Blood Sciences Departmental Handbook

Review Interval	**Every 2 years or following significant change**
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I Richards	Head BMS	10/2015	IR	10/2017
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S Khan Dr M Livingston N Ahmed M Lowe K Stanton S Harris	Head BMS Consultant Clinical Biochemist, Senior BMS Senior BMS Senior BMS Senior BMS	07/2019	SK ML NA ML KS SH	07/2021
Dr M Livingston N Ahmed S Norton S Harris	Consultant Clinical Biochemist Senior BMS Senior BMS Senior BMS	12/2019	ML NA SN SH	12/2021
Significant Changes in this version				
12/2019	Inclusion of BCPS Fluid requirements and repertoire Inclusion of updated CSF requirements Inclusion of in-house analysis of Tumour Markers			
04/2020	Updated contact information, minor typos, TAT for Igs and IgE.			
05/2020	Inclusion of Procalcitonin			

06/2020 Addition of pre sampling storage conditions
07/2021 Remove Phlebotomy information
17/06/2022 Added minimum blood volume specimen requirements

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BCPS Blood Sciences at Walsall Handbook

Introduction

The Black Country Pathology Services (BCPS) is comprised of the Pathology services at Royal Wolverhampton NHS Trust (RWT), The Dudley Group NHS Foundation Trust (DGFT), Walsall Healthcare NHS Trust (WHT), and Sandwell and West Birmingham (SWBHT). The Blood Sciences department provides a high-quality, cost-effective service to Walsall Healthcare NHS Trust and comprises of three laboratory services: Biochemistry, Haematology, and Blood Transfusion. The Department provides a routine and emergency (analytical and consultative) service to assist clinicians with the diagnosis and management of their patients through the examination of blood, other bodily fluids, and the provision of blood products.

In addition to the main Blood Sciences laboratory, the department also has a POCT service that provides:

- Maintenance and training for the blood gas analysers located in the hospital.
- Quality control and external quality assurance support for extra-laboratory blood glucose testing.

To contact this service phone ext 7031 during working hours 09:00 – 16:00 or email walsall.poct@nhs.net

A Skin Prick Testing clinic operates on alternate Mondays (9 am - 5 pm) - prior appointments are required. Contact Andy or Vicky Hartland for more information – andrew.hartland1@nhs.net

Walsall trust provides a Phlebotomy service that covers inpatient, outpatient and community requirements.

The department is regulated by the Medicines and Healthcare Products Regulatory Agency (MHRA) (specific to Blood Transfusion) and is currently working towards UKAS ISO 15189 accreditation.

The department participates in a comprehensive quality management system, participating in all relevant National External Quality Assessment Schemes, and operates a schedule of internal audits, corrective actions, and quality improvements.

The quality management system is reviewed on a monthly basis to ensure the provision of a high-quality service is maintained.

The laboratory is recognised for training by the Institute of Biomedical Sciences for both generic and specialist portfolio training.

All work is performed with due care for the health and safety of staff and visitors and with proper regard for the environment. The laboratory complies with comprehensive safety procedures and the Control of Substances Hazardous to Health (COSHH) regulations.

Location and Opening Times

The Blood Sciences laboratory is in the main Pathology area on Route 020. The address of the department is:

Department of Blood Sciences
Walsall Manor Hospital
Moat Road
Walsall
West Midlands
WS2 9PS

Blood Sciences operates 24 hours a day; with a routine service between 9 am and 5 pm Monday to Friday.

Outside of the core day, i.e., 5.00 pm - 9 am, nights and weekends, the department is manned by two Biomedical Scientists, one covering Haematology and Blood transfusion and the other covering Biochemistry. These can be contacted via the bleep.

Biochemistry bleep number: 8013

Haematology bleep number: 5095

Key Contacts

Role	Name	Extension Number
Site lead	Mr Ian Richards	6474
Blood Bank Manager	Mrs L Brown	7847
Transfusion Practitioner	Mrs M Dhanda	6252

Laboratory contacts

Discipline	Laboratory Area	Extension / Bleep Number
Haematology	Main laboratory	6474 / 6496
	Out of Hours Bleep	5095
Biochemistry	Main Laboratory	6782
	Out of Hours Bleep	8013
Blood transfusion	Main Lab	6472 / 7812
	Out of Hours Bleep	5095

Consultants and other clinical staff

Dr A Hartland	Consultant Chemical Pathologist,	Ext. 6781
	Secretary: Mrs K Rubery-Smith	Ext. 7505
Dr M Livingston	Consultant Clinical Biochemist, Clinical Lead for Biochemistry (Walsall site)	Ext. 6780
	Secretary: Mrs Y Lewis	Ext. 6471
Dr V Tandon	Consultant Haematologist, Clinical Lead for Haematology	Ext. 7609
	Secretary: Mrs C Restell	Ext. 7485
Dr M Vega-Gonzales	Consultant Haematologist	Ext. 7608
	Secretary: Mrs S Simcox	Ext. 6487
Dr M Bhole	Consultant Immunologist (Providing an advisory service, based at Russel's Hall Hospital) and BCPS Clinical Lead	01384 244855
Dr A Kalansooriya	Clinical Scientist	Ext. 6476
Mrs V Hartland	Clinical Nurse Specialist (Metabolic Medicine)	Ext. 7515

Sampling requirements

Order Comms

Most requests received by the laboratory can be ordered using the Order Comms system. The system is in place in most areas including in-patients, out-patients, and GPs. This is an electronic ordering system that reduces the need for written forms. Once the order is complete, barcodes are printed for the tests requested, including

the tube type required. These can then be used to label the tubes once they have been taken. On receipt at specimen reception the request is simply scanned into the laboratory information system ready to process. There are several advantages to using this system, including a reduction in clerical activity in specimen reception resulting in improved turn-around times, a significant reduction in error rates and helping the Trust become paper lite.

In the event of the Order Comms system being unavailable, please revert to using the written request forms. Details on how to complete forms and samples can be seen in the ‘Completion of Request Forms and Labelling of Specimen Containers’ section of this page.

Requests for blood transfusion can also be made using the order comms system, however, a request form must be printed and signed, and the samples completed by hand. (See Blood Transfusion section)

Full training on the use of order comms is provided by the Trust IT department.

Different tests require different sample types. The common tests can be seen on the tube guide, supplied by the manufacturer. This is provided to all areas and GPs for reference.

Specific requirements for specialised tests should be discussed with the lab prior to the sample being taken.

Certain tests will require special arrangements, e.g., delivery on ice. These must be discussed, and arrangements made with the laboratory to ensure the samples are processed correctly prior to the samples being taken. If ordered using the order comms system, you should be prompted with information of any special requirements.

Requests for lipids and glucose

Please state the fasting status on the request form.

Requests on pregnant patients

For requests for Antenatal serology, Haemoglobinopathy screening and infectious disease screening (Microbiology) the same form should be used. This form also incorporates the Family Origin Questionnaire that is an essential requirement to

process the Haemoglobinopathy screens. These forms are provided by the laboratory.

Antenatal screen (AFP/HCG) must only be requested using the specific request form, which must be completed in full. Supplies of these forms are available from Biochemistry.

Requests for reproductive hormones on females

Please state the LMP date.

Requests for samples at specific times

Please state sample collection time on request form and specimen when relevant e.g. cortisol, serial glucose measurements, therapeutic drug monitoring.

Add on tests.

Tests may be added to samples already sent to the laboratory by sending a further request form.

THERE IS NO NEED TO PHONE THE LABORATORY BEFORE HAND.

Add on tests for inpatients/outpatients can be requested using the order comms system which will generate a paper request form that must be signed and sent to the laboratory. These can be requested using the Add tests to existing requests option on the Add-on tests tab. No tests will be added purely because of a telephone call except for requests from GPs.

It is possible to add most tests to a previous request during this time, with the exception of tests that have labile components, e.g. Insulin, Amino Acids. Tests can only be added where a suitable specimen has been received.

Additional tests may be performed by the laboratory dependent on the clinical details provided and the results of the initial tests to aid interpretation.

If you want to add on tests for different departments, such as Chemistry and Haematology, can you add them on separately so that a form is generated for both departments.

Completion of Request Forms and Labelling of Specimen Containers

Incorrect or illegible data on request forms or specimen labels can lead to error in collection from the patient, incorrect or inappropriate analyses being performed or results not reaching their correct destination. The request from must be completed legibly and in full and the Laboratory reserves the right to refuse to accept any incomplete request form or inadequately labelled specimen. Incomplete request forms will be returned to the appropriate ward if this can be identified.

The minimum acceptable data on a request form comprises:

1. Patient's full surname and forename
2. Patient's DOB (NOT age except in exceptional circumstances)
3. Patient's ward
4. Patient's Consultant
5. Patient's Hospital Unit Number (where possible)

On all specimen containers (except Cross Match Tubes which have labels specific to the Blood Transfusion Department, which must be completed in full) the MINIMUM acceptable information is:

1. Patient's FULL name
2. Patient's Hospital Unit Number (where possible)
3. Patient's DOB

All specimens, including blood specimens, should be treated with care. Appropriate labelling and handling of specimens and request forms are part of good medical practice.

All samples should have the initials of the person taking the sample written onto the tube, in the case of order comms requests please ensure the initials are written on the barcode label.

