Clyde Biochemistry 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 for hospital patients 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

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, for secondary care requests an additional paper (not Trakcare) request form should be completed and sent to the laboratory clearly indicating that it is an add on test. For primary care requests please phone the laboratory to discuss.

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 3 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 (Job share)

Mrs Sylvia Arthur
Technical Services Manager (Job share)

Clinical Issue:
Dr Helen Falconer
Clinical Lead

Address:
Biochemistry Department
Royal Alexandra Hospital
Corsebar Road
Paisley
PA2 9PN

Contact Telephone Numbers:

Inverclyde Royal Hospital:	01475 504827	ext 04827
Emergency requests	0141 314 4213	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, QEUH and GRI).

Colleen Ross	Consultant Clinical Biochemist	ext 06056
Andy Kerry	Consultant Clinical Scientist	ext 06657
Christina Kanonidou	Consultant Clinical Biochemist	ext 06209
Helen Falconer	Consultant Clinical Scientist	ext 07585
Karen Brazier	Technical Services Manager	ext 06098
Sylvia Arthur	Technical Services Manager	ext 06098
Jonny Strachan	Principal Scientist	ext 09574
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.

Discrimination

All testing will be performed in such a way to uphold the right of patients to care that is free from discrimination.

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 – Hospital Patients

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.

Urgent Requests and Result Turnaround Times – Primary Care

Routine samples for primary care are analysed with a usual turnaround time of a day.

If you require urgent analysis of a sample please contact the laboratory reception prior to sending the sample to the lab. Please limit requests to those that are truly urgent since these create a significant amount of extra work for the laboratory. We are unable to guarantee rapid turnaround of samples where “urgent” is merely written on the request form.

Pneumatic Tube

There are pneumatic tubes at IRH and RAH.

At IRH 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.

Sample Storage Prior to Transport to Laboratory – Centrifuged samples

To avoid blood specimens being rejected, specimens should be left for 30 minutes to settle before centrifuging then stored at room temperature prior to pick up. Do not store blood samples in the fridge.

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.

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. It is used in the detection and monitoring of 'stable' patients with suspected or established Chronic Kidney Disease (CKD).

The eGFR is not valid under the age of 18 years and in acutely ill patients. eGFR should be multiplied by 1.2 for African-Caribbean patients.

An eGFR >60ml/min/1.73m^2 does not exclude CKD stages 1 and 2. Patients with an eGFR between 30 and 59 mL/min/1.73m^2 on two separate samples about 90 days apart are classified as CKD stage 3.

Persistent proteinuria (protein:creatinine ratio (PCR) greater than 100 mg/protein/mmol creatinine) is the best indicator of risk to end stage renal disease in patients with early CKD (stages 1-3).

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. Urinary albumin estimations should be used in diabetic patients.

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

The 5 stages of Chronic Kidney Disease (CKD)

