# Clyde Biochemistry Departments Laboratory Handbook

A 24 hour biochemistry service is available from all three main hospital sites in Clyde: the Inverclyde Royal Infirmary, the Royal Alexandra Hospital and the Vale of Leven Hospital.

Between them the laboratories handle over 7 million tests per annum.

The laboratories are enrolled in National External Quality Assurance Schemes for all tests.

## Laboratory Hours

| | | |
|---|---|---|
| Routine Service: | Weekdays | 08.30 - 17.00 hrs |
| Restricted Service: | Saturday, Sunday and bank holidays | |
| | Royal Alexandra Hospital | 09.00 - 12.00 hrs |
| | Inverclyde Royal Hospital | 08.30 - 12.00 hrs |
| | Vale of Leven | N/A |

Routine samples are analysed with a usual turnaround of half a day.

Essential tests are carried out on urgent samples at other times, most being analysed within one hour of receipt in the laboratory.

At the Vale of Leven hospital out of hours iStat analysers are available for emergency tests (see POCT section) and the other tests on the Urgent out of hours repertoire can be accessed at the RAH laboratory.

## Telephone and Result Enquiries

Within the hospital results can be accessed through Trakcare or the Clinical Portal. It is not helpful to phone the laboratory for results as this delays other work.

For primary care access is through SCI or Share point as it becomes more widely available within GG&C.

If you need an access password within the hospital complete the relevant form found on Staffnet under Applications.

All staff are reminded to help prevent unauthorised access of confidential data.

Do not allow unauthorised persons to see data on screens. Log off after use. Do not allow, by action or inaction, the disclosure of information to any unauthorised person.

An audit trail of your access is retained on the system.

Severely abnormal results will be phoned to the ward/ practice/ secretary to pass information on to the clinician (see web site for full details).

When severely abnormal results are detected on primary care samples out of hours NHS 24 will be contacted if it is thought the results might need urgent attention.

## Add on Tests – Hospital Users

The laboratory cannot handle large numbers of phoned requests to add on tests to samples we have already received. However we will endeavour to do so if essential and unavoidable. Try to add the test onto your next request where possible. Samples may need to be retrieved from automated storage, which can take some time. If a result is required urgently it may be quicker to send a fresh sample urgently to the laboratory.

If not, you need to fill out an additional paper (not Trakcare) request form and send it to the laboratory clearly indicating that it is an add on test.

We cannot accept add on requests for unstable analytes. This applies in particular to bicarbonate. If you are not sure contact the laboratory.

Samples are stored in the laboratory for about 4 days.

## User Satisfaction and Feedback.

If you have reason to have concern about the accuracy of a result this may require urgent action – please discuss with the duty biochemist.

If you have positive or negative feedback on the laboratory's service, or if you wish to make a complaint, please contact:

Technical or General Issue:
Ms Karen Brazier
Technical Services Manager

Clinical Issue:
Dr Iain Jones
Clinical Lead

Both at:

Biochemistry Department
Royal Alexandra Hospital
Corsebar Road
Paisley
PA2 9PN

## Contact Telephone Numbers:

| | | |
|---|---|---|
| **Inverclyde Royal Hospital**: | 01475 504827 | ext 04827 |
| | Emergency requests | ext 04213 |
| **Royal Alexandra Hospital**: | 0141 314 6157 | ext 06157 |
| **Vale of Leven Hospital**: | 01389 817568 | ext 87568 |

**If you are seeking clinical advice please ask to speak to the reporting biochemist.**

Clinical Advice can also be obtained by emailing our advice Email address:

ClydeBiochemAdvice@ggc.scot.nhs.uk

**POCT testing (Blood gas analysers, hospital glucose meters etc):**

Please email routine enquiries regarding these analysers or meters and barcodes for using them to:

Clyde.BiochemistryPOCT@ggc.scot.nhs.uk

**Senior Staff** – senior staff can be contacted for advice and outside normal working hours the on-call Biochemist may be contacted via the switchboard (the on-call rota being shared between staff from Clyde and QEUH).

| | | |
|---|---|---|
| Colleen Ross | Consultant Clinical Biochemist | ext 06056 |
| Andy Kerry | Consultant Clinical Scientist | ext 06657 |
| Helen Falconer | Consultant Clinical Scientist | ext 07585 |
| Iain Jones | Consultant Clinical Biochemist | ext 06209 |
| Karen Brazier | Technical Services Manager | ext 06098 |
| Johnny Strachan | Principal Scientist | ext 07199 |
| Louise O'Donnell | Principal Scientist | ext 07199 |
| Louisa Lee | Principal Scientist | ext 06055 |

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**Laboratory Requests:**

As per section 2.13 of the Laboratory Quality Manual (available on the Clyde Laboratories Internet website), and in addition to any other formal agreements which may be in place:

The Department acknowledges that:
Each request accepted by the laboratory for examination(s) shall be considered an agreement.

**Request Forms – Patient Identification**

**Identification errors can have grave consequences for the patient.**

Please use Trakcare for ordering tests for secondary care patients, and ICE, if available, for primary care patients.

Ensure correct specimen types are collected as dictated by Trakcare request form, specimen labels are specific for bottle type. Each bottle may only have one sticker attached to it. Please attach labels with the long axis of the label parallel to the long axis of the bottle. If the label is mis-printed and is unclear or not on an adhesive label, please re-print the label.

For Trakcare only the label is used when the sample arrives in the laboratory, the counterpart form being disregarded on receipt unless there is an IT failure. Therefore please do not write additional tests or sampling handling requests for the lab on the form, as they will be missed.

Some more specialized tests are not in the ICE catalogue, and some very specialized tests are not in the Trakcare catalogue. For these tests please send a paper request form, along with additional suitable specimen tubes for the tests requested. If you are not sure what tubes are required, please contact the laboratory.

If a manual form is required please write legibly on request forms and use patient identification stickers where available for both specimen tubes and form. If the form is one with a second duplicate layer it is best to label both copies of the form as some sites require this.

**Requests with inadequate or mismatching identification will be refused. Unnamed samples will not be analysed.**

**The request form should give the name, date of birth, address and CHI number.**
**The sample must give the CHI, name and date of birth.**

The form can be used for chemistry and haematology requests together in one bag but please send urine samples with a separate form and bag (they tend to leak!).

**Samples for other disciplines**

Please ensure that samples for laboratory disciplines other than Biochemistry and Haematology are requested on that discipline's request form, not the Blood Science request form. They should be placed in a separate sample bag, and if coming from primary care should be placed in an appropriately coloured transport bag (blue for microbiology, grey for immunology, teal for virology).

**Temporary Residents / Patients without CHI**

CHI is a requirement for acceptance of requests to the laboratory. Temporary residents from outwith Scotland will not have a CHI.

Within Hospitals Trakcare can generate a "TJ number" for patients who do not have a CHI.

Outwith Hospitals the electronic ordering system will generate an "ICE number" for patients who do not have a CHI.

ICE electronic ordering will be rolled out to all practices served by Clyde Laboratories. Until such time, if a patient does not have a CHI number please state clearly that the patient is a "Temporary Resident" in the clinical details part of the request form and ensure that both the request form and sample have the following, matching patient details:

Name (first name and surname)
Date of Birth
First line of address

**Safety and Dangerous Specimens**

**Leaking Samples**

Leaking samples will not be processed by the laboratory. It is much better to send urine samples separately as leakage over a blood sample packaged with it will mean both samples are discarded.

Samples in vacuette tubes which have been decapped during the process of blood sampling are more likely to leak. Please do not ever remove the lid from vacuette tubes – if the sample leaks it may potentially contaminate and prevent the analysis of many other samples.

**Blood Borne viruses**

Clinical staff need no longer use "DANGER OF INFECTION" stickers to highlight samples containing (or suspected of containing) blood borne viruses

(BBV) such as HIV and hepatitis B or C. It is not necessary to alert the laboratory about potential infectivity of such samples since the laboratory observes standard precautions.

**Category 4 pathogens e.g. Lassa fever, Ebola**

The department cannot accept, analyse or store any sample from a patient with an illness suspected of being caused by a category 4 pathogen.

These patients should not be in these hospitals.

These are organisms with no known treatment that cause serious human disease, can be a serious hazard to employees and may spread in the community.

If there is any concern about the safety of sending a sample to the laboratory, please discuss with a Consultant Biochemist prior to sending the sample, and preferably prior to venesection / sampling.

**Tuberculous meningitis**

Users MUST alert relevant the laboratory by phone (or contact on call consultant via switchboard out of hours) for the following samples:
CSF from patients with tuberculous meningitis (or high suspicion of). (CSF spectrophotometry would not be performed on such samples). Additionally such samples should not be sent via the pneumatic tube system.

**Confidentiality**

The laboratory treats results produced as confidential. Results will be available via approved electronic systems (Trakcare, Clinical Portal, SCI Store etc). Results will be sent, in paper or electronic form, only to the location requesting them.

Results will be provided on telephone enquiry to the laboratory only to clinical staff responsible for the patient or their deputies (ward clerks, practice receptionists etc). Under no circumstances will the laboratory provide results or discuss results with patients or their relatives.

**Consent**

All testing should be undertaken with consent of the patient. For routine Biochemistry Testing implied consent should be sufficient. If the result may have significant medico-legal, forensic, or medical implications for the patient recording consent in patient notes may be appropriate.

Note that other laboratory disciplines, particularly genetics and virology, may have stronger recommendations or requirements for consent.

**Data Protection**

Laboratory processes account for the General Data Protection Regulation (GDPR) 2018.

**Venesection**
Please ensure that all waste materials associated with venesection are disposed of in the correct sharps bin (if sharps) and into appropriate waste disposal routes advised locally for other blood contaminated materials.

Please avoid removing the top of vaccutainer tubes. If not replaced correctly they may leak, contaminating and preventing the analysis of the sample in question and potentially many other patient's samples if it leaks whilst being processed.

Samples should never be sent to the lab with needles still in situ.

**Urgent Requests and Result Turnaround Times**

Routine tests are usually reported within half a day of receipt.

For samples sent marked urgent most analyses are complete within one hour of receipt. Samples should be transmitted to the lab via the pneumatic tube system where available.

Severely abnormal results will be phoned to both GPs and wards.

Hospital wards will access normal urgent results on the clinical portal.

A 'core' of tests is available out of hours and urgently (see later).

Unusual tests may be available after discussion with the Duty Biochemist.

Please contact the lab to notify them you are sending an urgent sample and mark the form "URGENT". Contacting the laboratory is an essential step – merely selecting the "Urgent" box in Trakcare will not cause your sample to be handled urgently.

During working hours phone the enquiries number.

Out of hours please page the laboratory BMS via switchboard.

**Pneumatic Tube**

There are pneumatic tubes at IRH and RAH.

The IRH tube is currently not available. A replacement system is currently being deployed. Blue pods should be used for laboratory samples (destination 90)

The RAH system also uses Blue pods for laboratory samples (destination 111)

CSF, faeces and “Precious” samples MUST NOT be sent down the tubes as they may be lost.

In case of breakdown or spillage please contact

| | |
|---|---|
| Estates at IRH | ext 05110 |
| Estates manager at RAH | page 56010 |

Please contact the porters to uplift “URGENT” urgent samples or CSF and “Precious” samples that are not sent by Tube.

**Sample Storage Prior to Transport to Laboratory**

When storing uncentrifuged samples prior to uplift for transport to laboratory please avoid storing samples in extremes of temperature. Uncentrifuged samples for Biochemistry MUST NOT be refrigerated. For guidance, the most appropriate temperature would be an appropriate temperature for comfortable working in an office. Centrifuged gel tubes may be refrigerated.