'High Risk' Patients

Specimens from the following categories of patients are regarded as 'High Risk':

1. Jaundice or liver disease of uncertain (but possibly infectious) aetiology
2. Suspected cases of AIDS
3. Unknown HbsAg, hepatitis C and HIV positive patients

4. Male homosexual/bisexual patients and their sexual contacts
5. Intravenous drug abusers and their sexual contacts.
6. Uncertain haemophiliacs and recipients of multiple blood/blood product transfusions.
7. Babies born to HIV positive mothers.
8. Renal transplant and dialysis patients not shown to be HBsAg negative.
9. Patients infected with other Hazard Group 3 pathogens (as defined by the Advisory Committee on Dangerous Pathogens);
10. Patients returning from abroad with undiagnosed infectious illnesses.

The following precautions apply to the submission of specimens from any patient known to be in a 'High Risk' group.

a. Collection of specimens

It is required and facilitates the handling especially of urgent requests to inform Pathology when it is intended to send specimens from 'High Risk' patients.

Investigations should be restricted to those essential for patient management.

Blood and blood-stained fluids are potentially infectious.

b. Specimen enclosure, labelling and transport.

- Each specimen container and request form must show the identity and source (location) of the patient.
- The container must be closed securely.
- A Danger of Infection label must be affixed to both container and request form.
- The container must be placed in the appropriate compartment of the transport bag.
- This must then be placed in another transport bag.
- The request form must be placed in the adjoining pocket.
- Only the warning label need be clearly visible during transport. In this way, the confidentiality of the clinical material may be maintained.
- It is the responsibility of the ward/medical staff to ensure that the Blood Courier is not placed at risk when transporting 'High Risk' specimens.
- The bagged specimens must be placed and sent to the laboratory in Pathology transport containers.

Transport of samples to the laboratory

All samples are delivered to the main specimen reception where they are processed and booked in prior to analysis in the main lab areas. Samples for the blood transfusion lab are passed directly to the lab without being processed in reception. The requests are booked into the WinPath system, and the required tests ordered. Bar codes are generated, and the samples labelled accordingly.

The samples can arrive at the main specimen reception by several routes:

Pneumatic Tube System (PTS).

There are several sites around the Hospital that have access to the PTS. This is used to send samples directly to reception. Before using the PTS Staff must be competency assessed. High Risk samples should not be sent via the PTS due to the risk of possible contamination.

Blood Portering Service.

The hospital portering services provide a 24-hour blood porter that will hand deliver any samples to the lab. Any samples must be suitably prepared for transport so that the porter is not put at risk.

Courier Service.

Most of the GP requests are delivered via the courier service. All these requests are received during the day and processed and labelled prior to analysis.

Phlebotomy Service.

The samples from blood tests are already booked in so are only sorted into the relevant labs for analysis. Samples from the phlebotomy ward rounds are labelled with bar codes from the ICE system, and therefore need only to be received onto to Winpath system. They are then ready to analyse.

Urgent requests

The lab will prioritise any sample that is considered urgent. For the lab to be able to do this, a phone call to the relevant area must be made.

Some samples are prioritised by the department to provide a service that meets the requirements of the hospital. All samples from A&E, AMU and those called as urgent are given priority. The routine in-patient work followed by the routine out-patient/GP is next.

It is possible to add most tests to a previous request during this time, with the exception of tests that have labile components, e.g. Insulin, Amino Acids. Tests can only be added where a suitable specimen has been received.

Turnaround Times

The turnaround times of the routine tests performed by Haematology and Biochemistry are monitored and reported monthly as part of the key performance indicators for the department.

The targets set for Haematology and Biochemistry are:

Area	Target	Tests monitored
A&E	90% within 1 hour	FBC, INR, D-Dimer, U&E, LFT and Troponin.
Acute Wards (AMU, UACU)	90% within 1 hour	FBC, INR, D-Dimer, U&E, LFT and Troponin.
Inpatients	90% within 4 hours	FBC, INR, D-Dimer, U&E, LFT and Troponin.
Outpatients	90% within 4 hours	FBC, INR, D-Dimer, U&E, LFT and Troponin.
GP	95% within 24 hours 100% within 48 hours	FBC, INR, D-Dimer, U&E, LFT and Troponin.

Result reporting

All results produced by Blood Sciences are available electronically either via the WinPath, Fusion or GP Links systems. All results are available in real time as they are accepted and authorised on the WinPath system.

All results received from referral labs are entered manually and checked to ensure accuracy. Some results have a comprehensive written report and if so, a scanned image is made available to view via Fusion as a readable document.

Reference Ranges

Please see final reports to view reference ranges for blood science analytes. The adult and paediatric biochemistry reference ranges from UK Pathology Harmony are in use where available. Reference ranges for FBC parameters obtained from Phase II of the Pathology Harmonisation Project (pathologyharmony.co.uk).

Telephone Reports

The results of tests performed are telephoned if they fall outside of defined critical limits.

Measurement Uncertainty

Measurement uncertainty is defined as a parameter associated with the result of measurement that characterises the dispersion of the values that could reasonably be attributed to the measurand. By quantifying the possible spread of measurements, an estimate of the confidence in the result may be obtained. Measurement uncertainty stems from imprecision because of random effects on the assay systems and laboratories have to minimise the effects of this and acknowledge this uncertainty. Uncertainty can be derived in two ways: 1) from repeated measurements and statistical analysis (sources of this data within Blood Sciences are obtained during assay verification and through daily observations and monthly review of internal quality control material); and 2) derived from other non-statistical means, such as manufacturer’s assay validation data (which is supplied within the kit inserts) and intra-individual biological variation. Further information is available by contacting the laboratory directly.

Referral laboratories

There are several specialised tests that are referred to other centres for analysis. Please call the duty biochemist for a full list of these tests and the referral laboratories.

Complaints Procedure

Complaints may be made directly to staff within the laboratory via telephone, email, or face to face contact. For all complaints, contact Ian Richards (01922 656474). For clinical complaints, please contact Dr A Hartland (01922 656781) / Dr M Livingston (01922 656780). Complaints can also be made through PALS.

Biochemistry Services

Introduction

The Clinical Biochemistry department provides a routine and emergency service (analytical and consultative) to assist clinicians with the diagnosis and management of their patients through the biochemical examination of body fluids and products. In addition to the main Clinical Biochemistry service, the POCT Department provides:-

Maintenance and training for all Blood Gas Analysers located throughout the hospital.

Quality control support is provided by the POCT team for extra-laboratory blood glucose and ketone testing.

To ensure the optimum use of the service, clinicians are encouraged to discuss the selection, performance, and interpretation of tests with the Department, and use of the advisory service provided by the Biochemistry Consultants, supported by senior scientific staff, is emphasised.

Repertoire and Sample Requirements

BLOOD:

The following lists are not comprehensive: more unusual tests may be available after discussion with senior laboratory staff.

Most "blood" assays are performed on serum from clotted blood in a SST tube (yellow capped Vacutainer). Where a different specimen type is required this is indicated in the test list below. Failure to supply the correct tube may result in the test being reported as unsuitable. We require a minimum of one Greiner minicollect for paediatrics (800 µl) and at least 1 mL for adults (ideally a full SST tube if you require more than one test).

The [] refer to the notes which follow this list.

ACTH [D, MS]
Alcohol [1, GY]
Alkaline Phosphatase. isoenzymes [2, M]
Amino acids [G]
Blood gases [3]
Gastrin [D, GS]
Glucagon [GS]
Glucose [GY]
Glycated haemoglobin (HbA1c) [M]
HCG β (? ectopic pregnancy) [4,R]
Homocystine [G]
Insulin antibodies [D, R]
Insulin [D, G]
Iron [5,Y]
Pancreatic polypeptide [D, GS]
Porphyrin [D]
Procalcitonin [Y] *limited availability, see section below
Triglycerides [6,Y]
VIP [D, GS]

Notes:

The alcohol method is NOT suitable for medico legal purposes.

Alkaline phosphatase isoenzymes are usually analysed on the specimen submitted for LFT or Calcium profile.

βHCG analysis should usually be used for the diagnosis of ectopic pregnancy.

Iron analyses are offered in cases of iron poisoning and in cases of suspected haemochromatosis. Ferritin assay is offered for the routine monitoring of patients' iron status.

Elevated triglycerides cannot be interpreted on a non-fasted sample.

D Discuss with laboratory in advance.
R Use red capped (plain) Vacutainer
Y Use yellow capped (SST) Vacutainer
M Use mauve capped (EDTA) Vacutainer
G Use green capped (Lithium Heparin) Vacutainer
GY Use grey capped (Fluoride Oxalate) Vacutainer
GS Contact laboratory for special heparinised tubes
MS Contact laboratory for special EDTA tubes

Storage conditions for specimens prior to sending to laboratory.

Potassium
DO NOT refrigerate prior to centrifugation and transport to lab as soon as possible.
Delayed separation ("left on cells") falsely increases potassium.
Spurious hyperkalaemia may also occur in thrombocytosis; leukocytosis and contamination with EDTA (additive in FBC and glucose tubes)
Haemolysed sera cannot be analysed.

Xanthochromia
Lumbar puncture should be performed >12h post-event in CT Brain Scan Negative patients
Ideally send the least blood-stained sample
CSF must be protected from light as bilirubin is photolabile.
CSF must be hand delivered to a member of staff in the laboratory (Do NOT use air tube or leave in reception/post box)
Serum sample for LFTs (bilirubin and total protein) should also be provided.

Ammonia
URGENT REQUEST
Sample tube should be completely filled with blood, immediately placed on ice and transported to the laboratory within 30mins.
Haemolysed plasma cannot be analysed.