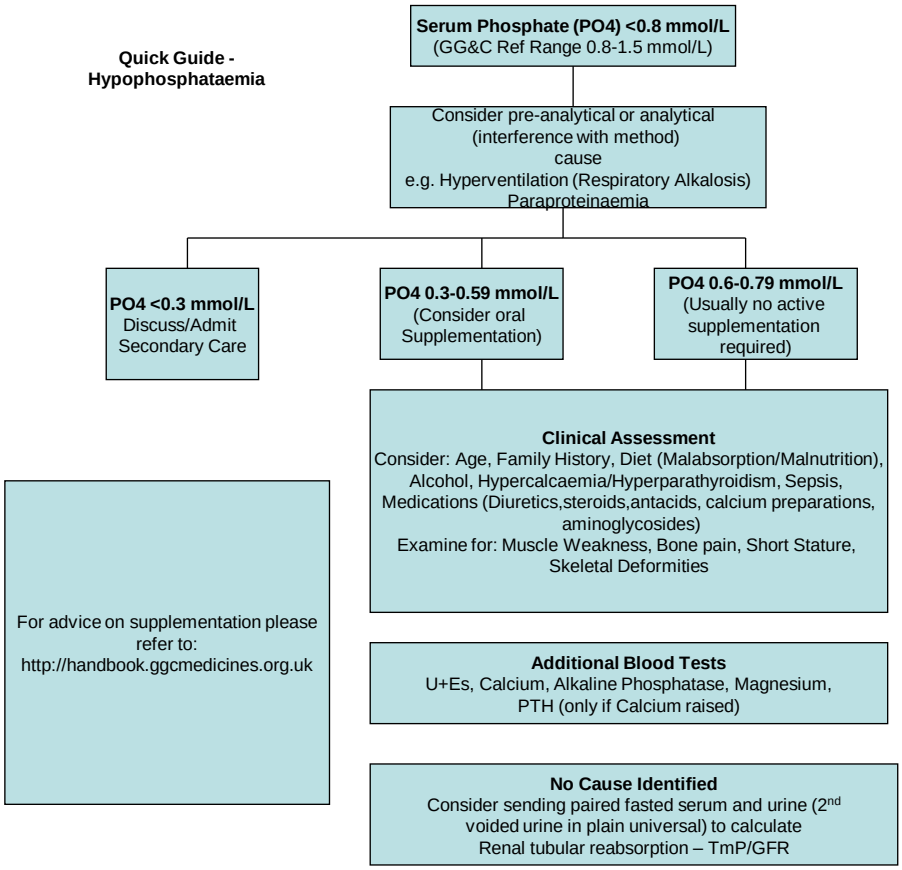
EGFR		STAGE
>90ml/min	with another abnormality* - otherwise regarded as normal	= stage 1 CKD
60-89ml/min	with another abnormality* - otherwise regarded as normal	= stage 2 CKD
30-59ml/min	(moderate impairment)	= stage 3 CKD
15-29ml/min	(severe impairment)	= stage 4 CKD
<15ml/min	(established renal failure)	= 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. Measurements should be continued every 8 weeks until the patient reaches their target value. After reaching target concentration, lipids should be checked annually, unless there is a clinical indication to do so sooner.

Liver function should also be checked prior to commencing statin therapy and 1-2 months after starting therapy or any dose increase. If LFTs are stable, measurement at one year should be adequate, unless there is a clinical indication to do so sooner.

If AST and ALT rise in a patient taking a statin:

- If less than 3 times the upper limit of normal, continue therapy but repeat LFTs in 4-6 weeks to exclude further rises. No further monitoring is required if LFTs are stable.
- If more than 3 times the upper limit of normal, consider reducing the dose or stopping statin therapy.

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. Address secondary causes Consider statin therapy at lower risk threshold
10-20 mmol/L	Repeat with fasting level within 2 weeks Review for secondary causes and manage accordingly 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
Alcohol
Renal Disease (Nephrotic)
Hypothyroidism
Obesity
Medications (steroids, retinoids, psychotropics, beta blockers, anti-retrovirals, thiazides, tamoxifen)
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.

Indications for thyroid function testing include patients presenting with:

- Signs/symptoms associated with thyroid dysfunction
- A suspected goitre
- Atrial fibrillation, dyslipidaemia, osteoporosis or sub-fertility.

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).

Autoimmune thyroid disease may take many years to develop. The frequency of follow up in patients with a pattern of subclinical hypothyroidism should be annual if the anti-TPO antibodies are positive, or 2-3 years if negative.

There is no merit in repeated testing of individuals with completely normal TFT results. Causes other than thyroid dysfunction should be sought to explain the symptoms.

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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

The menopausal transition can most often be determined on clinical grounds alone and **measurement of hormones is not appropriate.** 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**	**Biochemical Assesment**
>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	FSH and LH may be of value
<40 ?peri-menopause/menopause		See below

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. Synthetic oestrogens or progestogens cannot be detected by current assays and suppression of gonadotrophins is variable.

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 and TFTs.
- An androgen screen may be appropriate if PCOS is clinically indicated.
- Please give details of LMP, symptoms, suspected diagnosis and any hormone treatment to assist with interpretation of results.
- Please give relevant drug history if Prolactin is requested – phenothiazines and hormonal contraception being the most relevant medications.

When possible collect samples first line investigations during the follicular phase (days 1-7 of cycle / during menstruation). Avoid sampling during the mid-cycle gonadotrophin surge (days 13-17 of cycle).

Premature ovarian insufficiency

Premature ovarian insufficiency should be suspected in a woman younger than 40 years, providing she is not taking hormonal contraception if there are:

- Menopausal symptoms, including no or infrequent periods (taking into account whether she has a utertus) **and**
- Elevated serum FSH levels (more than 30 U/L) on two blood samples taken 4-6 weeks apart.