## Tests routinely available out of hours:

U&E, LFT, GGT, glucose, calcium, magnesium, amylase, CRP, uric acid, Paracetamol, salicylate, lithium, digoxin, alcohol, Carbamazepine, Phenytoin Gentamicin, Vancomycin, Tobramycin, HCG, ammonia, total protein, lipids, iron.

Osmolality (serum and urine)
High Sensitivity Troponin, CK, LDH
Direct Bilirubin (neonates)
CSF Protein and glucose

Other tests often require considerable additional staff time to set up and perform (and there is only one member of staff in the lab) and availability must be discussed with the on-call biochemist.

# Point of Care Testing (POCT)

Clyde Biochemistry operates and maintains a POCT service that includes Blood Gas analysers and Blood Glucose meters.

For general guidance on POCT please consult the GG&C POCT Policy.

Please email routine enquiries regarding these analysers or meters and barcodes for using them to:

Clyde.BiochemistryPOCT@ggc.scot.nhs.uk

## Blood Gas Analysers

**Please be aware that Training and Password Access is required to use these analysers**

Doctors starting at RAH and IRH will receive induction training in the use of these analysers. Any staff that have not been given but require training should contact the laboratory.

The GEM 5000 Blood gas analysers are located at a limited number of locations on the RAH and IRH wards. Only pre-heparinised blood gas syringes or pulsators (arterial sampling systems) should be used with the analysers. When using syringes the syringe should be filled completely.

Ward staff are expected to provide routine maintenance to these analysers out of hours (i.e. change cartridges). There are no staff available in the lab to do this as they cannot leave the Lab so please do not ask them to do so.

Required volumes for Blood Gas analysis on GEM 5000

| | |
|---|---|
| 150 µL | Gases, electrolytes, glucose/lactate and co-oximetry |
| 65 µL | Gases, electrolytes, glucose/lactate |

Not all analysers provide the above repertoire. Lactate is not available in the laboratory.

## i-STAT Analysers

The Abbott i-STAT Systems are situated on MAU ward at the VOL Hospital and are for use during the out-of-hours period, between 20:30 and 08:30 Monday to Friday and at the weekend. The Abbott i-STAT provides rapid measurement of chemistries/electrolytes, and blood gases using diagnostic cartridges.

Arterial or venous blood must be collected into either pre-heparinised syringes or lithium heparin samples for analysis.

Training is provided by key operators in MAU and POCT Ltd training support.

Required Volumes for i-STAT

95 μL for Blood gases and lactate (CG4 cartridge)
95 μL for U&Es, glucose, ionised calcium (CHEM8 cartridge)

**Blood Glucose meters**

Abbott FreeStyle Precision Pro meters are in place in a wide number of clinical areas within Clyde Hospitals. Only trained staff can operate these

Training is provided through Link Nurses and Abbott training support.

The IT Helpdesk should be contacted initially if there are problems docking your meter but for any issues regarding instruments, quality control or training/barcodes etc. please contact the laboratory.

## Specimens and containers

**Blood samples** The Greiner 'Vacuette' system is in use throughout Clyde.

Please make sure to fill the plain biochemistry tube first to avoid sample contamination with either fluoride, citrate or EDTA containing tubes.

Trakcare orders will have sample stickers for the appropriate container type.

Lists of container requirements are widely available (glucose requires the grey topped fluoride tube and trace metals the green heparin tube. HbA1c requires a separate lavender tube). If in doubt for specialist tests please contact the lab before you take the sample. When ordering tests electronically via Trakcare and ICE the printed labels will indicate what bottles are required.

**Sampling from Venflons is not a good idea. Samples are very frequently haemolysed requiring repeat sampling and lengthy delays for patient results.**

**Urine samples:** Urine analysis requires the plain white topped container firmly closed in a **separate** bag. It is best to bag the urine within the specimen bag in case of breakage/leakage in transit. Acidified 24 hour collection bottles are not in use – these samples will be acidified on receipt in the lab, and therefore should be sent promptly to the lab after 24 hour collection is complete.

**Faecal samples:** Faecal samples should be sent in either blue or white topped containers**. The silver topped microbiology tubes are not accepted and will be discarded.**

**Please be aware that a separate container is required for each test requested.**

**CSF** – please send a separate grey fluoride tube for glucose and protein. Bloodstained samples are not suitable for protein analysis. These precious samples should not be sent in the pneumatic tubes in case they are lost in the event of a tube failure.

Samples for Xanthochromia should be sent to the local Biochemistry laboratory immediately after withdrawal (within no more than half an hour) as CSF sitting on red cells will cause artefactual haemolysis to be seen in the scan. Samples received after this time with blood cells present cannot be analysed for xanthochromia. They should be protected from light (eg place sample within a brown envelope).

**Please write the time of sampling on the universal and request form if not using Trakcare.**

Analysis of the sample for xanthochromia is only helpful as long as the sample is taken more than 12 hours after the presumed onset of symptoms.

**Fluids** – Other than CSF and urine, we request that all fluid samples (pleural fluids, ascitic fluids, any other fluids) are sent in Vacuette tubes. For glucose samples this should be a grey topped tube, for other assays a white topped Vacuette tube. Samples received in universal containers will not be processed.

**Specific Analytes**

See the list of reference ranges below for sample requirements.

Guidance is also given for the volumes required for common paediatric tests.

Please contact the laboratory if you cannot find a test you require in the reference range list below or in the sendaway list on the laboratory web site or on Trakcare.

**Dynamic Function Testing**

Where possible bag all samples together for dynamic function tests. Advice for some tests is given further on. Please contact the lab for particular advice if needed.

**Supplies**

Please be aware that the laboratory does not supply tubes, request forms or postal containers, unless by special arrangement. These must be obtained through your normal supply routes.

**Specimen collection**

IRH – during the week there at least three ward collections across the day. There are two daily collections from the Larkfield unit.

RAH – there are three ward collections across the day. Weekend collections are completed mid morning.

VOL – there are three ward collections across the day during the week. At the weekend there is one Saturday mid morning collection for microbiology samples.

# CLINICAL INFORMATION

## Use of eGFR

The use of eGFR (estimated Glomerular Filtration Rate) allows the identification of minor degrees of renal impairment that may go unnoticed by the use of the serum creatinine alone.

The eGFR is not valid under the age of 18 years and in acutely ill patients. An eGFR >60ml/min/1.73m$^2$ does not exclude CKD stages 1 and 2.

All persons with suspected CKD should have a urine dipstick test for protein and the result quantified by a protein / creatinine ratio where positive unless infection is present.

Further information may be found at:
http://www.renal.org/information-resources/the-uk-eckd-guide

**The 5 stages of Chronic Kidney Disease (CKD)**

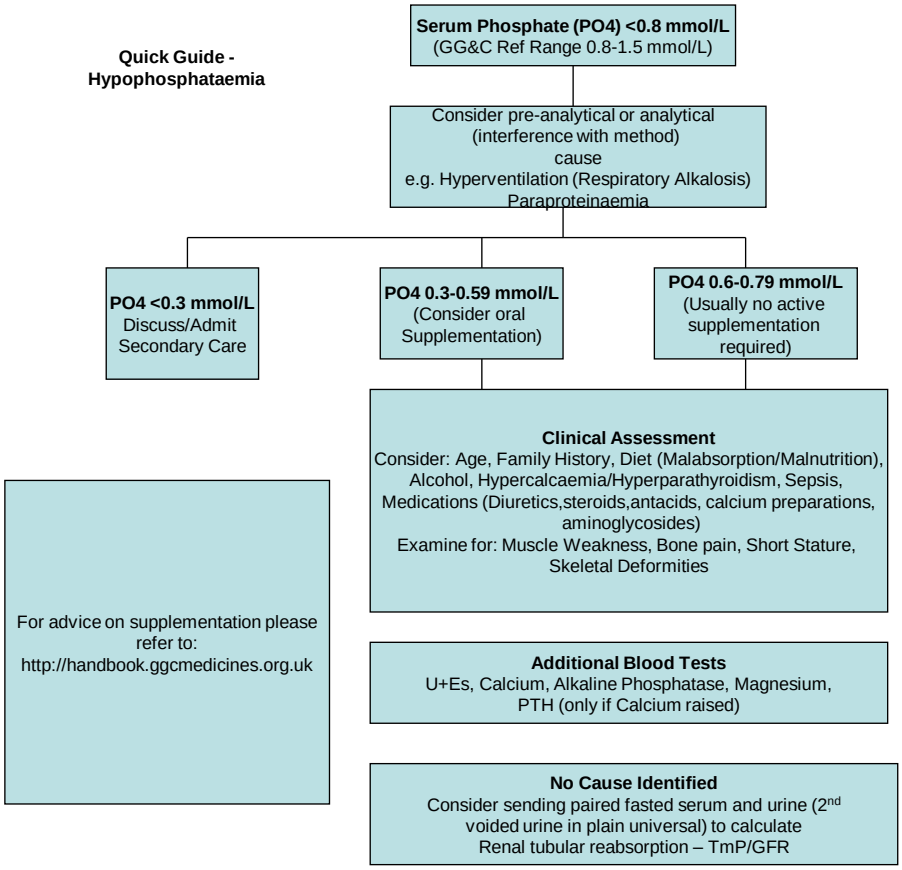
| EGFR | | STAGE |
|---|---|---|
| >90ml/min | with another abnormality* - otherwise regarded as normal | = stage 1 CKD |
| 60-89ml/min | with another abnormality* - otherwise regarded as normal | = stage 2 CKD |
| 30-59ml/min | (moderate impairment) | = stage 3 CKD |
| 15-29ml/min | (severe impairment) | = stage 4 CKD |
| <15ml/min | (established renal failure) | = stage 5 CKD |

*i.e. already known to have proteinuria, haematuria (but no urological cause) or (in diabetes) microalbuminuria.

## Electrolyte Disorders

Please see the NHSGGC Therapeutics Handbook , as guidance discussing pharmacological treatment options cannot be provided outside of documents under Pharmacy review.

## Investigation of Hypophosphataemia




## Lipids and Cardiovascular Risk

The lab routinely measures Cholesterol and triglyceride on samples. **When you require HDL for risk assessment you need to request a "Lipid Profile".**

## Cholesterol Measurement

All adults aged over 40 years should have a cardiovascular risk assessment at least once every 5 years.

High risk primary prevention patients should be checked annually.

Low risk patients should be checked every five years.

Primary prevention risk should be estimated using one of the standard risk calculators available:

www.assign-score.com
www.jbs3risk.com
www.qintervention.org/index.php

Most current guidelines suggest that fasting lipid profiles are only required if hypertriglyceridaemia is present and the fasting level may change the patient's management.

**Secondary Hyperlipidaemias**

Look for dietary, drug and alcohol history and history of increasing weight or poorly controlled diabetes.

Urine dipstick for protein, urea and electrolytes and liver function tests, blood glucose and thyroid function.

**Patients on Lipid Lowering Therapy**

Lipid levels should not be checked until at least six weeks after starting treatment.

Liver function should also be checked at this time and again after any dosage increase.

## Hypertriglyceridaemia

Hypertriglyceridaemia is associated with increased risk of pancreatitis, particularly when tirglycerides are > 10 mmol/L. It is often secondary to other pathologies, lifestyle factors or medications.