Contact the laboratory for any advice for any tests not listed above and if you are unsure of the storage requirements prior to sending to the lab.

URINE:

Analyte	Type	Preservative
Albumin/Creatinine Ratio	Random or EMU	None
Amino acids	Fresh, random	None
Amylase	Random	None
Calcium	24 hour	Hydrochloric Acid
Catecholamines	24 hour	Hydrochloric Acid
Cortisol	24 hour	None
Creatinine	24 hour	None
Cysteine	Random or 24 hour	None
Drug Screen	Random	None
Glucose	24 hour	None
5-Hydroxy indole acetic acid (5HIAA)	EMU	Hydrochloric Acid
Organic acids	Fresh, random	None
Osmolality	Fresh, random	None
Oxalate	24 hour	None
Phosphate	24 hour	Hydrochloric Acid
Porphobilinogen	Fresh, random	None
Porphyrins	Fresh, random	None
Potassium	Random or 24 hour	None
Reducing substances	Fresh, random	None
Sodium	Random or 24 hour	None

Analyte	Type	Preservative
Steroid profile	24 hour	None
Urate	24 hour	None
Urea	Random or 24 hour	None
Urobilinogen	Fresh, random	None

Notes:

- Samples marked with ‘Fresh’ MUST be delivered to the Department as soon as possible.
- Where a preservative is indicated, bottles containing the appropriate preservative are obtainable from the Biochemistry Department.
- Catacholamines. Many drugs can interfere and ideally patients should be off medication when urine is collected. The following should, if possible, be discontinued: monoamine oxidase inhibitors, phenothiazines, guanethidine, levodopa, imiprimine, methyldopa, labetalol. Catecholamines occur in significant amounts in vanillin containing foods such as bananas, coffee, chocolate, tea, broadbeans, nuts, custard, blancmange, sponges, cakes, biscuits and sweets. Intake of these should be restricted over the two days before and during the course of the urine collection.
- 5HIAA. No walnuts, bananas, pineapple, tomatoes, avocados, plums or large amounts of other fruits for 48 hours before or during the course of the urine collection. The following drugs can interfere and should, if possible, be discontinued: chlorpromazine and other phenothiazine derivatives, indomethacin.
- Androgen, oestrogen or glucocorticoid steroid profiles are available after discussion with the laboratory.

FLUID:

- Tables below give sample requirements for biochemical analysis of fluids.
- The sample must be adequately labelled and treated as any other biological sample.
- Paired serum sample should be sent with the fluid sample. To aid interpretation the same tests should be requested on both samples (serum and fluid).

- Analysis on haemolysed or heavily blood-stained samples is not available for any test as results would be uninterpretable.
- The analysis of fluid is subject to the condition of sample, analysis cannot be made on samples that are contaminated or have solid/precipitated products due to the potential risk of damage to the analytical equipment.

Tests and analysis available on pleural fluid

Working diagnosis:	**Transudative or Exudative**			
Sample	***Tube***	***Test***	***Required Volume (ml)***	***Department***
Fluid	Sterile universal 	Protein / LDH	1.0 ml	Chemistry
Serum	Sterile universal 	Protein / LDH	1.0 ml	Chemistry

Interpretation		
Test	**Results**	**Interpretation**
Fluid protein	<25 g/L	Transudative
Fluid protein	>35 g/L	Exudative
Fluid protein	25-35 g/L	Use Light's criteria below
Light's Criteria - *Pleural fluid is an exudate if one or more of the following criteria are met:*		
Fluid protein/Serum total protein ratio	>0.5	Exudative
Fluid LDH divided by Serum LDH ratio	>0.6	Exudative
Fluid LDH	> $^{2}/_{3}$ upper limit serum LDH	Exudative

Working diagnosis:	**Chylothorax**			
Sample	***Tube***	***Test***	***Required Volume (ml)***	***Department***
Fluid	Sterile universal 	Cholesterol / triglycerides	1.0 ml	Chemistry
Serum	Sterile universal 	Cholesterol / triglycerides	1.0 ml	Chemistry

Interpretation		
Test	**Results**	**Interpretation**
Triglycerides	< 0.56 mmol/L	pseudochylothorax
Triglycerides	> 1.24 mmol/L	Chylothorax
Cholesterol	> 5.18 mmol/L	pseudochylothorax
Cholesterol	< 5.18 mmol/L	Chylothorax
Appearance	Lipaemic	Chylothorax
Appearance	Icteric	Chylothorax

Working diagnosis:		**Urinothorax**		
Sample	***Tube***	***Test***	***Required Volume (ml)***	***Department***
Fluid	Sterile universal 	Creatinine	1.0 ml	Chemistry
Serum	Sterile universal 	Creatinine	1.0 ml	Chemistry

Interpretation		
Test	**Results**	**Interpretation**
Fluid creatinine / serum creatinine ratio	>1.0	Urinothorax

Other pleural fluid tests

Working diagnosis:		**unclear**		
Sample	***Tube***	***Test***	***Required Volume (ml)***	***Department***
Fluid	Sterile universal 	Amylase / pH / CA199/ CEA/ Bilirubin albumin / urea	3.0 ml	Chemistry
Fluid	Fluoride EDTA 	Glucose	1.0 ml	Chemistry
Serum	Sterile universal 	Amylase CA199/ CEA/ Bilirubin albumin / urea	4.0 ml	Chemistry

Interpretation

Test	Result	Interpretation
Fluid amylase to serum ratio	> 1.0	Exudative - pancreatitis, pancreatic cyst, malignancy
Glucose	<3.3 mmol/L	Possible exudate
Glucose	>1.6 mmol/L	Rheumatoid arthritis unlikely to be cause of exudate
pH	pH ~7.6	Normal
pH	Fluid pH <7.2 with normal blood pH	Similar diagnosis as low glucose

Tests and analysis available on Ascitic fluid

Working diagnosis: transudate or exudate				
Sample	***Tube***	***Test***	***Required Volume (ml)***	***Department***
Fluid	Sterile universal 	Fluid Albumin, Total Protein,	3.0 ml	Chemistry
Serum	Sterile universal 	Albumin/ Total Protein	4.0 ml	Chemistry

Interpretation		
Test	**Result**	**Interpretation**
Serum–Ascites-albumin gradient (SAAG) (SAAG calculation = Serum albumin – Ascitic fluid albumin)	**>= 11g/L**	**Transudate** **Possible causes:** Cirrhosis, Alcoholic hepatitis, CHF, Hepatic metastasis, Vascular occlusion, Fatty liver of pregnancy, Myxedema
Serum–Ascites-albumin gradient (SAAG)	**<= 11g/L**	**Exudate** **Possible causes:** Peritoneal carcinomatosis Peritoneal TB, Pancreatitis Serositis, Nephrotic syndrome, Bowel obstruction
Acitic fluid Protein	**>25 g/L**	Cirrhosis, Alcoholic hepatitis, CHF, Hepatic metastasis, Vascular occlusion, Fatty liver of pregnancy, Myxedema

Acitic fluid Protein	**<25 g/L**	Peritoneal carcinomatosis Peritoneal TB, Pancreatitis Serositis, Nephrotic syndrome, Bowel obstruction

Working diagnosis:		**Unclear**		
Sample	***Tube***	***Test***	***Required Volume (ml)***	***Department***
Fluid	Sterile universal 	Fluid LDH Amylase / pH / CA199/ CEA/ Bilirubin	3.0 ml	Chemistry
Fluid	Fluoride EDTA 	Glucose	1.0 ml	Chemistry
Serum	Sterile universal 	LDH/ Amylase CA199/ CEA/ Bilirubin	4.0 ml	Chemistry

Interpretation		
Test	**Result**	**Interpretation**
LDH	>500 IU/l	Increased likelihood of malignancy, tuberculosis or pancreatic ascites
Fluid Glucose: serum glucose ratio	<0.7	Possibility of infection (tuberculosis)
Fluid Amylase: serum amylase ratio	>0.5	pancreatitis and gut perforation
Triglycerides	>2.25 mmol/L	Chylous ascites
Cholesterol	>1.8 mmol/L	Increased likelihood of malignancy
CEA/CA199/CA125	NA	There is little added value of measuring tumour markers in ascites compared to tumour markers measurement in serum. Same limitations apply as using tumour markers diagnosis
pH	NA	Unclear use in diagnosis / no clinical utility

MISCELLANEOUS:

- Faecal Elastase
- Faecal Calprotectin
- Faecal porphyrins

- CSF glucose

- CSF total protein
- CSF Xanthochromia

Composition of Test Profiles

The Biochemistry Department offers two admission test profiles for Medical Admission and Surgical Admission, and several common organ test panels.

Liver Function Tests (LFTs)

Albumin
Total protein
Alkaline phosphatase (ALP)
Alanine amino transferase (ALT)
Total Bilirubin

Direct Bilirubin and Gamma glutamyl transferase (GGT) are also available separately.

Cardiac Profile

Troponin T

Electrolytes

Sodium
Potassium
Urea (inpatient only unless requested)
Creatinine

Bicarbonate and chloride are not measured routinely but are available on request.

Thyroid Function Tests (TFTs)

Thyroid-Stimulating Hormone, TSH (as first-line screen)

Free T4 will be analysed on those samples with an abnormal TSH, on all patients on thyroid active drugs, suspected or known pituitary/hypothalamic disease or as otherwise indicated after discussion with senior laboratory staff. Free T3 is also available when required.

