg/dl multiply with 0.0884 → mmol/L&lt;br&gt;* μmol/L divide by 1000 → mmol/L</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 4.3 URINE PROTEIN CREATININE RATIO (UPCR)

<table>
<thead>
<tr>
<th>TEST/CLINICAL SIGNIFICANCE</th>
<th>SPECIMEN COLLECTION &amp; PREANALYTICAL REQUIREMENTS</th>
<th>RECOMMENDED METHOD</th>
<th>CALCULATION &amp; UNIT</th>
<th>COMMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>URINE PROTEIN CREATININE RATIO (UPCR)</strong></td>
<td>Correlate with 24-Hr protein excretion</td>
<td><strong>Urine Protein</strong></td>
<td><strong>Urine Protein Creatinine Ratio (UPCR)</strong> is expressed in mg/mmol</td>
<td>• Interpretation of Urine Protein to Creatinine Ratio (REFER TABLE 2)</td>
</tr>
<tr>
<td></td>
<td>First morning urine specimen is preferred.</td>
<td>Methods include:</td>
<td>To calculate, follow these steps:</td>
<td>• Activity/condition that may increase urinary protein over baseline values</td>
</tr>
<tr>
<td></td>
<td>A random urine specimen is acceptable if a first-morning urine specimen is not available.</td>
<td>• Dye binding (colorimetric) (e.g. Pyrogallol Red)</td>
<td>1. Measure urine Protein in mg/L.</td>
<td>• Congestive heart failure</td>
</tr>
<tr>
<td></td>
<td>Stability of urine protein:</td>
<td>• Turbidimetric (e.g. Benzethonium Cl)</td>
<td>2. Measure urine Creatinine in mmol/L.</td>
<td>• Exercise</td>
</tr>
<tr>
<td></td>
<td>• 2–8 °C : stable up to 7 days</td>
<td>Currently, there is no reference measurement procedure and no standardized reference material for urinary total protein.</td>
<td>3. Calculate UPCR</td>
<td>• Fever</td>
</tr>
<tr>
<td></td>
<td>• Frozen at -20°C : stable up to 1 year</td>
<td><strong>Urine Creatinine</strong></td>
<td><strong>Urine Protein (mg/L)</strong> = --------------</td>
<td>• Haematuria</td>
</tr>
<tr>
<td></td>
<td>Preferably analyse on fresh sample</td>
<td>Methods include:</td>
<td><strong>Urine Creatinine (mmol/L)</strong> = __mg/mmol (no decimal point)</td>
<td>• Infection</td>
</tr>
<tr>
<td></td>
<td>Stability of urine creatinine:</td>
<td>• Enzymatic method</td>
<td></td>
<td>• Marked hyperglycaemia</td>
</tr>
<tr>
<td></td>
<td>• 2–8 °C : stable up to 4 days</td>
<td>• Kinetic Jaffe method</td>
<td></td>
<td>• Postural proteinuria</td>
</tr>
<tr>
<td></td>
<td>• Freeze for longer storage</td>
<td>Due to lack of certified secondary reference material for urine creatinine, calibration of routine methods of urine measurement is often performed with serum based reference material.</td>
<td></td>
<td>• Pregnancy</td>
</tr>
<tr>
<td></td>
<td>Preferably analyse on fresh sample</td>
<td><strong>Urine Protein</strong></td>
<td></td>
<td>• Severe/malignant hypertension</td>
</tr>
<tr>
<td></td>
<td><strong>Urine Protein</strong></td>
<td><strong>g/L multiply with 1000 → mg/L.</strong></td>
<td></td>
<td>• Urinary tract infection</td>
</tr>
<tr>
<td></td>
<td><strong>Urine Creatinine</strong></td>
<td><strong>µmol/L divide by 1000 → mmol/L.</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 4.4 24-Hr Urine Protein