The following guidance is suggested if considering referral to the lipid clinic with hypertriglyceridaemia:

| Triglyceride Level | Management |
|---|---|
| Above 2.5 and < 10mmol/L | Manage as per Primary and Secondary CVD prevention guidelines.<br>Address secondary causes<br>Consider statin therapy at lower risk threshold |
| 10-20 mmol/L | Repeat with fasting level within 2 weeks<br>Review for secondary causes and manage accordingly<br>Refer if triglyceride value persists >10 mmol/L |
| >20 mmol/L | If no obvious secondary cause e.g. alcohol excess, poorly controlled diabetes refer to local lipid clinic. |

| **Secondary Causes of Hypertriglyceridaemia** |
|---|
| Diabetes Mellitus<br>Alcohol<br>Renal Disease (Nephrotic)<br>Hypothyroidism<br>Obesity<br>Medications (steroids, retinoids, psychotropics, beta blockers, anti-retrovirals, thiazides, tamoxifen)<br>Liver Disease |

Please bear in mind that the effect of statin therapy on hypertriglyceridaemia is mild (no more than a one third reduction typically seen), and that hypertriglyceridaemia is not an indication for high intensity statin therapy (in the absence of another valid indication for high intensity statin therapy).

## Diagnosis of Diabetes Based on Venous Plasma Glucose

NHSGGC has issued recommendations on the diagnosis of diabetes to include the use of HbA1c. The guideline is available here:

http://www.staffnet.ggc.scot.nhs.uk/Info%20Centre/PoliciesProcedures/GGCClinicalGuidelines/GGC%20Clinical%20Guidelines%20Electronic%20Resource%20Direct/Diabetes%20Mellitus,%20Diagnosis.pdf

The key principles of the guidelines are:

New type 1 diabetes is a medical emergency and should be diagnosed by clinical features and a random blood glucose > 11mmol/L, and same day referral to an appropriate specialist. HbA1c, fasting glucose and OGTT are not appropriate tests to use in suspected type 1 diabetes mellitus.

For the diagnosis of type 2 diabetes the first line test should be a fasting glucose.
A fasting glucose of ≥ 7 mmol/L with osmotic symtoms is diagnostic of diabetes.
A fasting glucose of 6.1-7mmol/L or ≥ 7mmol/L without osmotic symptoms should be followed up by an HbA1c level, with a result ≥48 mmol/mol consistent with diabetes and 42-47 mmol/mol “prediabetes”.

OGTT use, as recommended by these guidelines, is largely now restricted to diagnosis and follow-up of patients suspected of having gestational diabetes mellitus.

**Thresholds for results consistent with diabetes in non-pregnant adults:**

| | |
|---|---|
| **Random venous plasma glucose** | **≥ 11.1 mmol/l** |
| **Fasting venous plasma glucose** | **≥ 7.0 mmol/l** |
| **Venous plasma glucose** | **≥ 11.1 mmol/l at 2 hours after an oral glucose tolerance test (OGTT).** |

An HbA1c ≥ 48 mmol/mol is diagnostic of diabetes.
An HbA1c < 48 mmol/mol does not exclude the diagnosis of diabetes.

Some of the factors below may influence and confound the HbA1c result. In these and other cases where there is doubt the glucose criteria must be used for the diagnosis of diabetes.

**Erythropoiesis**
Increased HbA1c: iron or Vit B12 deficiency, decreased erythropoiesis
Decreased HbA1c: administration of iron, vitamin B12, erythropoietin, reticulocytosis, chronic liver disease

**Altered Haemoglobins**
Genetic or chemical alterations in haemoglobin: haemoglobinopathies, HbF, methaemoglobin can increase or decrease HbA1c glycation
Increased HbA1c: alcohol dependence, chronic renal failure
Decreased HbA1c: aspirin, Vit C and E

**Erythrocyte destruction**
Increased HbA1c: splenectomy
Decreased HbA1c: splenomegaly, antiretrovirals, rheumatoid arthritis, haemoglobinopathies

These lists are not exhaustive. Glucose remains the more reliable (and cheaper) criteria.

**Gestational Diabetes**

For detailed information please see the current SIGN diabetes guidelines www.sign.ac.uk/guidelines/fulltext/116/index.html full guideline page 63.

In early pregnancy a random glucose at least two hours after food of > 5.5 mmol/l or > 7.0 mmol/l within two hours of food are suspicious.

If the diagnosis is in doubt in early pregnancy with intermediate levels of blood glucose, or if a high risk patient in late pregnancy, an OGTT is recommended to assist in making the diagnosis.

**75g Oral Glucose Tolerance Test**

Note that Lucozade Energy Original Drink is being reformulated as of April 2017 and should no longer be used for performing OGTT. OGTT is now rarely indicated outside of pregnancy.

The patient should fast overnight.

A basal sample should be taken and then the patient should drink a solution of 75 g anhydrous glucose in 250 – 350 ml fluid. A premade solution named “Rapilose OGTT” is available. A further sample should be taken at 2 hours. Both samples in the fluoride tubes should be sent to the laboratory together please.

**Microalbumin**

All diabetic patients should be screened annually for microalbuminuria. Early morning urine samples should be used and two out of three samples are required to be positive.

**Thyroid function tests**

**Please indicate on your request what, if any thyroid medication a patient is on. This is needed to interpret the results and also to add Total T3 and thyroid antibodies as appropriate.**

Screening for thyroid disease. – is not recommended in the healthy adult population.

Acutely ill patients – abnormalities of thyroid function occur and testing should be avoided unless there are specific indications to do so.

Changes in thyroid medication – wait at least six weeks to re-measure thyroid function.

Frontline TSH and Free T4 are measured by the lab. Total T3 is added on by the lab where appropriate.

Thyroid peroxidase antibodies may be checked by the lab where a pattern of sub clinical hypothyroidism is suspected, if the patient is not on thyroxine.

Follow up of patients should be generally not more frequently than annually (pregnancy see below).
.
Pregnancy and thyroxine - demand for thyroxine increases with pregnancy and TFT should be more closely monitored to adjust treatment.

The 2006 British Thyroid Association (and others) guideline is recommended if further guidance on testing thyroid function and interpreting results is required:

http://btf-thyroid.org/images/documents/tft_guideline_final_version_july_2006.pdf

**Investigating the Menopause**

In November 2015 NICE published guidelines on menopause diagnosis and management. The current guidance is that for women aged >45 Follicle Stimulating Hormone (FSH) is not required to diagnose the peri-menopause or menopause. The diagnosis should be based on age and symptoms.

| Age | Symptoms | FSH |
|---|---|---|
| >45 ?peri-menopause | Irregular periods/vasomotor symptoms | Not required |
| >45 ?menopause | No period for 12 months | Not required |
| >45 ?menopause, no uterus | Vasomotor symptoms | Not required |
| 40-45 ?peri-menopause/menopause | Irregular periods/vasomotor symptoms | Consider FSH |
| <40 ?peri-menopause/menopause | | FSH required |

An audit of FSH requesting in Clyde from March 2017 until February 2018 has shown that 47% of our female FSH requests are in women >45 years of age. In addition a majority of these FSH requests are accompanied by LH and oestradiol requesting. There is potentially scope to therefore reduce unnecessary testing and streamline the diagnostic pathway for these patients by adopting the NICE guidelines. For further information the guidance can be viewed at:
www.nice.org.uk/guidance/ng23/chapter/recommendations#diagnosis-of-perimenopause-and-menopause

Hormone measurements are of no value in assessing the response to HRT.

Hormone measurements are of little assistance in determining when a patient remains at risk of becoming pregnant. It should be assumed a patient remains at risk of pregnancy for up to 2 years after the last menstrual period.

**Menstrual Irregularity / Amenorrhoea under 40 years**

Rule out pregnancy.
General illness, anorexia and excessive weight loss should be considered.
First line investigations include LH/FSH/Prolactin, Testosterone, SHBG and TFT.
Please give relevant drug history if Prolactin is requested – phenothiazines and hormonal contraception being the most relevant medications.

**Ovulation**

Day 21 progesterone should be measured (or 7 days before the next period if the cycle is not 28 days).

## Macroprolactin

Macroprolactin is the presence of an abnormally large protein complex. The laboratory will check for this if as a cause of any persistently raised prolactin. If the patient is found to have a macroprolactin this will be highlighted to you by the lab. It is not biologically active and requires no further investigation.

## Tumour markers

It is generally unhelpful to measure tumour markers as a screening test. Their role is in monitoring established malignancy. Guidance for their use by non-specialists was available in this BMJ article.

## Prostate Specific Antigen (PSA)

Screening in asymptomatic men is not recommended but should be available, with counselling, on patient request. Levels may be abnormal with a UTI. Levels may be raised for a time after acute urinary retention, catheterisation or PR examination of the prostate. Raised levels may be due to a benign cause and normal levels do not exclude a malignancy.

Objective information for asymptomatic men is available at:
https://www.gov.uk/government/collections/prostate-cancer-risk-management-programme-supporting-documents

## CA125

CA125 should only be considered in high risk groups of women following national guidelines and interpreted in conjunction with ultrasound scoring as appropriate.

NICE guidance on the use of CA125 for the diagnosis of ovarian cancer is available:

https://www.nice.org.uk/Guidance/CG122

## Therapeutic Drug Measurement

Drug measurement is not generally routinely recommended except for Lithium. In particular there is a very poor correlation between Valproic acid levels and affect.

Digoxin levels must be taken at least 6 hours after the last oral dose.

Lithium – levels should be monitored every 3 months and TFT, renal function and calcium annually.

For all drugs pre-dose trough levels are generally the best time to make a measurement if unsure. However for Theophylline it is often helpful to determine the peak level that can be achieved, timing depends on the preparation (2 hours post dose, or for slow release 4-6 hours, i.v. infusion at 30 minutes)

## Troponin Measurement

A high sensitivity Troponin assay is now in use in NHSGGC. TNIhs results are normal if ≤ 34 ng/L in men and if ≤16 ng/L in women.

Guidelines for timing of samples and interpretation of results should be available locally.

## NT Pro BNP Measurement

The NT Pro BNP assay is available to support primary care heart failure pathways. Appropriate cut-offs to aid decision making within this pathways are provided for patients within the pathway. Reference ranges and interpretive guidance are not available for patients out with these pathways. The test should only be used outside the pathways when advised by a cardiologist. The previous BNP assay is no longer available.

The pathway is available here:

http://www.nhsggc.org.uk/about-us/professional-support-sites/heart-stroke-diabetes-rheumatology-and-chronic-pain-mcns/heart-disease/guidelines-and-protocols/

## Electrolyte Abnormalities

GGC Guidance on the assessment and management of electrolyte abnormalities in adults is available via the Therapeutics Handbook:

http://handbook.ggcmedicines.org.uk/guidelines/electrolyte-disturbances/

## Suspected Myeloma

Not all paraproteins are malignant. The presence of a paraprotein is only one element of a diagnosis of myeloma.
The initial screening test for detecting paraproteins is serum protein electrophoresis (ochre tube). In addition, immunoglobulins will be measured by the laboratory to look for immune paresis or a polyclonal increase of all immunoglobulin classes.

Urine electrophoresis, to look for Bence Jones Proteins (free light chains), on an early morning urine sample, should be requested in a plain urine tube if there is a high index of suspicion of myeloma. This must reach the lab the same day.

## Monoclonal Gammopathy of Unknown Significance (MGUS)

In patients where a small paraprotein is detected with no other clinical signs or pathology national guidelines for follow up or further investigation should be followed. http://www.b-s-h.org.uk/guidelines/guidelines/investigation-of-newly-detected-m-proteins-and-the-management-of-mgus/

This is a relatively common incidental finding in the elderly or those with any chronic inflammatory condition.