Calcium Profile

Calcium
Alkaline Phosphatase (ALP)

Albumin
Total protein
Adjusted calcium is also reported.

For a combination of these panels, one full SST tube is required. A second SST is required if any other tests are requested. If tests for departments other than Biochemistry are required, then extra specimens must also be sent. The order comms system will generate the appropriate labels for different combinations of tests.

CLINICAL PROTOCOLS AVAILABLE

It is recommended that the selection, performance, and interpretation of these procedures is discussed with clinical laboratory staff in each individual case in order to make the most effective use of these tests or services.

Test	Indication
Aldosterone and Renin	Suspected hyperaldosteronism
Ammonium chloride loading test	Suspected renal tubular acidosis (RTA)
Combined pituitary function test	Suspected pituitary dysfunction
Long Dexamethasone suppression test	Distinguishing causes (low and high doses) of Cushing's Syndrome
Short Dexamethasone suppression test	Suspected Cushing's Syndrome (overnight test)
Fasting hypoglycaemia test	Suspected Insulinoma
Fluid Deprivation test	Suspected Diabetes Insipidus
Gastrin and related dynamic tests	Suspected Zollinger Ellison Syndrome
Glucose tolerance test (OGTT)	Suspected Diabetes mellitus

Test	Indication
Gonadotrophin releasing hormone	To test the pituitary-gonadal axis
Growth hormone during OGTT	Suspected Acromegaly
Growth hormone	Growth hormone deficiency (before and after exercise) in children
Insulin and C-peptide	Suspected insulinoma
Lactose tolerance test	Suspected Lactose Intolerance
Neonatal hypoglycaemia investigations	Tests to determine underlying cause of hypoglycaemia
Porphyria investigations	Tests to determine suspected porphyria
Sweat test (check with Biochemistry)	Suspected Cystic fibrosis
Synacthen stimulation test (short)	Suspected adrenocortical hypofunction
Synacthen stimulation test (long)	Distinguishing causes of adrenocortical hypofunction
Thyrotrophin-releasing hormone test	Investigating secondary and tertiary thyroid disorders

SPECIAL TOPICS

BLOOD GAS ANALYSIS

The blood gas analysers are situated on Neonatal Unit, Delivery Suite, Intensive Therapy Unit, High Dependency Unit, Acute Medical Unit, Emergency department Resuscitation, Majors, West Wing Theatres, W17 and W29, for the following tests on each machine: pH, pCO2, pO2, calcium, glucose, lactate, sodium, potassium, co-oximetry. These are operated under the supervision of the Blood Sciences Department. Non-laboratory staff wishing to use these instruments must be trained

in their correct operation by the POC Department staff and issued with a user identification number. In the event of a fault occurring with any of these gas analysers out of hours, staff should contact the Blood Sciences out of hours BMS. The contingency is to use the nearest located analyser until the fault is fixed.

The blood gas analysers can only be operated by staff with a valid user ID number. This number enables an audit trail to be established for the analysis of patient samples. The patient's unit number, name and date of birth are required before results are issued by the analyser.

Incorrect sample handling before analysis leads to significant artefacts. For accurate estimation of pO2 and pCO2 it is necessary to avoid frothing, to expel all air bubbles within two minutes and to present (do not inject) the sample into the machine within ten minutes if the syringe is kept at room temperature. Samples kept at 0°C by immersion in a crushed ice/water mixture remain stable for far longer. Syringes should be capped to prevent contact with the atmosphere. If heparin makes up 10% or more of the total volume of a sample for gas analysis important errors, especially in apparent pCO2, may occur.

MARKERS OF MYOCARDIAL DAMAGE

Troponin T

Cardiac Troponin T does not start to rise until 4 - 6 hours post MI but by 12 hours after the onset of pain diagnostic sensitivity is close to 100%; tissue specificity of Troponin T for cardiac muscle is also high, although false positives can occur. Troponin levels remain elevated for over a week following MI.

The main indication for requesting Troponin T in this Trust is risk stratification in patients with Acute Coronary Syndrome (ACS); see Trust protocol on ACS (on the Trust intranet).

Resolving diagnostic ambiguity with conventional tests, e.g. if non-cardiac CK release is a possibility (NB, if the ECG and CK are both repeatedly normal the probability of an abnormal Troponin is very low);

Troponin T is available 24 hours a day, 7 days a week.

Diagnosis of late-presenting MI.

Analyte	Result	Interpretation
Troponin T	< 14 pg/ml	no evidence of myocardial damage
Troponin T	> 14 pg/ml	evidence of myocardial damage

Others

The CRP assay offered by this laboratory is not suitable for detecting early myocardial damage.

LIPIDS

When making requests for lipid analysis, please state explicitly on the request form whether the patient was in a fasted state when the sample was obtained (use the tick box provided).

Routine lipid profile - (all samples accepted, but need to state when ordering if fasting/non-fasting):

Total cholesterol
HDL cholesterol
Non-HDL cholesterol (calculated)
TC/HDL ratio (calculated)

Extended lipid profile - (all samples accepted, but need to state when ordering if fasting/non-fasting):

Total cholesterol
HDL cholesterol
Non-HDL cholesterol (calculated)
TC/HDL ratio (calculated)
LDL-cholesterol (on fasting samples only & if triglycerides <4.5 mmol/L)
Triglycerides

Triglycerides only - (as a separate test, no need to be fasting)

If no information on the patient's fasting state is given the sample will be assumed to be random/routine.

The UK Heart Protection Study indicated that most patients with established CHD or other occlusive arterial disease may benefit from statin treatment. Where Simvastatin is the chosen agent, the optimum dose is probably 40 mg; in an adequately treated patient population (e.g. those on a practice CHD register) the target median total cholesterol is <4 mmol/l. With regard to primary prevention of CHD, initiation of drug therapy for lipids should not be undertaken without a formal CHD risk assessment; clinicians can contact senior laboratory staff for assistance in this matter. Fasting plasma glucose should be checked as a part of CHD risk assessment.

As a first line screen, it is reasonable to measure a random (i.e., not necessarily fasted) total cholesterol, avoiding excessive stasis during venepuncture.

If raised lipid levels are found on a non-fasted sample then request lipids on a sample obtained after an overnight fast (no breakfast, water only to drink).

Cholesterol levels fall within 24 hours as part of the metabolic response to injury and do not return to base line for several weeks or months. It is therefore recommended that lipid levels should be reassessed 8-12 weeks after a MI or other vascular event, unless it has been decided not to give lipid therapy for some reason. Annual lipid checks are recommended on patients established on long-term lipid therapy.

Remember secondary hyperlipidaemias. The commonest secondary cause of hypercholesterolaemia is hypothyroidism, while the most frequent secondary causes of hypertriglyceridaemia are diabetes mellitus and alcohol abuse. Beta-blockers and thiazide diuretics (and may other drugs) affect lipid profiles adversely.

Some genetic dyslipidaemias can be investigated by DNA methods. Such cases should be discussed with the Consultant Chemical Pathologist.

DIABETES MELLITUS

Oral glucose tolerance test

A protocol for this procedure is available from the Department. There is no need to carry out a glucose tolerance test if a patient has classical features of diabetes

mellitus (e.g., polyuria and polydipsia, ketonuria, rapid weight loss) and unequivocal marked hyperglycaemia (random plasma glucose greater than 11 mmol/l) or a fasting plasma glucose of 7.0 mmol/l or above.

Normal fasting plasma glucose < 6.1 mmol/l

Full international expert committee recommendations for the diagnosis of diabetes mellitus are given below:

A patient is classified having diabetes mellitus if they have:

Diabetic symptoms (e.g. polyuria, polydipsia and unexplained weight loss)

Plus either

a random venous plasma glucose concentration ≥ 11.1 mmol/l;

OR

a fasting plasma glucose concentration ≥ 7.0 mmol/l (whole blood ≥ 6.1mmol/l);

OR

2 h plasma glucose concentration ≥ 11.1 mmol/l 2 h after the administration of 75 g anhydrous glucose in an oral glucose tolerance test (GTT).

Where there are no symptoms, diagnosis should not be based on a single glucose determination but requires confirmatory plasma venous determination. At least one additional glucose test result on another day with a value in the diabetic range is essential, either fasting, from a random sample, or from the two hour post glucose load. If the fasting or random values are not diagnostic the 2-hour value should be used.

It should be noted that children usually present with severe symptoms and diagnosis should then be based on a single raised blood glucose result, as above. Immediate referral to the Paediatric Diabetes Team should be made.

Impaired Glucose Tolerance (IGT)* is a stage of impaired glucose regulation (fasting plasma glucose < 7.0 mmol/ and GTT 2-hour value ≥ 7.8 mmol/l but < 11.1 mmol/l).

Impaired Fasting Glycaemia (IFG)* has been introduced to classify individuals who have fasting glucose values above the normal range but below those diagnostic of diabetes. (fasting plasma glucose ≥ 6.1 mmol/l but < 7.0 mmol/l).

*IGT and IFG are not clinical entities in their own right but rather risk categories for cardiovascular disease (IGT) and/or future diabetes (IFG).

A diagnosis of diabetes has important legal and medical implications for the patient, and it is therefore essential to be secure in the diagnosis. A diagnosis should never be made on the basis of glycosuria or a stick reading of finger prick blood glucose alone, although such tests may be useful for screening purposes.