<table>
<thead>
<tr>
<th>Test / Clinical Significance</th>
<th>Specimen Collection &amp; Preanalytical Requirements</th>
<th>Recommended Method</th>
<th>Calculation &amp; Unit</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>24-Hr Urine Protein</td>
<td>Instructions for 24-Hr urine collection</td>
<td>Methods include:</td>
<td>24-Hr Urine Protein is expressed in g/24Hr</td>
<td>• 24-Hr urine collections may be associated with significant collection errors, largely due to improper timing and missed samples, leading to over-collection and under-collection.</td>
</tr>
<tr>
<td></td>
<td>Day 1: Instruct patient to void at 8 am and discard the sample. Collect all urine in a 24-Hr urine container for the next 24 Hrs. Day 2: Include the final sample voided at 8 am into the urine container. Keep sample in the refrigerator or in a cool place during the collection period. Label the container with • Two identifiers (Name and NRIC/MRN) • Date and time collection started • Date and time collection completed</td>
<td>• Dye binding (colorimetric) (e.g. Pyrogallol Red) • Turbidimetric (e.g. Benzethonium Cl) Currently, there is no reference measurement procedure and no standardized reference material for urinary total protein.</td>
<td>To calculate, follow these steps: 1. Measure 24-Hr urine volume in L/24Hr 2. Measure the urine protein in mg/L 3. Calculate 24 Hr Urine Protein [ \text{Urine Protein (g/24Hr)} = \frac{\text{Urine Volume} \times \text{Urine Protein (mg/L)}}{1000} ]</td>
<td>• Normal urine output for an adult is 0.5 to 1.0 ml/kg/Hr. Under collection of 24 Hr urine volume may give falsely low concentration of urine protein.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Interpretation of 24-Hr Urine Protein (REFER TABLE 2)</td>
</tr>
</tbody>
</table>

24-Hr Urine Protein is a 'gold standard' for the quantification of proteinuria.
### 4.5 CREATININE CLEARANCE (CrCl)

<table>
<thead>
<tr>
<th>TEST/CLINICAL SIGNIFICANCE</th>
<th>SPECIMEN COLLECTION &amp; PREANALYTICAL REQUIREMENTS</th>
<th>RECOMMENDED METHOD</th>
<th>CALCULATION &amp; UNIT</th>
<th>COMMENT</th>
</tr>
</thead>
</table>
| CREATININE CLEARANCE (CrCl) | Sample needed:  
- Serum/plasma Creatinine shall be taken within 24-Hr of urine collection  
- 24-Hr Urine collection for Creatinine measurement  
Instructions for 24-Hr urine collection  
Patient Preparation:  
Avoid taking interfering medications (REFER TABLE 1). If possible, drugs should be stopped beforehand. Ensure patient drink sufficient water before start collecting and continue good hydration throughout the procedure. A meat free diet is recommended  
Urine Creatinine  
Methods include:  
- Enzymatic method  
- Kinetic Jaffe method | Serum creatinine  
Methods include:  
- Enzymatic method that has calibration traceable to an IDMS reference measurement procedure  
- Kinetic Jaffe method that has calibration traceable to an IDMS reference measurement procedure  
Urine Creatinine  
Methods include:  
- Enzymatic method  
- Kinetic Jaffe method | Creatinine clearance is expressed in ml/min  
To calculate, follow these steps:  
1. Measure 24-Hr urine volume in L/24Hr  
2. Measure urine creatinine in mmol/L  
3. Measure serum creatinine in µmol/L  
4. Calculate creatinine clearance in ml/min  
Urine Creatinine x 24-hr Urine Volume (mmol/L) / 1440  
= __ x 1,000,000 ml/min (no decimal point)  
Serum Creatinine (µmol/L) | 24-Hr urine collections may be associated with significant collection errors, largely due to improper timing and missed samples, leading to over-collections and under-collections. |
### SPECIMEN COLLECTION & PREANALYTICAL REQUIREMENTS

**Day 1:** Instruct the patient to void at 8 am and discard the sample. Collect all urine in a 24-Hr urine container for the next 24-Hrs.

**Day 2:** Include the final sample voided at 8 am into the urine container. Keep sample in the refrigerator or in a cool place during the collection period.

Label the container with:
- Two identifiers (Name and NRIC/MRN)
- Date and time collection started
- Date and time collection completed

### RECOMMENDED METHOD

Due to lack of certified secondary reference material for urine creatinine, calibration of routine methods of urine measurement is often performed with serum based reference material.