A very small proportion of patients with an MGUS will progress to a clinically significant myeloma which is why follow up should be considered.

Usually 3-4 monthly follow up for up to 2 years and then annually would be recommended for an MGUS.

Electrophoresis is a manual test where sequential investigation to type a paraprotein is required and can take some time (this may be 2-3 weeks).

## qFIT

qFIT testing is now available as part of the colorectal patient pathway. Further guidance from GRI, who perform the test is now available here:

https://www.nhsggc.org.uk/about-us/professional-support-sites/laboratory-medicine/laboratory-disciplines/biochemistry/faecal-haemoglobin-qfit/

## Urine Metadrenalines and 5HIAA

The previous Urine Catecholamine profile from Crosshouse was replaced for adults with separate Medadrenaline and 5HIAA assays provided by Glasgow Royal Infirmary.

Both require 24 hour collections. Urine Metadrenalines require a plain urine bottle as previously. 5HIAA now requires an acidified bottle – please contact the lab to arrange supply of this bottle.

The indications for urine metadrenaline and 5HIAA analysis are different, and it is rare that patients would require both being measured. The following table is intended to serve as a reminder of which test is desired:

| Test | What is the analyte? | Used to test for | Typical symptoms |
|---|---|---|---|
| Urine metadrenalines | Metabolites of adrenaline, noradrenaline and dopamine | Phaeochromocytoma Paraganglioma | Hypertension, sweating, tremor, palpitations, headaches |
| Urine 5-HIAA | Serotonin metabolite | Carcinoid | Flushing, diarrhoea, cramping, wheeze |

With regards to metadrenalines **it is no longer required to avoid paracetamol. Sotalol, labetalol and tricyclic antidepressants may affect results and should be avoided** for at least 1 week prior to collection is safe and feasible.

Some foods 5HIAA collections. The following foods should be avoided for three days before collecting a urine catecholamine sample and during the collection:

**Walnuts, bananas, tomatoes, avocado, kiwi fruit, pineapple, plantain, plums, pecan nuts.**

Medications can affect catecholamine results. Paracetamol should be avoided for 72 hours before the collection and during the collection. Other medications which can affect the result are listed below. If it were safe to withhold them this would ideally be done for 2 weeks prior to the test, but it is acknowledged this will rarely be possible.

Historically three collections were often requested as some of the metabolites produced by phaeochromocytoma were secreted sporadically. However as metadrenalines are produced continuously by these this will not be required.

Samples should be delivered to the practice at 0900 on the day collection finishes, or left into the Biochemistry labs at IRH, RAH or VoL prior to 10am Monday – Friday on the day the collection finishes. Collections should therefore be started prior to 0800.

**Paediatric Hypogylcaemia Tests**

The protocol for metabolic tests for paediatric hypoglycaemia should be available with "grab bags" of sample tubes in the RAH and IRH A&E departments, where acutely hypoglycaemic children may present. The protocol is provided below for reference:

# Paediatric Hypoglycaemia "GRAB BAG"

(For all patients requiring a 'Hypo screen' for hypoglycaemia in RAH/IRH)

| **'PAEDS HYPOGLYCAEMIA - TIME CRITICAL SAMPLES'** (Samples required **PRIOR** to administration of glucose) | | |
|---|---|---|
| TEST | TUBE TYPE | VOLUME REQUIRED |
| Glucose | Fluoride oxalate (Grey) | 500 microlitres (half full) |
| Free fatty acids | Fluoride oxalate (Grey) | 500 microlitres (half full) |
| Insulin<br>C-peptide | Lithium Heparin (Green) | 1ml ideally |
| Beta OH butyrate | Lithium Heparin (Green) | 500 microlitres (half full) |
| Cortisol | Lithium Heparin (Green) | 500 microlitres (half full) |
| Lactate<br>(Capillary blood gas) | Capillary blood gas tube<br>**(Gas analyser on ward)** | Aim for 1 full capillary tube. |

*****SAMPLES MUST BE IN LAB WITHIN 15 MINUTES OF COLLECTION*****

CONTACT LAB TO INFORM THEM OF URGENT HYPOGLYCAEMIA SAMPLES

| **'PAEDS HYPOGLYCAEMIA - ADDITIONAL ESSENTIAL'** (Sample can be taken **AFTER** administration of glucose) | | |
|---|---|---|
| TEST | TUBE TYPE | VOLUME REQUIRED |
| *Ammonia<br>U&Es<br>LFTs<br>CRP | Lithium Heparin (Green)<br>* labile sample, must arrive in lab within 15 mins, **phone lab to inform** | 1ml (1 bottle) |
| Acylcarnitine | Blood spot - Guthrie card | Send to lab |
| FBC | EDTA<br>(small Purple screw top) | 500 microlitres<br>(up to mark on bottle) |
| Blood culture | Age and volume dependant | |
| **URINARY** organic acids | **URINE** in **WHITE** top universal container | 5mls |

**SEE OVER PAGE FOR GUIDANCE ON ORDERING ALL ABOVE SAMPLES ON TRAKCARE**

# How to order on TRAKCARE

***Do NOT use Hypoglycaemia Screen on TRAKCARE***

## 'PAEDS HYPOGLYCAEMIA - TIME CRITICAL SAMPLES'

(Samples required **PRIOR** to administration of glucose)

TO ORDER THE '**TIME CRITICAL SAMPLES'** THEN FOLLOW THESE STEPS:

1. ENSURE PATIENT HIGHLIGHTED ON SCREEN THEN CLICK ON "NEW REQUEST" TAB.
2. SELECT APPROPRIATE TEST IN POP-UP SCREEN FOR: GLUCOSE
3. ON THE RIGHT SIDE OF SCREEN TYPE THE REQUESTED TEST IN SECTION TITLED "ITEM" THEN HIT THE MAGNIFYING GLASS [Q] (TO THE RIGHT OF THE BOX)

****ALWAYS SELECT THE '- CHILD' OPTION FOR THE TEST REQUESTED (WHEN AVAILABLE)****

**HINTS:**

- FOR **INSULIN** TYPE 'INS' THEN HIT [Q] – POP-UP CLICK ON 'UPDATE'
- FOR **C – PEPTIDE** ENSURE THERE IS A SPACE EITHER SIDE OF THE '-' BEFORE HITTING [Q]
- FOR **FFAS** TYPE 'FREE' THEN HIT [Q]
- FOR **BETA OH BUTYRATE** TYPE 'BETA' THEN HIT [Q]
- FOR **CORTISOL** TYPE 'COR' THEN HIT [Q]
- REMEMBER LACTATE IS TAKEN ON A CAPILLARY GAS TUBE AND PROCESSED ON THE WARD.

## 'PAEDS HYPOGLYCAEMIA - ADDITIONAL ESSENTIAL'

(Sample can be taken **AFTER** administration of glucose)

TO ORDER THE '**ADDITIONAL ESSENTIAL'** SAMPLES THEN FOLLOW THE SAME PROCESS AS ABOVE.

****ALWAYS SELECT THE '- CHILD' OPTION FOR THE TEST REQUESTED (WHEN AVAILABLE)****

**HINTS:**

- FOR **AMMONIA** TYPE 'AMMON' THEN HIT [Q]
- FOR **ACYLCARNITINE** ENSURE YOU SELECT THE OPTION WITH 'BS' AT THE END.
- FOR **URINARY ORGANIC ACIDS** TYPE 'ORGANIC' THEN HIT [Q]

ONLY STICK **ONE** 'TRAKCARE' LABEL TO THE CORRESPONDING TUBE.
THE REMAINING LABELS SHOULD REMAIN ON THE REQUEST FORM AND ACCOMPANY THE SAMPLES TO THE LAB

# REFERENCE RANGES

Ranges are shown for adult, paediatric, pregnancy, paediatric sample size requirements and reproductive hormones.

Reference ranges listed below are for guidance only. An appropriate reference range, where available, will be provided with your result and is the range which should be used in interpreting your result.

Sample requirements are provided below for guidance. When ordered electronically via Trakcare or ICE information on the appropriate sample type will be given on the labels provided.

It is particularly difficult to derive reference ranges for neonates, children and in pregnancy.

Uncertainty of measurement, in crude terms, relates the result the laboratory provides to the range of values that result could represent. Information regarding uncertainty of measurement of specific analytes can be provided to users of the laboratory on request – please contact the duty Biochemist to discuss.

Less frequently requested tests may be sent to other laboratories for analysis both within Glasgow and across the UK.

If you cannot find a test you are looking for in this table please refer to the web site or contact the reporting biochemist by phoning the lab.

Results are issued with reference ranges. Please contact the laboratory if in difficulty and we will endeavour to help. Reference ranges listed below are for guidance only. There may be very significant differences between ages, genders and different populations etc.
MOST DRUG LEVELS ARE GENERALLY MEASURED AS TROUGH LEVELS. FOR MOST THIS IS EASIEST JUST BEFORE THE NEXT DOSE. DIGOXIN MUST BE AT LEAST 6 HOURS POST DOSE.– see timing required below.

| Test | Sp | Container | Vol (ml) | Reference range (adult) | Result Time | Comments |
|---|---|---|---|---|---|---|
| ACE | B | Ochre | 2 | <88 u/L | 2 weeks | |
| ACTH | B | Lavender | 2 | < 20 mU/L (7-9 am) unstressed | 2 weeks | Must reach lab rapidly for separation and freezing **unstable** |
| ALT | B | Ochre | 2 | <50 IU/L | 1 day | |
| Albumin | B | Ochre | 2 | 35-50 g/L | 1 day | |
| Albumin/creat ratio | U | White universal | 10 | M <2.5<br>F <3.5 | 1 day | Early morning urine required |
| Aldosterone | B | Ochre | 2 | See report, >300 pmol/L may need investigating | 1 week | Measure with renin for ratio aldo/renin ratio >35 may need investigation |