Glycated Haemoglobin

During the life span of a red cell following its release from the marrow into circulation, a small percentage of the haemoglobin (Hb) becomes glycated. The average glucose level to which the red cells are exposed during their life span determines the proportion of total Hb modified in this way. For this reason, glycated Hb tends to be increased in diabetes mellitus and, particularly in insulin-dependent diabetics, glycated Hb gives a better measure of overall glycaemic control over the previous 2-3 months or so than do random glucose measurements. Conditions which reduce the life expectancy of red cells in circulation (e.g., bleeding, in vivo haemolysis) give falsely low results and so invalidate the test. Some haemoglobinopathies can cause analytical interference, as can gross uraemia.

Since 2011, the World Health Organisation (WHO, 2011) has recommended that glycated haemaglobin A1c (HbA1c) can be used as a diagnostic test for diabetes in most situations. The main exceptions are rapid onset diabetes, anaemia, haemoglobinopathies and other diseases associated with changes in red cell turnover (e.g. malaria, drug-induced haemolysis) or glycation rates (e.g. chronic renal disease). In these situations, HbA1c is not recommended as the sole test to diagnose diabetes, and it is also inappropriate to use HbA1c to identify gestational diabetes mellitus.

An HbA1c of ≥48 mmol/mol is now the recommended cut off for diagnosing diabetes, but in an asymptomatic patient a repeat measurement is required to confirm the diagnosis (ideally after 1 month). An HbA1c ≥48 mmol/mol can also be used to confirm a diagnosis of diabetes in an asymptomatic individual with a fasting glucose ≥7.0 mmol/L or random glucose ≥11.1 mmol/L, precluding the need for a repeat glucose measurement or glucose tolerance test (except in the circumstances mentioned above, e.g. in pregnancy).

However, an HbA1c value <48 mmol/mol does not exclude diabetes diagnosed using glucose tests.

HbA1c values in the range 42–47 mmol/mol indicate a high risk of developing diabetes in the future, i.e. are pre-diabetic. Such patients should receive intensive lifestyle advice and warned to report any symptoms of diabetes (annual monitoring of HbA1c is recommended). The reference range provided for HbA1c is for identifying new diabetes or pre-diabetes only and is NOT a target range for optimal glycaemic control. We still recommend that all HbA1c results are reviewed.

Criteria for Glycaemic Control using HbA1c in Patients with Type 1 and Type 2 Diabetes:

	Good	Borderline	Sub-optimal
Type 1	<48 mmol/mol	48 – 58 mmol/mol	>58 mmol/mol

	Low risk	Arterial risk	Microvascular risk
Type 2	<48 mmol/mol	≥48 mmol/mol	>58 mmol/mol

HbA1c levels only change slowly due to the red cell lifetime of approximately 120 days, so measurements more frequently than every 3 months are of limited value when monitoring those with known diabetes. Thus, repeat requests in known diabetic patients received within 3 months will generally be rejected (unless the patient is pregnant).

Microalbumin

Microalbuminuria is the condition of pathologically increased urinary albumin excretion below the detection limit of common side-room tests for proteinuria (e.g. reagent sticks). As a first line screen, an albumin:creatinine ratio can be determined on a random daytime urine sample obtained from an ambulant patient. If the results in this test are abnormal, the urinary albumin:creatinine ratio should be repeated twice within 1 month; if two of the three tests are positive the patient is deemed to be at high risk of renal and other complications of diabetes. For the two confirmatory tests, first morning urine samples should be obtained, where practicable. This is because there is a postural effect on urinary albumin loss. Timed urine collections

are not recommended for the assessment of microalbuminuria. See also section 4.7.2 on proteinuria.

THYROID FUNCTION

The first line test performed in this Department is TSH, assayed by a highly sensitive 'third generation' technique. A normal TSH level makes primary thyroid disease extremely unlikely in patients not taking thyroid active medication.

Free T4, assayed by a labelled antibody technique, is used as a follow-up test when the TSH is abnormal, in patients on thyroid active drugs and when pituitary/hypothalamic disease is suspected.
Free T3 is occasionally useful in the investigation of suspected thyrotoxicosis or in patients on certain drugs, including Amiodarone. The need for T3 measurements will be assessed in the light of the clinical context and the results of first and second line tests. Serum T3 is generally of no diagnostic value in suspected hypothyroidism.

In general, tests of thyroid functions are most effective in patients in whom the objective is to confirm/exclude untreated primary thyroid disease. Thyroid function tests may be of value in monitoring patients either on thyroxine or anti-thyroid medication, although opinion is divided on interpretation in some circumstances. The fact that a patient is receiving thyroid-active drugs significantly affects the interpretations of the tests and relevant therapeutic details should always be supplied with TFT (TSH) requests, as well as an indication of the thyroid status suspected clinically.

Abnormalities in both free T4 and, to a lesser extent, TSH are common in patients with non-thyroid disease, particularly in the elderly and in patients with more severe intercurrent illnesses. Interpretation can be very difficult and, indeed, genuine primary thyroidal dysfunction may be masked by these non-thyroidal factors, so that both false positives and false negatives can occur. For these reasons, requesting TFTs as part of a metabolic screen in a patient admitted with non-thyroidal illness, and with no genuine suspicion of thyroid disease, is usually futile and potentially misleading. Therefore, TFTs should not be requested on an acutely ill patient or for six weeks after a major illness.

The interpretation of TFTs in pregnancy, the new-born and the elderly is complex and discussion in doubtful cases is encouraged.

Interpretation of highly-sensitive TSH and free T_4 in patients not receiving thyroid-active medication

Thyroid Function Interpretation		TSH		
		Low	Normal	High
Free T_4	High	Primary hyperthyroid	Abnormal binding proteins or TSH-secreting tumour or abnormal T_4 metabolism	Primary hypothyroid with abnormal binding proteins or TSH-secreting tumour
	Normal	Non-thyroid illness or borderline thyrotoxicosis or T_3-toxicosis	Euthyroid	Borderline primary hypothyroid
	Low	Non-thyroidal illness or hypopituitarism	Non-thyroidal illness or hypopituitarism	Primary hypothyroid

Based on:

Beckett, Smith, Walker and Rae; Lecture Notes on Clinical Chemistry; Blackwell 1998

THE ADRENAL CORTEX

'Spot' serum cortisol is generally unhelpful in the investigation of either hypo- or hyper-corticoadrenalism, and assessment of the diurnal rhythm of cortisol secretion is also of limited value.

Suspected primary adrenocortical failure

The most useful screen for potential adrenocortical failure is the short tetracosactrin (Synacthen) test. A normal result excludes adrenal failure but abnormal outcomes should be followed up by more extended testing with a depot preparation of tetracosactrin. Such 'long' Synacthen tests are useful in confirming abnormalities found in the short screen. They may help discriminate between primary adrenocortical hypofunction (in which the response remains flat) and adrenal failure secondary to hypothalamic-pituitary disease (in which the adrenal response to repeated stimulation with tetracosactrin may increase over a few days). It may be appropriate to investigate pituitary function more fully in the latter situation. It may be useful to store a sample for possible ACTH assay (with due attention to sample handling requirements) before steroids are administered.

Strategy for investigation:

Screening test -

Short Synacthen Test

Store sample for possible future ACTH assay before giving steroids.

Follow up tests -

Long Synacthen Test

ACTH (Sample stored as a(ii) above)

Adrenal autoantibodies

Suspected adrenoglucocorticoid hypersecretion

Suspected hyperfunction of the adrenal cortex should be investigated in the first instance by either an overnight dexamethasone suppression test and/or measurement of free cortisol excretion in a 24 hour urine collection. Various test protocols are available for the follow-up of abnormal results. To help ensure that the most appropriate investigations are carried out and that procedures are correctly performed, close liaison between the laboratory and the requesting clinician is essential.

Strategy for investigation:

Outpatient screening tests -

Overnight dexamethasone suppression test

24 hour urinary free cortisol

Tests to confirm hypersecretion -

Low dose dexamethasone suppression test

Insulin hypoglycaemia

Tests to establish cause of hypersecretion -

ACTH assay

High dose dexamethasone suppression test

CRH test, selective venous catheterisation

Imaging techniques

Tumour markers

Reproductive Hormones

For menopausal status, request FSH and LH. Progesterone should not be requested for menopausal status.

For ovulation, request progesterone on a sample taken on or about day 21.

For other common conditions, specimens for hormone requests are best taken early in the follicular phase.

ALWAYS indicate hormones required when sending requests; DO NOT request "hormone profile".

RENAL FUNCTION

Glomerular function

Glomerular function can be assessed by measuring the serum concentration of urea or creatinine, or by estimating glomerular filtration rate (GFR)

As a simple screen serum urea (as part of the 'U&Es') is adequate, a normal urea level excluding a major glomerular problem in most circumstances. However, serum urea concentrations may be elevated for a variety of non-renal reasons, including upper gastro-intestinal haemorrhage ('blood meal'), catabolic states and hypovolaemia.

Serum creatinine is a more specific test of glomerular function than is serum urea (although ketoacidosis can cause false elevations in creatinine estimations as a result of analytical interference) but some patients with significant impairment of glomerular function may have serum creatinine levels within the population reference range.

Despite the imperfect sensitivity of serum creatinine for the detection of glomerular failure, measurement of creatinine clearance is rarely helpful, mainly because of the poor reproducibility of clearance determinations and because creatinine clearance overestimates the true GFR at all levels of renal function. For this reason, in chronic kidney disease, the estimation of GFR using a calculation based on the NICE EPI equation is now recommended.