Stopping the progesterone-only pill

If a woman aged over 50 years with amenorrhoea wishes to stop contraception before the age of 55 years:

- Check serum follicle-stimulating hormone (FSH) levels on two occasions, with an interval of 6 weeks between tests.
- If both FSH levels are more than 30 U/L, the progestogen-only pill (POP) can be discontinued after a further year.
- If the FSH level is in the premenopausal range, continue the POP and recheck the FSH level after 1 year.

Once a woman reaches 55 years of age, contraception can be stopped even if there is still menstrual bleeding.

Reference Intervals

Analyte	Phase of cycle	Reference interval
FSH	Follicular Mid-cycle Luteal	3-8 U/L 2-16 U/L 1-5 U/L
LH	Follicular Mid-cycle Luteal	2-13 U/L 34-115 U/L 1-16 U/L
Prolactin		<630 mU/L

Ovulation

Progesterone should only be measured to determine if ovulation has occurred. Samples for progesterone measurement should be collected on day 21 of a 28 day cycle (or 7 days before next period is due, if cycle length is different). A progesterone concentration of >20nmol/L is consistent with ovulation. Gonadotrophins should not be measured on day 21.

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

The use of most tumour markers is not recommended in a Primary Care setting due to the lack of their specificity for malignancy and reference ranges are generally not well defined. For most serum tumour markers a concentration within the reference range does not exclude malignancy and an elevated concentration does not confirm it. Markers such as CEA and CA19-9 should only be requested where recommended by an oncologist for monitoring purposes.

In secondary care 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.

Scottish Referral guidelines for suspected cancer recommend measuring PSA in men who present with unexplained possible signs and symptoms of prostate cancer such as:

- Changes to urinary patterns
- Erectile dysfunction
- Unexplained haematuria
- Lower back pain
- Bone pain
- Weight Loss

This should be done in conjunction with a digital rectal examination.

PSA should not be measured in any of the following situations:

- In a patient with a known UTI or who has been catheterised or has had another invasive procedure such as a prostate biopsy (PSA may stay elevated for 6 weeks)
- In a patient known to have recently ejaculated (PSA may be raised within 3 days of ejaculation)
- In a female patient (with the exception of transgender patients)

An isolated increase in an asymptomatic patient should be confirmed before further tests are considered. Patients with borderline PSA concentrations should have the measurement repeated in 6-12 weeks; if the concentration is rising, the patient should be referred urgently.

Age-related reference ranges are used in the interpretation of PSA results:

50 – 59 years	<3µg/L
60 – 69 years	<4µg/L
70+ years	<5µg/L

A PSA concentration within the reference range does not exclude malignancy; a raised concentration may be due to a benign cause, such as benign prostatic hyperplasia.

CA 125

CA 125 measurement is part of the ovarian cancer diagnostic pathway. It is usually diagnosed late with approximately 30% of cases having a palpable pelvic mass at presentation. Symptoms are often non-specific abdominal symptoms but are characterised by their persistency and frequency.

Scottish Referral guidelines for suspected cancer recommend investigating patients who present with symptoms suspicious for ovarian cancer in:

- Women >50yrs with new symptoms of irritable bowel syndrome (IBS)
- Women >18 yrs with recurrent/persistent symptoms
    - Bloating or abdominal distension
    - Loss of appetite
    - Feeling full quickly (early satiety) and /or loss of appetite
    - Pelvic/abdominal pain
    - Increased urinary frequency/urgency
    - Change in bowel habit

First-line investigations include

- Abdominal palpation
- Urgent Pelvic ultrasound scan AND serum CA 125 (Do not measure during menstruation or pregnancy)

CA 125 may also be requested in the context of follow up/monitoring of patients with previously raised CA 125 or monitoring of patients with known ovarian cancer (typically requested via secondary care).

Therapeutic Drug Measurement

Samples should generally be taken at steady-state (see table on next page) but earlier analysis may be indicated in the following circumstances:

- Suspected overdose or toxicity
- Poor clinical response despite high dose
- Unstable clinical condition (particularly changing renal function)
- Potential/ suspected drug interactions

Drug analysis is **not** recommended in the following circumstances:

- Routine analysis of anticonvulsants and digoxin, especially when clinical control is satisfactory
- Valproic acid therapy (poor correlation between serum concentration and clinical effect)
- Digoxin within 6 hours of oral dose

Lithium

For patients on lithium therapy, lithium concentrations should be checked every 3 months, and thyroid function tests, calcium and renal function should be assessed annually.