### CALCULATION & UNIT

To calculate, follow these steps:
1. Measure 24-Hr urine volume in ml/24Hr
2. Measure urine creatinine in µmol/L
3. Measure serum creatinine in µmol/L
4. Calculate the creatinine clearance in ml/min

\[
\text{Urine Creatinine} \times \frac{24\text{-hr Urine Volume} (\mu\text{mol/L})}{(\text{ml/24Hr})} = \frac{\text{Serum Creatinine} (\mu\text{mol/L})}{1400 \text{ min}} = \text{ml/min (no decimal point)}
\]

### COMMENT

Or
### STANDARDIZATION OF CREATININE ASSAY, eGFR REPORTING AND LABORATORY INVESTIGATIONS OF CHRONIC KIDNEY DISEASE IN ADULTS

#### 4.6 ESTIMATED GLOMERULAR FILTRATION RATE (eGFR) by MODIFICATION OF DIET IN RENAL DISEASE (MDRD)

<table>
<thead>
<tr>
<th>TEST/CLINICAL SIGNIFICANCE</th>
<th>SPECIMEN COLLECTION &amp; PREANALYTICAL REQUIREMENTS</th>
<th>RECOMMENDED METHOD</th>
<th>CALCULATION &amp; UNIT</th>
<th>COMMENT</th>
</tr>
</thead>
</table>
| ESTIMATED GLOMERULAR FILTRATION RATE (eGFR) by MODIFICATION OF DIET IN RENAL DISEASE (MDRD) | Sample needed:  
- Serum/plasma Creatinine | Methods for serum/plasma creatinine include:  
- Enzymatic method that has calibration traceable to an IDMS reference measurement procedure  
- Kinetic Jaffe method that has calibration traceable to an IDMS reference measurement procedure. | MDRD eGFR value is expressed in ml/min/1.73m² (no decimal point)  
To calculate, follow these steps:  
1. Measure serum creatinine in µmol/L  
2. Age is expressed in years.  
3. Calculate MDRD eGFR in ml/min/1.73m²  
   \[ 175 \times (S_{cre} / 88.4)^{-1.154} \times (Age)^{-0.203} \times (0.742 \text{ if female}) \]  
   (no decimal point)  
The equation does not require weight measurement because the results are reported normalized to 1.73 m² body surface area, which is an accepted average adult surface area.  
The above equation is not applicable for African Black. However, the result can be generated by multiplying the eGFR result derived from the above equation with 1.212 | • Interpretation of MDRD eGFR value (REFER TABLE 3) |

#### LIMITATIONS OF THE MDRD eGFR

The MDRD equation should not be used in some populations where it has not been specifically validated, including:

- Paediatric patients (<18 years)
- Elderly patients (>70 years)
- Dialysed patients
- Pregnant mothers
- Extremes of body habitus (e.g., malnutrition, paraplegia, quadriplegia)
- Patients with skeletal muscle disorders
- Vegetarians
- Patients with very rapidly changing kidney function
- Patients on renally excreted drugs that have significant toxicity
- Severe dehydration
- Patients on medications that might interfere with the creatinine measurement
- Not suitable for drugs dosing
- Incomplete essential information (age, gender, race)
APPENDIX
1. Borang permohonan
   1.1 Gunakan borang PER. PAT 301
   1.2 Maklumat lain
       • Maklumat sejarah penyakit yang berkaitan
       • Keputusan ujian creatinine lampau, jika ada
       • Keputusan Creatinine Clearance lampau, jika ada
       • Pengiraan ujian eGFR lampau, jika ada

2. Keputusan serum/plasma creatinine yang sampelnya dihantar bersama-sama borang PER. PAT 301 sahaja akan dibuat pengiraan eGFR.

3. Keputusan creatinine yang lampau (previous results) tidak akan digunakan bagi pengiraan eGFR. Ini kerana keputusan ujian lampau eGFR boleh menimbulkan masalah dari segi intepretasi keputusan ujian mengikut keadaan semasa pesakit.

4. Pengiraan eGFR secara manual
   4.1 eGFR boleh dikira menggunakan CKD and eGFR Laboratory Tools (CELT) software.
   4.2 Semakan transkripsi perlu dilakukan.

5. Pengiraan eGFR secara automatik
   5.1 Gunakan formula eGFR yang disarankan dan format laporan yang disediakan. Formula dan format laporan perlu disahkan oleh Pakar Patologi Kimia atau pegawai yang bertanggungjawab sebelum memulakan penggunaannya buat pertama kali.