View the eGFR Flowchart at:
(https://lifestyle.walsallhealthcare.nhs.uk/media/136495/egfr_flowchart.pdf)

Proteinuria

There is no need to perform 24-hour urine collections for the quantitation of proteinuria. A positive dipstick test for protein should result in a urine sample (preferably early morning, so as to eliminate the orthostatic effect on proteinuria) being sent to the laboratory for confirmation by measurement of the albumin:creatinine ratio, after exclusion of urinary tract infection. Patients with two or more positive tests for proteinuria, preferably spaced 1 to 2 weeks, should be classified as having persistent proteinuria.

Interpretation	Dipstick	Urinary albumin:creatinine ratio (mg/mmol)
Normal	Negative	<2.5 (males), <3.5 (females)
Microalbuminuria	Negative	≥2.5 (males), ≥3.5 (females)
"Trace" proteinuria	Trace	15-29
Clinical Proteinuria	1+ or more	≥30

Renal concentrating function:

A protocol is available for fluid-deprivation tests (with or without follow-up DDAVP test). This procedure tests the ability of the posterior pituitary to secrete AVP (ADH) appropriately and the responsiveness of the renal concentrating apparatus to the hormone. This test is sometimes helpful in the investigation of suspected cranial or nephrogenic diabetes insipidus.

Other causes of polyuria and polydipsia include-

diabetes mellitus

hypercalcaemia

hypokalaemia

chronic renal failure

primary ('hysterical') polydipsia

Urinary acidification

A protocol is available for the ammonium chloride loading test, a test of distal tubular urinary acidification. Suspected renal tubular acidosis is one of the rare indications for assay of serum chloride, hyperchloraemia often being found in this condition.

Renal Calculi

24-hour urine collection (in a plain container) should be collected on patients with a history of calculi or a high risk of developing calculi.

The following analysis will be carried out:

Calcium and Urate at the Manor Hospital

Oxalate and Citrate at the University College Hospital, London

Reference Ranges		
Analyte	Gender	Range (mmol/24 h)
Calcium	Male	<7.5
	Female	<6.2
Urate	Male	<4.8
	Female	<4.5
Oxalate	Male & Female	0.10 - 0.46
Citrate	Male	0.6 - 4.8
	Female	1.3 - 6.0

GASTROINTESTINAL FUNCTION TESTS

Fat absorption:

Faecal Fat estimation has now been replaced by Faecal Elastase estimation as an indicator of exocrine pancreatic function.

Tests of (proximal) small intestinal function may be arranged after discussion with the gastroenterologists.

BIOCHEMICAL MONITORING OF PATIENTS RECEIVING TOTAL PARENTERAL NUTRITION

The following suggestions are not intended to be didactic but rather to serve as broad guidelines for the monitoring of patients established on total parenteral nutrition (TPN). Over the first few days of TPN, patients' requirements may undergo rapid changes so that during the initiation of TPN, and at other times when the metabolic state is labile, monitoring should be intensive.

Daily on blood:

- urea, sodium, potassium, glucose

In stable patients, measurements of these analytes on alternate days may be sufficient.

It is sometimes helpful to measure the electrolyte content of daily collections of other fluids, when there are excessive and rapidly changing losses.

Twice weekly:-

Blood:

- bilirubin, alanine aminotransferase (ALT), alkaline phosphatase, gamma-glutamyl transferase, albumin, total protein, calcium, phosphate, magnesium

Urine (24 hour collection):

- urea, sodium, potassium

If the serum urea is stable and the urine is not infected with urea-splitting organisms, the urinary excretion of urea can be used to estimate urinary nitrogen losses.

Other measurements:

In prolonged TPN, assays of zinc and other trace elements may be justified. Direct assay of vitamins is hardly ever necessary.

THERAPEUTIC DRUG MONITORING AND TOXICOLOGY

Therapeutic Drug Monitoring (TDM):

The table gives guidelines that are useful in deciding whether to assay a particular drug. There are very few situations where a request for Phenobarbitone or Valproate is justified, since these drugs exhibit a very poor relationship between serum levels, dose and clinical effect.

The Department sends some requests for therapeutic drug monitoring (Phenobarbitone, Ethosuximide, Gabapentin, Caffeine, Theophylline) to other laboratories, although Lithium, Phenytoin, Carbamazepine and Valproate are assayed at the Manor. Use of specialist facilities like this has been encouraged by the Audit Commission. We know that in the past many drug assays requested

through this Department have been of doubtful clinical value and because of this we audit requests forwarded elsewhere. Our intention in doing this is not merely to avoid waste but also to help ensure that clinicians obtain the clearest possible answer to the clinical question that they are asking in making requests. Discussion about requests and the interpretation of results is welcomed.

We require a minimum amount of information before a sample will be sent for assay:

a. full patient details (including post code);

b. full details of all drugs the patient is on including dose and dose frequency;

c. time of last dose;

d. time sample taken;

e. clinical condition of patient and the reason for request (control, compliance, toxicity etc.)

TDM Guidelines

Drug	Recommended time of sampling	Therapeutic Range	Time (days) to reach steady state	Value of monitoring plasma	Frequency of monitoring	Detection limit
Carbamazepine	Before next dose (not critical) standardise timing	4-12 mg/l	2-3	Proven	monthly	2 mg/l
Digoxin[4]	At least 6 hours after an oral dose and upto immediately before the next dose	0.5-2.0 µg/l	7	Proven	monthly	0.1-0.2 µg/l
Ethosuximide	Before next dose (not critical) standardise timing	40-120 mg/l[1]	7-14	-	-	-
Gabapentin	Before next dose (not critical) standardise timing	2.0-20.0 mg/l[1]	1-2	-	-	-

Drug	Recommended time of sampling	Therapeutic Range	Time (days) to reach steady state	Value of monitoring plasma	Frequency of monitoring	Detection limit
Lamotrigine	Before next dose (not critical) standardise timing	1.0-4.0 mg/l[1]	4-6	-	-	-
Lithium	12 hr ± 30 minutes after last dose	0.6-1.0 mmol/l[3]	5	Well proven	monthly	0.1 mmol/l
Phenobarbitone	Before next dose(not critical)standardise timing	15-40 mg/l[1]	10-20	Unproven	not recommended	5 mg/l
Phenytoin	Before next dose (not critical) standardise timing	10-20 mg/l	7-10	Well proven	2 monthly	2.5 mg/l
Theophylline[2]	Before or 2-4 hrs after an oral dose	10-20mg/l[1]	1-2	Proven	monthly	2.5 mg/l
Valproate	Standardise timing (6-12 hrs) after last dose	up to 100 mg/l	1-2	Unproven	not recommended	10 mg/l

Drug	Recommended time of sampling	Therapeutic Range	Time (days) to reach steady state	Value of monitoring plasma	Frequency of monitoring	Detection limit
Vigabatrin	Standardise timing, before next dose	5-35 µg/l[1]	5-10	-	-	-

Notes:

1. Reference ranges as quoted by the measuring laboratory, Biochemistry, New Cross Hospital, Wolverhampton.
2. For Theophylline monitoring in acutely ill patients baseline serum samples should be obtained. When on continuous intravenous therapy obtain serum samples every 12 hours for dose adjustment. The therapeutic range given is for childhood and adult asthma. For neonatal apnoea aim for 5-10 mg/l and for children 1 year of age aim for 5-15 mg/l.
3. In view of the possible long term toxic effects of lithium, the lowest possible dose giving effective control of symptoms should be used. Patients on long term lithium therapy should have their renal and thyroid function monitored.
4. Digoxin effect and toxicity is increased by hypokalaemia, hypercalcaemia, renal failure, hypothyroidism, advanced heart disease.

5. Carbamazepine, Valproate, Phenytoin, Lithium and Digoxin are analysed on site Monday to Friday routinely. These tests can be performed urgently following discussion with the laboratory.

   There are very few situations where a request for Phenobarbitone or Valproate is justified, since these drugs exhibit a very poor relationship between serum levels, dose and clinical effect.

   Therapeutic ranges are target ranges associated with optimal therapeutic effect in the majority of cases. However, 'sub-therapeutic' or 'toxic' concentrations may be the effective concentrations in some patients. Ingestion of other drugs may also modify the concentration of the drug being measured or its pharmacological activity. The drug concentration value should always be used in conjunction with clinical observations.

Toxicology:

Paracetamol:

In cases of suspected paracetamol overdose blood should be collected at least 4 hours after ingestion of the drug. Serum levels measured less than 4 hours post-ingestion cannot be interpreted. Therapeutic levels of paracetamol are usually less than 10 mg/l. If serum levels are more than 200 mg/l at 4 hours after ingestion or more than 50 mg/l at 12 hours or detectable at all at 24 hours, liver damage is likely unless active antidote treatment is given. The prognostic accuracy of serum paracetamol levels after 15 hours is uncertain. The levels requiring antidote treatment in relation to time are given in the figure and table below:

Time after overdose (hours) above which liver damage is likely, unless antidote treatment given.	Serum paracetamol concentration (mg/l)
4	200
5	170
6	140
7	120
8	100
9	85
10	70
12	50
15	30

If the patient is to be treated with antidote, INR, serum creatinine and ALT should be monitored.

Certain patients, particularly chronic alcoholics or those who take certain drugs (including Phenytoin, Carbamazepine, Phenobarbitone,

Primidone, Rifampicin and St John's Wort) are at higher risk of paracetamol-induced hepatic necrosis and should be treated at serum concentrations half as great as those indicated above. In addition, in patients likely to be glutathione deplete (e.g. eating disorders, cystic fibrosis), the serum paracetamol concentration at which antidote is indicated is halved.