Phenytoin

There is a non-linear rise in serum concentration with increasing dose. Toxicity may develop with small dose adjustments or the introduction of interacting drugs.

Free (active) phenytoin concentrations can increase from normal when serum albumin concentration falls and when phenytoin is displaced from albumin with co-administered drugs. **Care should be taken in interpreting results when albumin concentration is less than 32g/L.** Care in interpretation should also be taken when renal failure is present.

Digoxin

Results from samples taken within 6 hours of an oral dose are unreliable.

Hypokalaemia, hypomagnesaemia and hypercalcaemia potentiate digoxin toxicity.

Unexpected results in hepatic and renal failure should be interpreted with caution; contact Reporting Biochemist for interpretation.

Target Ranges for Therapeutic Drugs

Drug	Time to steady state	Ideal sample time	Target range
Carbamazepine	2-3 weeks (new therapy) 2-4 days (dose change)	Predose (not critical)	4.0 – 12.0 mg/L
Phenytoin	2-3 weeks	Predose (not critical)	Adults: 5.0 – 20.0 mg/L
Theophylline	2-3 days	Predose (not critical)	Adults: 10.0 – 20.0 mg/L (5.0 – 10.0 mg/L adequate in some circumstances)
Digoxin	7-10 days	6-24 hours after dose	0.5 – 2.0 µg/L
Lithium	5 days	12 hours after dose	0.6 – 1.0 mmol/L (0.4 – 0.8 mmol/L for prophylaxis and older patients)

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:
heart-mcn-investigation-and-management-of-heart-failure.pdf (scot.nhs.uk)

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 tests for detecting paraproteins is serum protein electrophoresis (ochre tube) and urine electrophoresis, to look for Bence Jones Proteins (free light chains), on an early morning urine sample (plain urine tube). In addition, immunoglobulins will be measured by the laboratory to look for immune paresis or a polyclonal increase of all immunoglobulin classes.

Monoclonal Gammopathy of Unknown Significance (MGUS)

Asymptomatic paraproteinaemia i.e. MGUS, is a relatively common incidental finding in the elderly or those with any chronic inflammatory condition. A very small proportion of patients with MGUS may progress to a clinically significant myeloma, therefore follow up should be considered. Typically this should consist of 3-4 monthly repeat serum protein electrophoresis for 2 years, then annually if serum paraprotein concentration is stable or the patient is asymptomatic. Where serum free light chain levels have been assessed and indicate lower risk of progression, less frequent monitoring may be appropriate. However, if the patient develops symptoms or signs of myeloma or lymphoma at any point, re-assessment is advised.

Further information and guidance is available at:
http://www.b-s-h.org.uk/guidelines/guidelines/investigation-of-newly-detected-m-proteins-and-the-management-of-mgus/

Turnaround time for serum and urine electrophoresis may be up to two or three weeks, respectively if a paraprotein is detected. Please do not send repeat specimens without checking with laboratory as previous specimens may still be in process.

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 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 (Capillary blood gas)	Capillary blood gas tube **(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 U&Es LFTs CRP	Lithium Heparin (Green) * 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 (small Purple screw top)	500 microlitres (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. Any changes to reference ranges will be highlighted as a comment next to results.

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 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
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 >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 >41 y F <3 nmol/L 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

Test	Sp	Container	Vol (ml)	Reference range (adult)	Result Time	Comments
Bilirubin	B	Ochre	2	<20 µmol/L	1 day	
Blood gases (arterial)	B			H^+ 36-44 nmol/L pCO_2 4.6-6.0 kPa pO_2 10.5-14 kPa	POC	
Blood gases (venous)	B			H^+ 42-48 nmol/L 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
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 F 11 – 25 µmol/L	1 week	Ochre samples not acceptable
Cortisol	B	Ochre	2	240-600 nmol/L (7-9 am) 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 <165 nmol/24h		Screening for Cushings Early morning urine required

Test	Sp	Container	Vol (ml)	Reference range (adult)	Result Time	Comments
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 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 2.5-16µmol/L 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
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 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 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.**