| Test | Sp | Container | Vol ml | Reference range (adult) | Result Time | Comments |
|---|---|---|---|---|---|---|
| Aldosterone | B | Ochre | 2 | See report, >300 pmol/L may need investigating | 1 week | Measure with renin for ration aldo/renin ratio >35 may need investigation |
| Alkaline phosphatase | B | Ochre | 2 | 30 – 130 IU/L | 1 day | |
| Aluminum | B | Green | 2 | <0.2 µmol/L | 2 weeks | |
| AFP | B | Ochre | 2 | <7 kU/L | 1 week | |
| Alpha – 1 - antitrypsin | B | Ochre | 2 | 1.1 – 2.1 g/L | 1 week | |
| Ammonia | B | Green | 2 | W 4 <100 µmol/L<br>>4 weeks 20 – 50 | 1 day | Must reach lab promptly **unstable** |
| Amphetamines | U | White universal | 10 | Qualitative | 1 week | |
| Amylase | B | Ochre | 2 | <100 IU/L | 1 day | |
| Amylase (urine) | U | White universal | 2 | <600 U/L (amylase/creat clearance 1-5%) | 1 day | Clearance ratio for detecting macroamylasaemia. |
| Antimullerian hormone | B | Ochre | 2 | No reference range provided | 1 week | Consultant gyn request only |
| Androstenedione | B | Ochre | 2 | 18-40y <5.5 nmol/L<br>>41 y F <3 nmol/L<br>M <5.5 nmol/L | 2 weeks | Part of Androgen Profile |
| Anti Streptolysin O titre | B | Ochre | 2 | <200 IU/L | 1 week | Contact Microbiology for Clinical Advice on ASO |
| Anti thyroid peroxidase antibody | B | Ochre | 2 | <6 IU/mL | 1 week | |
| AST | B | Ochre | 2 | <40 IU/L | 1 day | |
| Bence Jones Protein | U | White universal | 20 | | 2 weeks | Early morning urine best as more concentrated |
| Benzodiazepines | U | White universal | 10 | Qualitative | 1 week | |
| Beta-2 Microglobulin | B | Ochre | 2 | 1-2.6 mg/L | 7 days | |
| Bicarbonate | B | Ochre | 2 | 22 – 29 mmol/L | 1 day | **Unstable** on storage |
| Bile acids | B | Ochre | 2 | <17 µmol/L | 1 week | For cholestasis of pregnancy – dw lab for other indications |
| Bilirubin | B | Ochre | 2 | <20 µmol/L | 1 day | |
| Blood gases (arterial) | B | | | $H^+$ 36-44 nmol/L<br>$pCO_2$ 4.6-6.0 kPa<br>$pO_2$ 10.5-14 kPa | POC | |
| Blood gases (venous) | B | | | $H^+$ 42-48 nmol/L<br>$pCO_2$ 5.6-6.7 kPa | POC | |
| Ca 125 | B | Ochre | 2 | Female <35 kU/L | 1 week | See NICE CG122 |
| Ca 15.3 | B | Ochre | 2 | <32 U/L | 2 weeks | Specialist use only |
| Ca 19.9 | B | Ochre | 2 | <37 U/L | 1 week | Specialist use only |
| Calcitonin | B | Green | 2 | <9 ng/L | 2 weeks | Medullary Thyroid Cancer diagnosis and f/up only. |
| Calcium(adj) | B | Ochre | 2 | 2.20 – 2.60 mmol/L | 1 day | |
| Calcium (urine) | U | White universal | 2 | 0.04-0.7mmol/mmol Creat | | |
| Calprotectin | F | White universal | 20g | 10 – 50 µg/g faeces | 1 week | For diagnosis of IBD |
| Caeruloplasmin | B | Ochre | 2 | 0.16-0.47 g/L | 1 week | **Low** in Wilson Disease |

| Test | Sp | Container | Vol ml | Reference range (adult) | Result Time | Comments |
|---|---|---|---|---|---|---|
| Cannabinoids | U | White universal | 10 | Qualitative | 1 week | |
| Carbamazepine | B | Ochre | 2 | 4 – 12 mg/L | 1 day | Levels usually pre-dose |
| CarboxyHb | B | Lavender | | Non-Smokers 0.5-3.0%; 5% pregnancy and anaemia, up to 15% smokers | POC | **Unstable Much higher levels (up to 15%) in smokers.** |
| Catecholamines | U | White Universal | 10 | See report | 2 weeks | **For Paediatrics only. For adults request metadrenaline or 5HIAA as appropriate.** |
| CEA | B | Ochre | 2 | <5 µg/L | 1 week | Not a screening test |
| Chloride | B | Ochre | 2 | 95 – 108 mmol/L | 1 day | |
| Cholesterol/Trig/LDL/ HDL | B | Ochre | 2 | refer to GGC cholesterol guidelines | 1 day | Request Lipid profile if HDL + LDL required. |
| Cholinesterase | B | Lavender | 2 | >5300 IU/L | 2 weeks | |
| Chromium | B | Lavender | 2 | <40 nmol/L | | Implant monitoring with cobalt |
| Ciclosporin | B | Lavender | 2 | | 1 week | Individual targets vary so please discuss with appropriate clinician.. |
| Cocaine | U | White universal | 10 | qualitative | 1 week | |
| Cobalt | B | Lavender | 2 | < 50 nmol/L | | Implant monitoring with chromium |
| Copper | B | Green | 2 | M 10 – 22 µmol/L<br>F 11 – 25 µmol/L | 1 week | Ochre samples not acceptable |
| Cortisol | B | Ochre | 2 | 240-600 nmol/L (7-9 am)<br>50-290 (9pm-12am) | 1 day | Can be suppressed by steroid inhalers. Not a screen for Cushings |
| Cortisol/creatinine ratio / 24 hour urine cortisol | U | White universal | | <40 nmol/mmol creat<br><br><165 nmol/24h | | Screening for Cushings Early morning urine required |
| C – peptide | B | Green | 2 | 0.36-1.12 nmol/L fasting | 2 weeks | Must measure with insulin and glucose, rapid transit to lab - **unstable** |
| CRP | B | Ochre | 2 | < 10 mg/L | 1 day | |
| CK | B | Ochre | 2 | M 40-320 IU/L<br>F 25-200 IU/L | 1 day | |
| Creatinine | B | Ochre | 2 | 40 – 130 µmol/L | 1 day | Interpret renal function with eGFR |
| Creatinine (urine) | U | White universal | 2 | | | |
| Cryoglobulin | B | Ochre | 2 | Normally absent | 1 week | Contact lab to arrange **sample at 37°C** |
| CSF glucose | CSF | Grey | 1 | 2.5 – 4.5 mmol/L | 1 day | |
| CSF xanthochromia | CSF | White universal | 1 | | 1 day | Must reach lab ASAP, protect from light. |
| CSF protein | CSF | Grey | 1 | 0.1-0.5 g/L | 1 day | Presence of red cells can give falsely high result. |
| DHAS | B | Ochre | 2 | M 16-50yr 2.5-16umol/L<br>F 16-50yr 2-12.5 | 2 weeks | |
| Digoxin | B | Ochre | 2 | 0.5 – 2.0 µg/L | 1 day | At least 6 hours after dose |

| Test | Sp | Container | Vol ml | Reference range (adult) | Result Time | Comments |
|---|---|---|---|---|---|---|
| Drug of abuse screen | U | White universal | 10 | | 1 week | |
| eGFR | B | Ochre | 2 | 90 – 120 ml/min | | |
| Elastase (faecal) | F | White or blue cont | 10 | > 200 µg/g | 4 weeks | Separate spec tube for each faecal test required |
| Erythropoietin | B | Green | 2 | 2.6 – 18.5 U/L | 1 week | For clinical advice on erythropoietin please dw Haematology. |
| Ethanol | B | Grey | 2 | | 1 day | |
| Ferritin | B | Ochre | 2 | M 20 – 300 µg/L<br>F 15 – 200 µg/L | 1 day | Raised by acute inflammation |
| FSH | B | Ochre | 2 | M 1.0 – 12.0 u/L | 1 day | |
| *FAI (free androgen index)* | *B* | *Ochre* | *2* | | *1 week* | *No longer available since Androgen Profile introduced* |
| GammaGT | B | Ochre | 2 | M < 70 IU/L<br>F < 40 | 1 day | Request separate to LFT if required. |
| Gases | B | | | See blood gases | Poc | |
| Gastrin | B | Green | 2 | <120 ng/L | 2 weeks | Pt must be fasting and off acid blockers for at least 2 weeks **unstable** |
| Globulins | B | Ochre | 2 | 23 – 38 g/L | 1 day | Request separately if required |
| Glucose | B | Grey | 2 | 3.5 – 6.0 mmol/L | 1 day | |
| Growth hormone | B | Ochre | 2 | | 1 week | Fasting. <0.4 ug/L may exclude acromegaly. |
| Gut hormones | B | Trasylol Tube | 3.5 | Please contact lab to arrange | | **Unstable. Fasting. Off PPI for two weeks. D/w lab to supply tube.** |
| Haptoglobin | B | Ochre | 2 | 0.3 – 2 g/L | 1 week | Levels fall with intravascular haemolysis. |
| HbA1c | B | Lavender | 2 | 20–42 mmol/mol Hb | 2 days | |
| HCG | B | Ochre | 2 | < 5 u/L | 1 day | |
| HFE gene | B | Lavender | 2 | | 4 weeks | Not a front line screen. Send to Genetics. |
| 5HIAA | U | 24 hour acid bottle | | 5-42 umol/24 hours | 28 days | Contact lab for 24 hour bottle. Test for carcinoid. |
| Homocysteine | B | Lavender | 2 | 0-20 umol/L | 2 weeks | **Labile – please transport to lab urgently.** |
| IGF-1 | B | Ochre | 2 | See GRI age related ranges | 2 weeks | Appropriate ref range will be on report. |
| Immunoglobulin<br>IgA<br>IgG<br>IgM | B | Ochre | 2 | <br>0.8 – 4.0 g/L<br>6.0 – 16.0<br>0.4 – 2.4 | 1 day | |
| Immunoreactive trypsin | B | 2xguthrie card spots | | | | 2 cards 24 hours apart before six weeks of age. |
| Insulin | B | Green | 2 | <13 mU/L | 2 weeks | Must be fasting with glucose **unstable. Send a paired glucose sample.** |

| Test | Sp | Container | Vol ml | Reference range (adult) | Result Time | Comments |
|---|---|---|---|---|---|---|
| Iron<br>Transferrin<br>Transferrin saturation | B | Ochre | 2 | 10 – 30 µmol/L<br>2 – 4 g/L<br>25 – 50 % | 1 day | Please use ferritin to assess iron deficiency. Saturation useful to detect iron overload. |
| Lactate | B | Grey | 2 | 0.5 – 2.2 mmol/L | 1 day | |
| LDH | B | Ochre | 2 | 80 – 240 IU/L | 1 day | |
| Lead | B | Lavender | 2 | < 0.5 µmol/L | 1 week | |
| Lithium | B | Ochre | 2 | 0.4 – 1.0 mmol/L | 1 day | 12 hours post dose |
| LH | B | Ochre | 2 | M 1.0 – 12.0 U/L | 1 day | |
| Magnesium | B | Ochre | 2 | 0.7 – 1.0 mmol/L | 1 day | |
| Magnesium (urine) | U | White universal | 2 | 0.2 – 0.6 mmol/mmol Creat | 1 week | |
| Metadrenalines (urine) | U | Plain 24 hour container | | Metadrenaline < 350<br>Normetad'ine < 650<br>3-MT < 400<br>Units all nmol/24hr | 28 days | For diagnosis / monitoring of phaeochromocytoma and paraganlgioma |
| Metadrenalines (plasma) | B | Lavender | 2 | Metadrenaline < 510<br>Normetad'ine < 1180<br>3-MT < 180<br>Units all pmol/L | 28 days | **Labile. Must reach lab within 2 hours venesection.** |
| Methadone | U | White universal | 10 | Qualitative | 1 week | |
| Methaemoglobin | B | POC only | | 0.5 – 1.5% | POC | 6 – 7 % may be acceptable with dapsone |
| Methotrexate | B | Ochre | 2 | | 1 week | Only for patients on methotrexate infusion. |
| NT-Pro BNP | B | Lavender | 2 | Refer to appropriate pathway | 1 day | Only provided for use in approved pathways |
| Oestradiol | B | Ochre | 2 | | 1 day | |
| Opiates | U | White universal | 10 | Qualitative | 1 week | |
| Osmolality | B/ U | Ochre/ white universal | 2/2 | B 275 – 295 mOsmol/L<br>U 50 – 1200 | 1 day | |
| Paracetamol | B | Ochre | 2 | Nomogram in BNF | 1 day | |
| PTH | B | Lavender | 2 | 1.6 – 7.5 pmol/L | 1 week | **Unstable beyond one day** |
| Phenobarbitone | B | Ochre | 2 | 15 – 40 mg/L | 1 week | Usu predose, not critical |
| Phenytoin | B | Ochre | 2 | 5 – 20 mg/L | 1 day | Usu predose, not critical |
| Phosphate | B | Ochre | 2 | 0.8 – 1.5 mmol/L | 1 day | |
| Phosphate (urine) | U | White universal | 2 | <16y 15 – 50 mmol/24h | 1 day | |
| Porphobilinogen | U | White universal | 10 | | 1 week | Screen for acute intermittent porphyria. Protect from light. **Unstable. DW LAB IF NEEDED URGENTLY** |
| Porphyrins | B/ U/F | Lavender White universal | 2/10/ 10g | | 2 weeks | Protect samples from light. Best to send blood and urine if porphyria suspected. Only request faecal prophyrins on specialist advice. |
| Potassium | B | Ochre | 2 | 3.5 – 5.3 mmol/L | 1 day | |