6. Format Laporan eGFR
   6.1 Formula pengiraan eGFR menggunakan MDRD eGFR dalam ml/min/1.73m²
      \[ 175 \times \left( \frac{S_{cr}}{88.4} \right)^{-1.154} \times (Age)^{-0.203} \times (0.742 \text{ if female}) \]
      *The equation does not require weight measurement because the results are reported normalized to 1.73 m² body surface area, which is an accepted average adult surface area.*

      This equation is not applicable for African Black.

   6.2 Kenyataan di bawah (Disclaimer) akan dikeluarkan bersama laporan eGFR (eGFR report)

   **LIMITATIONS OF THE MDRD eGFR**
   The MDRD equation should not be used in some populations where it has not been specifically validated, including:
   • paediatric patients (<18 years)
   • elderly patients (>70 years)
GARIS PANDUAN UNTUK MEMOHON DAN MELAPOR eGFR

- Dialysed patients
- Pregnant mothers
- Extremes of body habitus ie malnutrition, paraplegia, quadriplegia
- Patients with skeletal muscle disorders
- Vegetarians
- Patients with very rapidly changing kidney function
- Patients on renally excreted drugs that have significant toxicity
- Severe dehydration
- Patients on medications that might interfere with the creatinine measurement
- Not suitable for drugs dosing
- Incomplete essential information (age, gender, race)
# APPENDIX II: eGFR REPORTING FORMAT

## eGFR REPORT

<table>
<thead>
<tr>
<th>NAME</th>
<th>WARD / CLINIC</th>
<th>RN</th>
<th>MRN</th>
<th>DATE OF REQUEST</th>
<th>DATE RECEIVED</th>
<th>NAME OF DOCTOR</th>
<th>BARCODE NO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**eGFR REPORT**

- **Creatinine Result**: \( \text{\mu mol/l} \)
- **eGFR Value**: \( \text{ml/min/1.73 m}^2 \)
- **Creatinine Assay Method**: Jaffe Kinetic / Enzymatic
- **Modification of Diet in Renal Disease (MDRD) Equation**

\[
175 \times (\text{Scr}/88.4)^{1.154} \times (\text{Age})^{-0.203} \times (0.742 \text{ if female})
\]

The equation does not require weight measurement because the results are reported normalized to 1.73 m\(^2\) body surface area, which is an accepted average adult surface area.

*This equation is not applicable for African Black*

### Stages of CKD

<table>
<thead>
<tr>
<th>STAGES OF CKD</th>
<th>GFR (ml/min/1.73m(^2))</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>&gt;90</td>
<td>Normal or increased GFR, with other evidence of kidney damage</td>
</tr>
<tr>
<td>2</td>
<td>60-89</td>
<td>Slight decrease in GFR, with other evidence of kidney damage</td>
</tr>
<tr>
<td>3A</td>
<td>45-59</td>
<td>Moderate decrease in GFR, with or without other evidence of kidney damage</td>
</tr>
<tr>
<td>3B</td>
<td>30-44</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>15-29</td>
<td>Severe decrease in GFR, with or without other evidence of kidney damage</td>
</tr>
<tr>
<td>5</td>
<td>&lt;15</td>
<td>Established renal failure</td>
</tr>
</tbody>
</table>

**Limitations of the MDRD eGFR**

The MDRD equation should not be used in some populations where it has not been specifically validated, including:

- Paediatric patients (<18 years)
- Elderly patients (>70 years)
- Dialysed patients
- Pregnant mothers
- Extremes of body habitus ie malnutrition, paraplegia, quadriplegia
- Patients with skeletal muscle disorders
- Vegetarians
- Patients with very rapidly changing kidney function
- Patients on renally excreted drugs that have significant toxicity
- Severe dehydration
- Patients on medications that might interfere with the creatinine measurement
- Not suitable for drugs dosing
- Patients on medications that might interfere with the jaundice measurement

**COMMENT:**

<table>
<thead>
<tr>
<th>VALIDATED BY:</th>
<th>REPORTED BY:</th>
<th>DATE:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### TABLE 1: FACTORS THAT MAY AFFECT CREATININE GENERATION