Test	Sp	Container	Vol (ml)	Reference range (adult)	Result Time	Comments
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 µmol/24 hours	28 days	Contact lab for 24 hour bottle. Test for carcinoid.
Homocysteine	B	Lavender	2	0-20 µmol/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 IgA IgG IgM	B	Ochre	2	 0.8 – 4.0 g/L 6.0 – 16.0 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.**
Iron Transferrin Transferrin saturation	B	Ochre	2	10 – 30 µmol/L 2 – 4 g/L 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 Normetad'ine < 650 3-MT < 400 Units all nmol/24hr	28 days	For diagnosis / monitoring of phaeochromocytoma and paraganlgioma
Metadrenalines (plasma)	B	Lavender	2	Metadrenaline < 510 Normetad'ine < 1180 3-MT < 180 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	

Test	Sp	Container	Vol (ml)	Reference range (adult)	Result Time	Comments
Osmolality	B/ U	Ochre/ white universal	2/2	B 275 – 295 mOsmol/L 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	
Potassium (urine)	U	White universal	2		1 day	
PSA	B	Ochre	2	<60yrs < 3.0 µg/L <70yrs < 4.0 µg/L >=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 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				

Test	Sp	Container	Vol (ml)	Reference range (adult)	Result Time	Comments
Renin concentration	B	Lavender	2	<40 mIU/L supine <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 F 20 – 155 nmol/L	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 F <1.5 nmol/L	1 week	
Theophylline	B	Ochre	2	adult 10-20 mg/L 1m – 1y 5-15	1 day	GGC Medicines handbook advises 8-12 hr post dose. BNF advises 4 -6 hrs post dose for slow release preparations.
TPMT (thiopurine methyl transferase)	B	Lavender	2	Normal 35 – 79 nmol/gHb/hr	1 week	Recommend checking levels before starting azothioprine.
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 (IP/OP), Ochre (GP)	2	F ≤16 ng/L M ≤36 ng/L	1 day	Measure in accordance to local protocol
Tryptase	*B*					*Request via immunolgy*
Urate	B	Ochre	2	M 200 – 430 µmol/L F 140– 360 µmol	1 day	
Urate (urine)	U	Plain 24 hour container	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 F 10 – 18 µmol/L	1 week	Ochre and 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 phoned to the GP out of hours service. They will also be phoned to the patient's GP practice when the practice reopens unless the patient has been admitted to secondary care.

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 (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	≥ 16 years old	1.8	3.5	mmol/L
Adjusted Calcium	< 16 years old	1.8	3.0	mmol/L
Calcium (not adjusted)	Adjusted calcium result not available	1.8	3.5	mmol/L
Phosphate	All	0.3		mmol/L
AST	≥ 16 years old		1000	U/L
AST	< 16 years old		500	U/L
ALT	≥ 16 years old		1000	U/L
ALT	< 16 years old		500	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
Lactate	≥ 16 years old		4.0	
Lactate	< 16 years old		3.0	
Amylase	All		500	U/L
Salicylate	All		350	mg/L
Paracetamol	All		5	mg/L
Magnesium	All	0.4		mmol/L
Digoxin	All		2.5	µg/L
Phenytoin	All		30	mg/L
Carbamazepine	All		24.9	mg/L
Theophylline	All		24.9	mg/L
Lithium	All		1.0	mmol/L
Ammonia	All		100	µmol/L
Bilirubin (total)	<8 weeks age		300	µmol/L
Bilirubin (conj)	<8 weeks age		25	µmol/L
Urea	Not Renal, ≥ 16 years old		30	mmol/L
Urea	Not Renal, < 16 years old		15	mmol/L
Creatinine	Not Renal, ≥ 16 years old		400	µmol/L
Creatinine	Not Renal, < 16 years old		150	µmol/L
CRP	Primary care only		300	mg/L
Troponin (high sensitivity)	Primary care, male		34	ng/L
Troponin (high sensitivity)	Primary care, not male		16	ng/L
Troponin (high sensitivity)	Emergency departments only		200	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 <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 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 2nd month 80-500 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	

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*".

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.

Please refer to the PN referral process document on the Clyde Biochemistry Website to refer patients who require parenteral nutrition to the Nutrition team: **Clyde Biochemistry - NHSGGC**

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) or POC tests are accredited). Some tests performed in referral laboratories may also not be 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		
rritin	PTH		