| Test | Sp | Container | Vol ml | Reference range (adult) | Result Time | Comments |
|---|---|---|---|---|---|---|
| Potassium (urine) | U | White universal | 2 | | 1 day | |
| PSA | B | Ochre | 2 | <60yrs < 3.0 µg/L<br><70yrs < 4.0 µg/L<br>>=70yrs < 5.0 µg/L | 1 day | Routine screening not advised. Should only be on patient request. |
| Procalcitonin | B | Ochre | 2 | See report | 1 day | ITU or at direction of microbiology consultant only. Needs to arrive at lab in morning. Wards need to use paper request form. |
| Procollagen III N terminal Peptide (PIIINP) | B | Ochre | 2 | Interpretative ranges on report | 1 week | Methotrexate monitoring. Dermatology only. |
| Progesterone | B | Ochre | 2 | >20 nmol/L confirms ovulation | 1 day | Mid luteal sample needed |
| 17OH Progesterone | B | Ochre | 2 | Adults <6 nmol/L | 1 week | Used in screen for congenital adrenal hyperplasia. |
| Prolactin | B | Ochre | 2 | M <400 mU/L male<br>F <630 mU/L female | 1 week | Macroprolactin excluded by PEG precipitation. |
| Protein | B | Ochre | 2 | 60 – 80 g/L | 1 day | Request separately if required |
| Protein/creat ratio | U | White universal | 10 | < 30 mg/mmol creat | 1 day | |
| Protein electrophoresis | B | Ochre | 2 | Qualitative | 1 week | Secondary tests may take longer |
| qFIT | F | qFIT picker tube | N/A | <9 ug Hb/g faeces | 1 week | Primary care only |
| Reducing substances | F | This test is no longer available | | | | |
| Renin concentration | B | Lavender | 2 | <40 mIU/L supine<br><52 ambulant | 2 weeks | Rapid transfer to lab needed **unstable** |
| Salicylate | B | Ochre | 2 | mg/L | 1 day | Levels may continue to rise for several hours |
| SHBG | B | Ochre | 2 | M 13 – 70 nmol/L<br>F 20 – 155 | 2 weeks | Of limited utility now that FAI not calculated. |
| Sodium | B | Ochre | 2 | 133 – 146 mmol/L | 1 day | |
| Sodium (urine) | U | White universal | 2 | <16y 40 – 220 mmol/24h | | |
| Tacrolimus | B | Lavender | 2 | | 1 week | |
| Testosterone | B | Ochre | 2 | M 10 – 36 nmol/L<br>F <1.5 nmol/L | 1 week | |
| Theophylline | B | Ochre | 2 | adult 10-20 mg/L<br>1m – 1y 5-15 | 1 day | GGC Medicines handbook advises 8-12 hr post dose. BNF advises 4 -6 hours post dose for slow release preparations. |
| TPMT (thiopurine methyl transferase) | B | Lavender | 2 | Normal 35 – 79 nmol/gHb/hr | 1 week | Recommended to check levels before starting azothioprine. |

| Test | Sp | Container | Vol ml | Reference range (adult) | Result Time | Comments |
|---|---|---|---|---|---|---|
| TSH | B | Ochre | 2 | 0.35 – 5.0 mu/L | 1 day | See below for pregnancy levels |
| Thyroxine(FT4) | B | Ochre | 2 | 9 – 21 pmol/L | 1 day | |
| Total T3 | B | Ochre | 2 | 0.9 – 2.5 nmol/L | 1 day | |
| Troponin (high sensitivity) | B | Green gel tube (IP/OP), Ochre (GP) | 2 | F ≤16 ng/L<br>M ≤36 ng/L | 1 day | Measure in accordance to local protocol |
| *Tryptase* | *B* | | | | | *Please request via immunolgy* |
| Urate | B | Ochre | 2 | M 200 – 430 umol/L<br>F 140– 360 | 1 day | |
| Urate (urine) | U | White universal | 2 | <16y 1.5 – 4.5 mmol/24h | | |
| Urea | B | Ochre | 2 | 2.5 – 7.8 mmol/L | 1 day | |
| Urea (urine) | U | White universal | 2 | | 1 day | |
| Valproate | B | Ochre | 2 | | 1 day | Only useful to detect toxicity or non compliance. |
| Vitamin D | B | Ochre | | | 1 week | Do not repeat for at least 6 months (half life 30 days) |
| Vitamin E /cholesterol | B | Green | 2 | 3.5-9.5 µmol/mmol cholesterol | 1 week | Protect from light |
| Vitamins (other) | B | Green (A,C,E,K) Lavender (B1,2,6) | 10 | Please refer to GRI handbook – **vitamin C rarely needed and must reach RAH lab within 4 hours** | | |
| Xanthochromia | CSF | White universal | 2 | | 1 day | Must reach lab ASAP, protect from light. |
| Zinc | B | Green (non gel) | 2 | M 11 – 18 µmol/L<br>F 10 – 18 µmol/L | 1 week | Ochre samples not acceptable. Green gel samples not acceptable. Needs to reach RAH lab within 4 hours |

## Phone Limits

NHSGGC follows the Royal College of Pathology guidance on telephoning abnormal results to requestors.

Results from primary care will be phoned to the GP practice. If the results become available outwith normal working hours they will be reviewed by the on-call Biochemist to determine whether they need to be phoned to the GP out of hours service. Whether phoned to the out of hours service or not, they will be phoned to the patient's GP practice when the practice reopens.

Results from secondary care will be phoned to the requesting ward (inpatient) or Consultant secretary (outpatient). For results available out of hours for out patient clinics, the results will be reviewed by the on-call Biochemist to determine whether they need to be phoned to the on-call physician for the specialty the requestor belongs to.

Results will only be automatically phoned when they first become abnormal. Results may not be phoned if they do not demonstrate a significant change from previous results.

Results may be phoned if they do not meet these criteria during the laboratory's normal working hours at the discretion of the duty Biochemist, where it is felt that drawing the results to the attention of the requestor before they might otherwise be routinely reviewed is likely to be helpful.

| Test (all serum / plasma) | Patient Group | Lower limit | Upper Limit | Units |
|---|---|---|---|---|
| Sodium | >= 16 years old | <120 | >155 | mmol/L |
| Sodium | < 16 years old | <130 | >155 | mmol/L |
| Potassium | All | <2.5 | >6.5 | mmol/L |
| Bicarbonate | All | <10 | | mmol/L |
| Adjusted Calcium | All | <1.8 | >3.5 | mmol/L |
| Calcium (not adjusted) | Adjusted calcium result not available | <1.8 | >3.5 | mmol/L |
| Phosphate | All | <0.3 | | mmol/L |
| AST | All | | >1000 | U/L |
| ALT | All | | >1000 | U/L |
| CK | All | | >5000 | U/L |
| Glucose | >= 16 years old | <2.5 | >30 | mmol/L |
| Glucose | < 16 years old | <2.5 | >15 | mmol/L |
| Serum osmolality | All | | >350 | mmol/L |
| Amylase | All | | >500 | U/L |
| Salicylate | All | | >350 | mg/L |
| Paracetamol | All | | >5 | mg/L |
| Magnesium | All | <0.3 | | mmol/L |
| Digoxin | All | | > 2.5 | ug/L |
| Phenytoin | All | | >30 | mg/L |
| Carbamazepine | All | | >25 | mg/L |
| Theophylline | All | | >24.9 | mg/L |
| Lithium | All | | >1.0 | mmol/L |
| Ammonia | All | | >70 | umol/L |
| Bilirubin (total) | <8 weeks age | | >250 | umol/L |
| Bilirubin (conj) | <8 weeks age | | >25 | umol/L |
| Urea | Not Renal, >= 16 years old | | >30 | mmol/L |
| Urea | Not Renal, < 16 years old | | >10 | mmol/L |
| Creatinine | Not Renal, >= 16 years old | | >400 | umol/L |
| Creatinine | Not Renal, < 16 years old | | >200 | umol/L |
| Troponin (high sensitivity) | Primary care, male | | >34 | ng/L |
| Troponin (high sensitivity) | Primary care, not male | | >16 | ng/L |
| Cortisol | When not part of Dexamethasone suppression test. | <50 | | nmol/L |

**PAEDIATRIC SAMPLES**

Minimum sample volumes for paediatric samples are listed in the table below. If obtaining adequate sample volume has been problematic and sample is small in a neonate, please discuss with the duty Biochemist to arrange for tests to be prioritised.

Lithium Hep tubes (1.8 ml) are used for all tests except fluoride for glucose and EDTA for Ammonia and HbA1c.

The table below outlines approximately how much the tube requires to be filled to ensure analysis is possible.

| **TEST** | **Fraction of tube** |
|---|---|
| U&E | 0.25 |
| LFT | 0.25 |
| U&E, LFT | 0.5 |
| SBR | 0.25 |
| U&E,SBR | 0.5 |
| U&E,LFT,SBR,Ca, Mg | 0.5 |
| Ca,Mg,SBR | 0.25 |
| Theophylline | 0.25 |
| Glucose | 0.25 |
| Copper | 0.5 |
| Zinc | 0.5 |
| Copper,Zinc | 0.75 |
| CRP | 0.25 |
| TFT | 0.5 |
| AA's | 1.0 |

**REFERENCE RANGES FOR MATERNITY AND NEONATES – these ranges are for guidance only.**

| **Test** | **Maternal** | | | | **Premature neonates** |
|---|---|---|---|---|---|
| | **1st trimester** | **2nd trimester** | **3rd trimester** | | |
| TSH mU/L | 0.09-2.84 | 0.18-2.81 | 0.30-2.92 | | |
| FT4 pmol/L | 10 - 18 | 9 - 16 | 8 - 14 | | |
| Total T3 nmol/L | 1.24-2.75 | 1.42-3.21 | 1.35-3.19 | | |
| Sodium mmol/L | | | 132-140 | | 130-145 |
| Potassium mmol/L | | | 3.2-4.6 | | 3.5-6.0 |
| Chloride mmol/L | | | 97-107 | | 95-110 |
| Bicarbonate mmol/L | | | 18-26 | | 15-25 |
| Urea mmol/L | | | 1.0-4.0 | | <7.0 day1-7<br><3.5 >day 7 |
| Creatinine µmol/L | | | 40-85 | | <80 |
| Total protein g/L | | | 55-70 | | 45-65 |
| Albumin g/L | | | 32-42 | | 25-35 |
| Bilirubin µmol/L | | | 3-14 | | |
| Alk phos IU/L | | | <230 | | <600 |
| AST IU/L | | | <40 | | <80 |
| ALT IU/L | | | <40 | | <80 |
| GGT IU/L | | | <40 | | <80 |
| | | | | | |
| Ammonia µmol/L | | | | | Pre <180<br>Term <100 |
| Calcium mmol/L | | | 2.1-2.5 (adj) | | 2.0-2.4 (unadj) |
| Copper µmol/L | | | | | 7-18 |
| Ferritin µg/L | | | | | 1st month 450-500<br>2nd month 80-500<br>3rd month 20-200 |
| IgM g/L | | | | | <0.2 |
| Magnesium mmol/L | | | 0.6-0.8 | | 0.7-1.2 |
| Theophylline mg/L | | | | | 5-10 |
| Urate mmol/L | | | <340 | | |
| | | | | | |