<table>
<thead>
<tr>
<th>Mechanisms</th>
<th>Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced creatinine generation- Decrease serum / plasma creatinine</td>
<td>• Older Age</td>
</tr>
<tr>
<td></td>
<td>• Female Sex</td>
</tr>
<tr>
<td></td>
<td>• Malnutrition</td>
</tr>
<tr>
<td></td>
<td>• Muscle wasting</td>
</tr>
<tr>
<td></td>
<td>• Amputation</td>
</tr>
<tr>
<td>Increased creatinine generation- Increase serum / plasma creatinine</td>
<td>• African Black</td>
</tr>
<tr>
<td></td>
<td>• Increased muscle mass</td>
</tr>
<tr>
<td></td>
<td>• Ingestion of cooked meats (Transient increase)</td>
</tr>
<tr>
<td>Decreased creatinine clearance by inhibiting tubular secretion of creatinine</td>
<td>Medications that may increase serum/plasma creatinine include:</td>
</tr>
<tr>
<td></td>
<td>• Cephalosporin and aminoglycoside antibiotics</td>
</tr>
<tr>
<td></td>
<td>• Flucytosine</td>
</tr>
<tr>
<td></td>
<td>• Cisplatin</td>
</tr>
<tr>
<td></td>
<td>• Cimetidine</td>
</tr>
<tr>
<td></td>
<td>• Trimethoprim</td>
</tr>
</tbody>
</table>
### TABLE 2: DIAGNOSIS OF ABNORMAL PROTEIN OR ALBUMIN EXCRETION

<table>
<thead>
<tr>
<th>CLASS</th>
<th>UACR (mg/mmol)</th>
<th>UPCR (mg/mmol)</th>
<th>URINE 24 HR PROTEIN (g/24 Hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>&lt;2.5 (male)</td>
<td>&lt;15</td>
<td>&lt;0.15</td>
</tr>
<tr>
<td></td>
<td>&lt;3.5 (female)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trace protein</td>
<td>≥ 2.5 to 30</td>
<td>15-44</td>
<td>0.15 – 0.44</td>
</tr>
<tr>
<td>(Microalbuminuria)</td>
<td>(male)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>≥ 3.5 to 30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(female)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overt Proteinuria</td>
<td>&gt;30</td>
<td>&gt; 45</td>
<td>&gt; 0.45</td>
</tr>
<tr>
<td>(Macroalbuminuria)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Modified from Scottish Intercollegiate Guidelines Network. Diagnosis and management of chronic kidney disease. Edinburgh: SIGN; 2008*
### TABLE 3: STAGING OF CHRONIC KIDNEY DISEASE

<table>
<thead>
<tr>
<th>STAGE OF CKD</th>
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</table>
WORKING GROUP FOR THE STANDARDISATION OF
eGFR IN CKD (ADULTS)

Chairman

Dr. Muhammad Arif Mohd. Hashim
Senior Consultant Pathologist and
Head of Pathology Department
Hospital Kuala Lumpur e-mail : drarif@hkl.moh.gov.my

Members

Dr. Baizurah Mohd. Hussain
Senior Consultant Pathologist and
Head of Pathology Department
Hospital Ampang e-mail : baizurah@sel.moh.gov.my

Dr. Siti Sharina Anas
Chemical Pathologist
Hospital Putrajaya e-mail : ppsharina@hpj.gov.my

Dr. Hanisah Abdul Hamid
Chemical Pathologist
Hospital Tengku Ampuan Rahimah, Klang e-mail : hanisah.hamid@yahoo.com

Dr. Nik Ahmad Zahar Nik Yah
Chemical Pathologist
Hospital Raja Permaisuri Bainun, Ipoh e-mail : nikahmad17@yahoo.com

En. Liew Chuan Hee
Scientific Officer (Biochemist)
Hospital Tengku Ampuan Rahimah, Klang e-mail : niccoliew@yahoo.com.sg

En. Abdul Rahim bin Osman
Scientific Officer (Biochemist)
Hospital Kuala Lumpur e-mail : arahim_osman@yahoo.com

Cik Kanchana Kanthasamy
Scientific Officer (Biochemist)
Hospital Kuala Lumpur e-mail : kkanch_85@yahoo.com

Cik Lili Tresa Arulananban
Medical Laboratory Technologist
Klinik Kesihatan Tanglin e-mail : lilitresa@wp.moh.gov.my

En. Lee Lian Hoe
Medical laboratory Technologist
Hospital Selayang e-mail :LeeLHO@selayanghospital.gov.my
REFERENCES

1. Ministry Of Health. Management of Chronic Kidney Disease in Adults. MOH/P/PAK/217.11(GU) ; 2011


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- Family Health Development Division
- National Public Health Laboratory

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