In the case of patients presenting 8 - 15 hours after ingestion antidote should be given immediately if it is thought that more than 150 mg/Kg body weight or 12 g in an adult (whichever is smaller) has been ingested. DO NOT WAIT for the result of the serum paracetamol concentration; the efficacy of antidote declines rapidly during this period, and it must therefore be given urgently.

Severe cases with liver and renal failure may be complicated by metabolic acidosis and hypoglycaemia.

Salicylate:

The therapeutic levels of serum salicylate for analgesia are of the order of 50-150 mg/l, for anti-inflammatory purposes 100-350 mg/l. Levels > 350 mg/l in children and >500 mg/l in adults are indications for active treatment, when the specimen is taken more than 6 hours after overdose. If the initial concentration exceeds 900 mg/l and if there is renal impairment or if other therapeutic measures fail, haemoperfusion or haemodialysis will usually be necessary. Serum salicylate levels should be measured during treatment as an indication of efficacy of treatment.

Other drugs:

In cases of acute poisoning with other agents that need to be identified for immediate patient management, please contact the Regional Laboratory for Toxicology at Birmingham City Hospital to discuss and justify the request. Specimens should, where possible, go through the Biochemistry Department to the City Hospital.

Gentamicin

For once daily Gentamicin dosing regimens take a **trough level** only within the hour before the next dose is due.

Reference range

Trough level ≤ 1.0 mg /l

For BD dosing regimens take a pre-dose (just before the dose) and a 1 hour post-dose specimen in yellow topped tubes. (The BD or TDS Gentamicin dosing is used only in treatment of neonates, neutropenic sepsis and bacterial endocarditis)

Reference range:

- Pre-dose : ≤ 1.0 mg /l
- Post-dose : aim for 3 to 5 mg/l

It is important to state carefully on the request form the date and timing of specimens (or whether pre or post dose specimen) and the dosing regimen as this information is vital for interpretation of results.

SERUM TUMOUR MARKERS

The Department performs these assays in batches, usually on Tuesdays and Fridays, with results usually available on the day of analysis.

It is important to remember that:

Measurements of serum tumour markers are useful for:

Monitoring of the progression of specific tumours diagnosed by other means;

Monitoring the response of specific tumours to therapy including recurrence & tachyphylaxis.

Most serum tumour markers are neither specific for:

Individual types of tumours;

nor

Even tumours in general.

They should not be used for attempting to diagnose tumours or identify primaries when metastases have been found.

An elevated serum tumour marker does not indicate the presence of a tumour.
A serum tumour marker within the reference range does not indicate the absence of a tumour.

There are very few exceptions to the guidance above but these include serum calcitonin for medullary carcinoma of the thyroid and AFP for hepatomas and germ cell tumours.

Each form requesting serum tumour markers is vetted by a senior member of the Biochemistry staff and specimens will not be processed if appropriate clinical details are not given. Clinical staff are encouraged to contact the Department to discuss individual cases.

Marker	Clinical Indication - remembering points above
AFP	Hepatoma, Germ cell tumours
CA125	Ovarian tumours
CA15-3	Breast
CA19-9	Pancreas
CEA	Colorectal tumours

HCG	Germ cell tumours, hydatidiform mole, choriocarcinoma

Haematinics

Mustard (SST) Vacutainer tube

Haematinic tests are vitamin B12, serum folate, red cell folate and ferritin. They are used as a further investigation to macro- and microcytic anaemias. It is important that specimens for B12 and folate assays are taken prior to the administration of haematinics in the case of anaemic patients, since any underlying deficiency may be masked after treatment. The ferritin is used as an indicator for iron deficiency. The serum folate is only used as an indicative screen as it is affected by dietary intake.

PROCALCITONIN (PCT)

At present, this test is only available to ICU / HDU.

PCT increases during bacterial infection; it is probable that multiple tissues express PCT throughout the body in response to sepsis. Increased PCT levels are often found in patients suffering from bacterial sepsis, especially sepsis and septic shock.
If required, clinical advice and interpretation is available by contacting the Consultant Microbiologists.

Sample Type required: Serum gel (Yellow top)
Sample stability: Stable for 24 hours at Room Temperature (20 25 °C), 48 hours at 2 8 °C (fridge)
Units: ng/ml (numeric result)
Reference ranges: not provided for this test.
Turnaround time: 1 day

SPECIMEN REQUIREMENT AND TRANSPORT FOR ANALYSIS OF CSF FLUID

- The tables give the CSF sample requirements for suspected infection of the CNS (meningitis/encephalitis); subarachnoid haemorrhage and demyelinating disorders.
- If meningitis and subarachnoid haemorrhage are differential diagnoses then please use the subarachnoid haemorrhage table only.
- For other diagnoses requiring CSF samples please discuss with the Duty Microbiologist prior to collection.
- **DO NOT** send CSF samples using the pneumatic post tube
- **DO** collect samples and number universals in the order given in the table.
- The sample must be adequately labelled and treated as any other biological sample.

Working diagnosis: Infection of CNS (Meningitis/encephalitis)				
CSF sample number	***Tube***	***Test***	***Required Volume (ml)***	***Department***
1	Sterile universal 	Microbiological investigation	0.5ml - 1ml	Microbiology
2	Sterile universal 	Protein	0.5ml	Chemistry
3	Sterile universal 	Microbiological investigation	0.5ml - 1ml	Microbiology
4	Fluoride EDTA 	Glucose	0.5ml	Chemistry

Working diagnosis: Subarachnoid Haemorrhage				
CSF Sample number	**Tube**	**Test**	**Required Volume (ml)**	**Department**
1	Sterile universal 	Microbiological investigation	0.5ml - 1ml	Microbiology

2	Sterile universal 	Protein	0.5ml	Chemistry
3	Sterile universal 	Microbiological investigation	0.5ml - 1ml	Microbiology
4	Sterile universal **PROTECT FROM LIGHT & TRANSPORT IMMEDIATELY**	Bilirubin (Xanthochromia)	At least 1.0ml	Chemistry
5	Fluoride EDTA 	Glucose	0.5ml	Chemistry
Serum sample	Gel tube 	LFT	5ml – 7ml	Chemistry

NB.A serum sample is required for interpretation of Xanthochromia.

Working diagnosis: Demyelinating Disorders				
CSF Sample number	**Tube**	**Test**	**Required Volume (ml)**	**Department**
1	Sterile universal 	Microbiological investigation	0.5ml - 1ml	Microbiology
2	Sterile universal 	Protein	0.5ml	Chemistry
3	Sterile universal 	Microbiological investigation	0.5ml - 1ml	Microbiology
4	Sterile universal 	Oligoclonal bands	0.5ml	Microbiology
5	Fluoride EDTA 	Glucose	0.5ml	Chemistry
Serum sample	Gel tube 	Oligoclonal bands	5ml – 7ml	Microbiology

Laboratory contact requirements post collection

Microbiology*:* This dept is no longer based on site so please ring New cross 01902 307999 ext 88560 during working hours (8:45am – 5pm Mon-Fri; 8am – 4.0pm Sat & Sun). Out-of-hours please contact the on

call microbiology biomedical scientist via switchboard (New Cross) as they will have to come in from home to process the CSF.

For diagnostic microbiology

- if TB meningitis suspected, obtain **additional** at least 10ml if possible for TB culture
- Meningococcal / pneumococcal PCR is performed on blood in EDTA.
- if herpes simplex virus meningo-encephalitis suspected, obtain **additional** 1 mL in separate sterile container for HSV PCR (microbiology may discuss the requirement for viral PCR with the attending medical team)
- request other CSF PCR tests according to suspected pathogen(s). If you suspect that more tests may be required later, send an additional sample to microbiology for storage
- If Creutzfeldt - Jakob disease (CJD) is suspected the clinician must telephone the CJD surveillance unit in Edinburgh, who will decide whether the CSF sample should be sent or not. They will send an online questionnaire. The telephone number is 0131 537 3075.
- send samples to microbiology lab

***Clinical Chemistry**:* Please ring **Ext 6782** if sending a sample for CSF Xanthochromia, as immediate centrifugation is required. Do not send in air tube system.

Additional information for subarachnoid haemorrhage

- CSF bilirubin must only be carried out on patients who have had a normal CT scan.
- The lumbar puncture must be carried out a minimum of 12 hours post onset of symptoms.
- CSF bilirubin may be raised for up to two weeks post event, however, there is limited data on the sensitivity of CSF bilirubin for the detection SAH >1 week post event.
- Date of any recent LP (previous 14 days) – repeat LP may give false positive xanthochromia results please contact Duty Biochemist to discuss
- Please indicate on the request:
    - Result of CT scan
    - Time of sample in relation to onset of symptoms

Clinical Advice

Microbiology: If clinical advice is required to treat patients with suspected meningitis/ encephalitis during normal hours (Mon-Fri 9am – 5.15pm) please contact the Duty Microbiologist via switchboard. Out-of hours contact the on-call Microbiology consultant also via switchboard. Please also refer to the Antimicrobial Prescribing Policy and the Adult Medical Guidelines.

Clinical Chemistry: Please contact the Duty Biochemist or out of hours the chemistry consultant on call via switchboard.

Birmingham Children's Hospital Pathology IMD Handbook

This document details the tests available and the samples required to investigate inborn metabolic disorders.