**REFERENCE RANGES FOR FEMALE HORMONES**

| **Test** | | **Follicular** | **Mid cycle** | **Luteal** | **Post men** | |
|---|---|---|---|---|---|---|
| Progesterone nmol/L | | <2 | >1-4 | 18-70 | | |
| Oestradiol pmol/L | | 77-920 | 140-2380 | 77-1145 | <100 | |
| FSH u/L | | 3-8 | 2-16 | 1-5 | 18-150 | |
| LH u/L | | 2-13 | 34-115 | 1-16 | 16-64 | |
| SHBG nmol/L | | 20-155 | | | | |

## Request Intervention

For some analytes where repeat sampling within a timeframe is out with current clinical guidelines, or will produce a result which cannot be safely interpreted (not enough time has elapsed to allow a new steady state to arise after a change in therapy) the request will be blocked automatically by the laboratory IT system and the requestor invited to contact the laboratory to discuss a repeat if it is felt to be clinically justified. Current tests and request intervention periods are outlined below:

| **Test** | **Period** | **Test** | **Period** | **Test** | **Period** |
|---|---|---|---|---|---|
| **Cholesterol / Triglycerides** | 28 days | **B12** | 28 days | **Beta carotene** | 14 days |
| **Lipid profile** | 28 days | **Serum folate** | 28 days | **Copper (plasma)** | 14 days |
| **Serum Electrophoresis** | 90 days | **Ferritin** | 28 days | **Manganese** | 14 days |
| **TFTs** | 30 days | | | **Selenium** | 14 days |
| **Total T3** | 30 days | **Faecal Calprotectin** | 120 days | **Vitamins A, B1, B2, B6, E, K** | 14 days |
| **Vitamin D** | 340 days | | | **Zinc** | 14 days |
| | | | | | |

## Test Profiles

The tests done when a set of tests eg U&Es is requested can vary nationally. The test profiles used in NHSGGC are outlined below.

| Set | Tests | Notes |
|---|---|---|
| **U&E** | Sodium, Potassium, Chloride, Urea, Creatinine, eGFR | |
| **Paediatric U&E** | Sodium, Potassium, Chloride, Bicarbonate, Urea, Creatinine | Paediatric creatinine by enzymatic method. |
| **LFTs** | Bilirubin, ALT, AST, Alkaline Phosphatase, Albumin | |
| **Paediatric LFTs** | Total Bilirubin, Conjugated Bilirubin, Unconjugated Bilirubin, ALT, AST, Alkaline Phosphatase, Albumin | Split bilirubin if age <= 26 weeks. |
| **Bone** | Calcium, Adjusted calcium, Phosphate, Albumin, Alk Phos | |
| **Proteins** | Total Protein, Albumin, Globulins | |
| **Immunoglobulins** | IgA, IgG, IgM | |
| **Lipid Profile** | Cholesterol, Triglycerides, HDL, LDL (calculated), VLDL (calculated), Cholesterol to HDL ratio | LDL calculated by Friedewald equation (LDL = Total cholesterol - HDL - (triglycerides/2.2)). Equation is not valid if triglycerides >4.5 and LDL result will not be provided under these circumstances. |
| **Cholesterol and Triglycerides** | Cholesterol, Triglycerides | |
| **Testosterone (male)** | Testosterone, SHBG, Free Testosterone (if Testosterone < 12) | |
| **Serum Electrophoresis** | Total Protein, Paraprotein ID, Paraprotein Quantitation, IgG, IgA, IgM | |
| **TFTs** | TSH, fT4 | |

## Unstable Analytes

Some analytes are unstable and need to reach the laboratory promptly and / or be treated in a special manner (protected from light etc). Where sample receipt is time critical, analysis can often only be performed on samples from secondary care.

When requested through Trakcare time critical samples will typically be labelled “*LABILE*”.

## DYNAMIC FUNCTION TESTS

**Advice here is for reference only. These are largely specialist tests and appropriate specialist guidance should be sought if necessary on test selection and appropriate test protocol. Please note that the water deprivation test, included in this section, should ONLY be performed under the supervision of a Consultant Endocrinologist.**

### Adrenal Function Tests

1. Prednisolone interferes with the laboratory measurement of serum or urine cortisol giving falsely high results.

   Wait 7 days after stopping prednisolone before performing the assay.

   Dexamethasone does not interfere.(but does suppress adrenal function). HRT and OCP should be stopped 6 weeks before performing test.

2. In normal pregnancy and in oestrogen therapy physiologically elevated cortisol binding proteins result in elevated serum cortisol.
   High cortisol values do not necessarily indicate abnormality in these conditions.

### Investigation of Adrenocortical Hypofunction

### Random Cortisol

Measurement of a random serum cortisol can be a useful screening test to exclude adrenal insufficiency but must be interpreted with regard to the patient's clinical status. A 9.00 am cortisol of >500 nmol/L effectively rules out the possibility of adrenal insufficiency in most cases. A level of <100 nmol/L (especially in a stressed individual) is suggestive of adrenal insufficiency. A random cortisol is not of use in diagnosing Cushing's syndrome as increased cortisol can be found as a result of stress and illness.

### Short Synacthen Test (Tetracosactrin)

Synacthen (tetracosactrin) is a synthetic polypeptide with the same structure as the N-terminal 24 amino acids of ACTH. The Synacthen Test is used to exclude adrenocortical insufficiency due to adrenal gland destruction and in the investigation of possible congenital adrenal hyperplasia. The test should be performed in the morning with the basal sample taken between 8.00 and 9.00 am. The patient does not require to be fasted.

Take **basal** specimen for cortisol (ochre) and EDTA (lavender) sample for plasma ACTH (if required, transport ACTH sample immediately to lab, phoning laboratory beforehand).

Give **Synacthen** 250 µg IV or IM.

Collect a **post-synacthen** specimen for cortisol 30 minutes after the dose has been given (additional sample at 60 mins for assessment of congenital adrenal hyperplasia). Please send both samples for cortisol with one request form.

| | |
|---|---|
| An adequate response is a serum cortisol | >430 nmol/L |
| Inadequate response | <430 nmol/L |

An inadequate response may be further investigated by basal ACTH measurement (useful in differentiating primary from secondary adrenal insufficiency).

The basal level for infants may be lower (60 to 70 nmol/L), especially if they have been on dexamethasone (which may be used in high doses in bronchial pulmonary dysplasia), when the basal level may be less than 50 nmol/L. They should still give a rise in response to Synacthen. The Synacthen dose for children will be determined by weight and / or age – please confirm with the responsible clinician the dose of synacthen to be used.

## Screening for Cushing's Syndrome (adrenocortical hyperfunction)

Clinical Background

Cushing's syndrome compromises symptoms and signs associated with prolonged exposure to inappropriately increased levels of glucocorticoids (cortisol). Diagnosis is important as untreated Cushing's syndrome has significant morbidity and mortality. In addition the physical and psychological features are reversible with treatment. Difficulties with screening are that the condition is rare, symptoms and signs associated with Cushing's are not specific (see Table 1) and pseudo – Cushing's causes (exogenous steroid use, stress, obesity, alcoholism, depression, schizophrenia) are a more common cause of increased cortisol.

### Table 1 Symptoms and Signs associated with Cushing's

| | |
|---|---|
| **Skin**<br>Ecchymoses, plethora, striae (wide purple) acne, hirsutism | **Biochemical**<br>Hypokalaemia, abnormal glucose tolerance, diabetes mellitus |
| **Body Habitus**<br>Unexplained osteoporosis, central obesity, buffalo hump, moon face, muscle weakness | **Miscellaneous**<br>Hypertension, oligomenorrhoea, decreased libido, psychosis |

If there is a clinical suspicion of Cushing's there are two stages to the investigation. The first is to establish if the patient has Cushing's syndrome and then to establish the cause. Prior to any biochemical testing it is important

to exclude exogenous steroid use and the possibility of other conditions which may result in a pseudo-Cushing's state. A drug history is important as oestrogens result in an increase in cortisol binding globulin which will lead to false positives and enzyme inducers (anticonvulsants, rifampicin) will result in an increased metabolism of dexamethasone which will also lead to false positives.

**Biochemical Screening Tests**

These investigations are used to establish the possibility of Cushing's syndrome:

**Overnight Dexamethasone Suppression Test**

Principle

This test is based on the principle of demonstrating an abnormal response to exogenous glucocorticoid administration. Dexamethasone is a potent synthetic glucocorticoid which will affect the Hypothalamic-Pituitary-Adrenal (H-P-A) axis by feedback suppression of ACTH which in normal subjects should result in decreased cortisol production.

Protocol & Sampling

The test is performed as an outpatient.

1 mg of oral dexamethasone is given at midnight. A venous blood specimen (ochre) for cortisol measurement is taken at 09.00 the next morning.

Interpretation

<50 nmol/L: Cushing's syndrome very unlikely
>50 nmol/L: Possible Cushing's syndrome. Ensure test compliance and no anticonvulsant medication. Proceed to urine cortisol analysis (see below). Contact Biochemist for advice on further testing and referral (plasma ACTH and long dexamethasone suppression test).

Reference:

Wood PJ et al. Evidence for the low dose dexamethasone suppression test to screen for Cushing's syndrome – recommendations for a protocol for biochemistry laboratories. Ann Clin Biochem 1997; 34: 222-229.

## Urine Cortisol Analysis (UFC – urinary free cortisol)

Principle

This test demonstrates abnormal urinary cortisol secretion. Compared to the overnight dexamethasone test it has slightly better specificity in the outpatient population. UFC reference ranges vary with the assay used. Renal function should be assessed prior to performing the test. If there is a possibility of cyclical Cushing's, UFC may be the better first line test as it provides an integrated measure of cortisol production over a 24 hr period (2-3 collections should be made)

Protocol & Sampling

The test is performed as an outpatient.
Three early morning urine specimens (EMU) taken into plain universal containers for cortisol/creatinine ratio should be sent, with separate dated request forms for each.
If the patient is well motivated and able to follow instructions two x 24 hr urine could be made for urinary free cortisol instead.
Multiple spot urine samples for Cortisol / creatinine ratio may be a more useful test when cyclical disease is suspected.

Reference Ranges:

24 hr urine cortisol: <165 nmol / 24 hours
EMU cortisol/creatinine ratio: <40 nmol/mmol

Reference:

Meier CA et al. Clinical and Biochemical Evaluation of Cushing's syndrome. Endocrine and Metabolic Clinics of North America 1997; 26(4): 741-762.

Boscaro M et al. The Diagnosis of Cushing's syndrome. Arch Intern Med 2000; 13: 3045-53.

## Low (LDDT) Dose Dexamethasone Suppression Tests

The LDDST is an addition to the ODST for the diagnosis of Cushing' Syndrome and can be used to help distinguish between pseudo-Cushing's and Cushing's.

Dexamethasone 0.5mg is given 6 hrly for 48 hours orally. A baseline blood sample is taken for cortisol and ACTH. 6 hours post the last dose a further blood sample is taken for cortisol. Normal individuals should suppress to <50 nmol/L. In ambiguous cases it may be prudent to re-evaluate after 3-6 months and resolution of underlying disease.

## Acromegaly

A random growth hormone / IGF 1 should first be measured when acromegaly is suspected.

An oral glucose tolerance test is used when acromegaly/gigantism is suspected. This will suppress normal growth hormone secretion but not in acromegaly.

Specimens are collected for glucose (grey tube) and GH (ochre tube) estimations every 30 minutes for two hours.

Interpretation

Failure to suppress to < 1 µg/L suggests a diagnosis of aromegaly or gigantism. However, abnormal GH dynamics are also seen in severe liver or renal disease, diabetes, Turner's syndrome, porphyria, Huntington's chorea, malnutrition, heroin addiction and in patients taking levadopa.

## Water Deprivation Test

**This test is potentially dangerous in patients with severe diabetes insipidus and patients must be monitored closely for the duration of the test. It would be expected that this test would only be performed on the advice and under the direction of a Consultant Endocrinologist.**

**Please notify the lab in advance that you will require urgent osmolality measurements for the course of the test.**

This test is indicated in patients with polyuria and polydipsia in whom hypothalamic or posterior pituitary diseases or renal tubular dysfunction is thought to be the cause (diabetes insipidus (DI)), and in whom other causes of these symptoms (e.g. diabetes mellitus, chronic renal failure) have been excluded. Check that the patient has a normal 9am cortisol concentration and is biochemically euthyroid before the test.

Principle

The test investigates the ability of the kidney to produce a concentrated urine in response to fluid deprivation. It is usually performed in two stages. Initially fluid is withheld and if the urine is not adequately concentrated then the second stage follows, where a synthetic analogue of anti-diuretic hormone, DDAVP (desaminocys-1-8-D-arginine) is given.

Patient Preparation

Patients receiving im DDAVP should have this stopped 3 days prior to testing. Any polyuria during this period can be controlled using DDAVP nasal spray. The latter should be stopped 12h before testing.

Protocol and Sampling

The test should not be performed if the patient is already dehydrated. The patient is allowed no food or water after 2200h. Smoking is forbidden. The patient is weighed. At 07:00 the bladder is emptied and the urine is sent to the laboratory along with a blood sample for urgent osmolalities. If the urine sample is >85OmOsm/Kg the test may be terminated. If it is less than this, continue taking urine samples for a few hours to see if osmolality increases.

The patient must be weighed frequently during the test.

The patient must be closely supervised as a patient with ADH deficiency can become dangerously dehydrated; **discontinue if patient loses more than 3% body weight.** Compulsive water drinkers who often have had a poor osmotic gradient in the kidney medulla for a long period of time may require several hours to give a maximally concentrated urine.

Interpretation

In normal subjects after overnight fasting, urine osmolality should be greater than 850mOsm/Kg; serum osmolality does not rise above 300mOsm/kg.
A low urine osmolality (<270mOsm/kg) and serum osmolality greater than 300mOsm/Kg indicates impaired renal concentrating power either due to tubular disease or cranial diabetes insipidus; it is appropriate then to continue with the DDAVP test.

**DDAVP Test**

2µg DDAVP (available from Pharmacy) is given intramuscularly. Urine is collected each hour for 2h for osmolality determination.

The patient may drink water **but for the next 24h be careful not to give more than twice the volume excreted during the first part of the test above;** there may be danger of water overload.

Interpretation

| **Diagnosis** | **After dehydration** | **After DDAVP** |
|---|---|---|
| Normal | >750 | >750 |
| PP or partial CDI | 300 - 750 | <750 |
| CDI | <300 | >750 |
| NDI | <300 | <300 |

Failure to concentrate urine during water deprivation but ability to do so after DDAVP confirms cranial DI.
Failure to concentrate urine after DDAVP suggests nephrogenic DI.

## NUTRITION

### Nutrition Support Team

**A combined support teams operates within Clyde – at Inverclyde and the Royal Alexandra. These are multidisciplinary teams who can provide advice for complex nutritional problems. The Nutrition Nurse Specialists can be contacted on 07117.**

**Referral pathways for Parenteral Nutrition are shown below.**

**Clyde Referral Pathway for Nutritional Support**

**Monday to Friday**

↓

Nutrition Profile Complete

↓

Full Biochemical Monitoring Complete

↓

Referral and Medical Treatment Plan Documented in Case Notes

↓

**Contact**

| **IRH (by 12.00am for same day PN)** | | **RAH (by 12.00am for same day PN)** | |
|---|---|---|---|
| **Inverclyde Royal Hospital** | | **Royal Alexandra Hospital** | |
| **Nutrition Support Team** | | **Nutrition Support Team** | |
| Parenteral Nutrition | Enteral Nutrition | Parenteral Nutrition | Enteral Nutrition |
| ↓ | ↓ | ↓ | ↓ |
| Biochemistry Contact Biochemistry Lab ext 06652 | Dietician Ext 04313 | Dietician Ext 06808 | Dietician Ext 06808 |

↓

**Ensure Trakcare referral to dietetics has been made**

**Further specialist advice available from Clyde nutrition Nurse Specialist or Nutrition Nurse Practitioner on ext 07117.**

**Parenteral Nutrition prescribing out-of-hours is not consistent with current GG&C policy.**

### Biochemical Monitoring of Patients on Intravenous Nutrition

U&E, LFT, Bone profile Magnesium, and glucose should be checked daily in patients on Parenteral nutrition for the first two weeks of therapy. Thereafter less frequent monitoring may be appropriate at the direction of the nutrition team.

Micronutrient profiles in PN patients on long term PN, and the profiles should be measured on well patients generally in an outpatient setting as many micronutirent levels can be suppressed in patients demonstrating an acute phase response.

Guidance on Parenteral Nutrition can be found within the NHSGG&C Nutrition Manual (link only works from hospital network). This can be found on Staffnet within the Food, Fluid and Nutrition pages.

## Accreditation

Clyde Biochemistry Laboratories (those based at Royal Alexandra Hospital, Inverclyde Royal Hospital and Vale of Leven Hospital) are accredited with UKAS to standard ISO 15189:2012. The certificate of accreditation is available online.

The scope of our accreditation includes the majority of the tests performed by our laboratories, with a small number of tests not falling within our accreditation status (for example, no fluid analyses (on fluids other than CSF, urine or blood / serum / plasma) are accredited).

Our accreditation is limited to those activities described on our UKAS schedule of accreditation found here.

The following list contains analyses which fall under our accreditation status:

| **Urine Tests** | **Calculated urine tests** | **CSF Tests** |
|---|---|---|
| Albumin | Albumin/Creatinine Ratio | Glucose |
| Bence Jones proteins ( BJP) | Calcium/Creatinine Ratio | Protein |
| Chloride | Creatinine clearance | |
| Creatinine | Phosphate/Creatinine Ratio | |
| Potassium | Protein/Creatinine Ratio | |
| Sodium | Urate/Creatinine Ratio | |
| Total protein | | |
| Urea | | |
| Urine Immunofixation | | |
| Urine osmolality | | |

| **Blood (serum / Plasma / whole blood as appropriate)** | | | **Calculated Blood Test Results** |
|---|---|---|---|
| AFP | Folate | Salicylate | Adjusted/corrected Calcium |
| Albumin | FSH | Serum Electrophoresis | eGFR |
| Alcohol | FT4 | Serum Immunofixation | Globulin |
| Alkaline Phosphatase | Gamma Glutamyl Transferase | SHBG | LDL Cholesterol |
| ALT | Gentamicin | Sodium | Protein/Creatinine Ratio |
| Ammonia | Glucose | Testosterone | Transferrin Saturation |
| Amylase | HbA1c | Theophylline | VLDL |
| Anti-TPO | hCG | Troponin (high sensitivity) | |
| AST | HDL-Cholesterol | Transferrin | |
| Beta 2 Microglobulin | IgA | TSH | |
| Bicarbonate | IgG | Total T3 | |
| Bilirubin, direct | IgM | Urate | |
| Bilirubin, total | Iron | Urea | |
| CA 125 | Lactate | Valproate | |
| CA 19-9 | Lactate Dehydrogenase (LDH) | Vancomycin | |
| Calcium | LH | Vitamin B12 | |
| Carbamazepine | Lithium | Vitamin D | |
| CEA | Macroprolactin | | |
| Cholesterol | Magnesium | | |
| Chloride | Oestradiol | | |
| Cortisol | Osmolality | | |
| C-Reactive Protein | Paracetamol | | |
| Creatine Kinase (CK) | Phenytoin | | |
| Creatinine | Potassium | | |
| Cryoglobulin screen | Progresterone | | |
| Cryofibrinogen screen | Prolactin | | |
| Digoxin | PIIINP | | |
| Ethanol | PSA | | |
| Ferritin | PTH | | |

## Recent Updates

| Date | Changes |
|---|---|
| 05/08/22 | Update staff list. Update faecal elastate turn around time. Update accreditation status. |
| 28/03/22 | Update staff list. Update test list details for procalcitonin, zinc. Include lactate in UKAS accreditation scope, remove redundant tests from scope. Update B2M TAT. |
| 23/06/21 | Update staff list. Update that lactate is now available within the laboratory. |
| 16/03/21 | Update CA19-9 reference range. |
| 23/12/20 | Add calcitonin to list of tests. |
| 29/07/20 | Update staffing. Correct name of P3NP. Add hypophosphataemia investigation pathway from newsletter. |
| 20/04/20 | Add ASO titres and EPO to test list. Correct contents of Testosterone profile. |
| 31/03/2020 | Add reference to email advice service.<br>Updated staffing<br>Indicated samples for other disciplines should be requested appropriately.<br>Updated guidance re Metadrenalines and 5HIAA<br>Homocysteine and metadrenalines added to list of test<br>Other small updates |
| 18/11/2019 | Updated accredited tests list<br>Update P3NP test details |
| 29/01/2019 | Update accredited tests list.<br>Correct Urine cortisol ref ranges.<br>Remove redundant tests from reference range document.<br>Small updates to NTProBNP and OGTT, blood gas sections.<br>Add newsletter guidance on hypertriglyceridaemia |
| 04/12/2018 | POCT email address added.<br>Added urinary catecholamine collection advice<br>Added link to qFIT information<br>Updated phone limits to reflect changes in light of new RCPath Guidelines.<br>Updated section on FSH testing in menopause to reflect advice from laboratory newsletter.<br>Added paediatric hypoglycaemia protocol<br>Update reference ranges for CA125 and cortisol in SST (acceptable cortisol in SST now 430nmol/L)<br>Update accreditation section<br>Update staff contacts<br>Add links to BNP protocol and Therapeutics Handbook Guidance on electrolyte abnormalities<br>Add guidance for patients who do not have CHI number<br>Add section on qFIT (work in progress, further guidance expected)<br>Add email address for POCT enquiries |

| | |
|---|---|
| | Remove PSA from list of tests with request intervention<br>Statements on confidentiality, consent and data protection added |
| 04/12/2017 | Recent Update Section added<br>Accreditation Section Added<br>Link added for Nutrition Resource Manual<br>CSF sample update to reflect guidance from QEUH Biochem<br>Section added on fluid sample requirements<br>New link for Tumour Marker Guidance as previous website defunct<br>All links reviewed<br>Limit for satisfactory post synacthen cortisol changed to > 450 nmol/L<br>Sample requirements / ref ranges reviewed |
| | |