BCH IMD Handbook 2017

https://themanor.xwalsall.nhs.uk/Data/Sites/1/media/pathology/bch-imd-handbook-2017.pdf

Covid – 19

Respiratory samples for SARS – CoV-2 testing or any other sample types from known and suspected COVID-19 patients must be double bagged, labelled with 'Danger of Infection', placed in a transport box or bag labelled UN3373, 'COVID-19' (red) and brought by hand to the laboratory – do not use the pneumatic tube system.

The laboratory is able to offer a rapid Covid-19 test, which utilises the GeneXpert analyser. However, there is a limited supply of cartridges and as a result the number of rapid tests is limited to a set number per day. Due to the limitation in the number the lab can test we have had to target areas where the rapid testing will be most effective, as a result, rapid testing is available for the following groups

- Patients on ICU who have not tested positive for COVID-19 previously.
- Selected patients coming through ED who look unlikely on clinical / radiological grounds to have COVID-19 but present with a respiratory infection. In these instances the test can be used to aid placement of these patients to non- COVID-19 areas.
- Situations where the IPCT request a rapid diagnosis for inpatients for infection control priorities, patient isolation and management.

Rapid swab samples will be tested between 08:00 am and 20:00 pm.

SUDI Protocol

The current Child Death – the management of when a child dies protocol is available via the Trust's Intranet page.

Child Death Protocol

https://themanor.xwalsall.nhs.uk/SharedFiles/Download.aspx?pageid=2032&fileid=8698&mid=3041

Haematology

Introduction

The Haematology department provides routine and emergency diagnostic services for patient diagnosis and management. These services are based around the main analysers in the laboratory, mainly the Full Blood Count analysers, the coagulation analysers and blood film morphology. A number of specialised tests are routinely referred to reference laboratories. The more popular referral tests are included at the end of this section and a full list of referral tests can be seen in the main Blood Sciences page.

Routine Tests

Full Blood Count

PURPLE capped Vacutainer tube, EDTA anticoagulant (4 ml)

The FBC is processed by an automated cell counter. Haemoglobin (Hb), red cell count (RBC), packed cell volume (Hct), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), white blood cell count (WBC), platelet count and an analyser differential will be provided automatically. A blood film will be reviewed and a manual differential white blood cell count will be performed if deemed necessary from the results or if it is has been specifically requested.

A minimum volume of 0.3 ml of blood is required to be able to perform the count accurately. Paediatric tubes for smaller volumes can be obtained from the department on request.

Requests for ESR, glandular fever screen, sickle screen, malarial parasites and Reticulocyte counts can all be performed on the same specimen sent for FBC.

A blood film is performed if there is an unexpected abnormal result reported from the FBC analysis. A film can also be automatically requested if required. The film is a microscopic examination of the blood cells and is made and stained from the FBC sample. The laboratory will report on the size, shape, numbers and maturity of the RBC, WBC and platelets. Any abnormal circulating cells will be reported, including any inclusion bodies and parasites. Grossly abnormal blood films, e.g., a new presentation of leukaemia, will be automatically referred to the Consultant Haematologist for follow up action.

Erythrocyte Sedimentation Rate (ESR)

The ESR is performed using the FBC request, so no further samples are required. A minimum of 1ml of sample is required to perform. The ESR is measured using the Alifax analyser. This gives us a capillary flow value that is consistent with a true ESR value. This allows the ESR to be measured in 2 minutes rather than 1 hour.

The ESR is not a specific test but can be used to indicate changes due to medical conditions or disease states where acute phase reactions occur, e.g., infections, arthritis. It can also be used to monitor treatment of conditions, e.g., in RA.

Reticulocyte Count

PURPLE capped Vacutainer tube, EDTA anticoagulant (4 ml)

Reticulocyte cells are immature RBCs that are released earlier by the bone marrow and can therefore be used to assess bone marrow activity. Reticulocyte counts will only be performed where the test would be relevant to the diagnosis or treatment, e.g. evidence of haemorrhage or haemolysis, recent treatment with haematinics, Aplastic anaemia. Reticulocyte counts are performed by the automated cell counter at the same time of the FBC, and reported as both a percentage and an absolute count. Reticulocyte count is performed using the FBC sample therefore, providing a minimum of 1ml of blood is provided for the FBC, no further samples are required.

Glandular Fever screen

PURPLE capped Vacutainer tube, EDTA anticoagulant (4 ml)

The GF screen is also referred to as an infectious mononucleosis screen. This is a viral illness usually affecting adolescents, and manifests as lethargy, swollen glands. The test is based on a latex agglutination against the heterophile antibody produced by the presence of the virus. It is reported as either a positive or negative result, and is performed along with a FBC and blood film. Morphological changes will be present as atypical mononuclear cells seen in the blood film. Glandular fever testing is performed using the FBC sample therefore, providing a minimum of 1ml of blood is provided for the FBC, no further samples are required.

Sickle Cell Screen

PURPLE capped Vacutainer tube, EDTA anticoagulant (4 ml)

Sickle cell screen are a quick test to determine the presence of Hb S in a patient sample. These are not routinely performed as all requests are

firstly sent for HPLC screening (see 6.2). the test will only be performed for urgent theatre cases or for confirmation of Hb S detected by HPLC. The test is based on the solubility of Hb S in a sodium disulphate solution. Normal haemoglobin will dissolve in the solution whereas Hb S will not, with the solution remaining cloudy. The result will either be positive or negative for Hb S but will not be able to distinguish between homozygous and heterozygous patients.

Sickle Cell Screen is performed using the HPLC sample therefore, providing a minimum of 2ml of blood is provided for HPLC, no further samples are required.

If not, a minimum of 1ml of blood is required.

Malarial Parasites (and other blood parasites)

PURPLE capped Vacutainer tube, EDTA anticoagulant (4 ml)

Malarial parasites are microscopic organisms that have part of its life cycle in the blood stream and cause serious illness with fever. It is possible to view and identify the different stages of the parasite infection in a blood film and therefore report the presence of a malarial parasite infection. It is possible to identify the species of the malarial infection, i.e., Plasmodium Vivax, Falsiparum, Ovale or Malariae.

The department can also perform a cartridge based antibody test, that can be use to confirm the presence of malarial parasites in a blood sample.

Other blood borne parasites, such as microfilaria, trypanosomes, can also be viewed and identified using a blood film made from the FBC sample. Malarial parasite testing is performed using the FBC sample therefore, providing a minimum of 2ml of blood is provided for the FBC, no further samples are required.

Glucose-6-Phosphate Dihydrogenase (G-6-PD)

PURPLE capped Vacutainer tube, EDTA anticoagulant (4 ml) - A minimum of 2ml of blood is required.

G-6-PD is a red cell enzyme, a deficiency of which can lead to Haemolytic Anaemia. Haemolysis may be precipitated by the ingestion of oxidant drugs e.g. those used for treatment of malaria (Primaquine, etc). A G-6-PD screen should be performed prior to treatment of malaria with oxidant drugs. The G-6-PD will be reported as normal or deficient.

A G-6-PD assay will be performed on those patients found to be deficient by screening; this is referred to Haematology at Birmingham Heartlands Hospital.

Haemoglobinopathy Screening

PURPLE capped Vacutainer tube, EDTA anticoagulant (4 ml) - A minimum of 2ml of blood is required.

Haemoglobinopathy screening is offered to all antenatal patients, any preoperative patient that may be affected or any patient considered to have an abnormal haemoglobin or thalassaemia. The screening performed using an automated High Pressure Liquid Chromatography (HPLC) method where the red cells are chemically haemolysed to release the haemoglobin. This solution is passed through the HPLC column that separates the different fractions according to charge. Any abnormal haemoglobin fraction is identified. The analyser will identify and measure the clinically significant haemoglobins - Hb A2, F, S, C and D. normal fractions, e.g., Hb A, will also be measured. The analyser will also indicate the presence of Hb E. Any abnormal variants are referred to Sandwell Hospital for confirmation with the exception of HbS. This is confirmed using the sickle screen. Some Hb variants can only be identified by DNA analysis, and are referred to the reference centre at John Radcliffe Hospital, Oxford. All abnormal variants are reported to the Haemoglobinopathy screening nurse, with any antenatal patients also be

referred to the antenatal screening coordinator. The service is designed to provide a counselling service to the patients affected.

Note

WATCH (antenatal Haemoglobinopathy) screens will only be processed where the sample is accompanied with a completed FOQ form as the test requires patient consent.

Coagulation Screen / Coagulation Factor Assays

BLUE capped Vacutainer tube containing liquid Sodium Citrate anticoagulant or in-house paediatric tube.

Samples should be taken by clean venepuncture and the tube containing the specimen should be mixed thoroughly with the anticoagulant. It is essential that the tubes are filled to the correct level to ensure that the ratio of blood to liquid anticoagulant is correct.

Underfilled samples will result in falsely prolonged coagulation times. Specimens which are received underfilled will be rejected and a second specimen requested. The correct fill level is attained when the Vacutainer tube has been allowed to fill as much as possible before withdrawal from the vein. If manually filled, however, the blood should be to the top of the label on the tube. If the tubes are not mixed thoroughly, clots may form precluding testing.

NB Specimens should NOT be taken from irrigated Venflons or arterial lines as heparin contamination will affect the results, particularly the APTT.

Specimens taken from the site of previous haematomas or obtained with great difficulty may also give inaccurate results.

All specimens for coagulation studies should reach the department as soon as possible after collection. Some coagulation factors are extremely labile and degrade rapidly on storage giving erroneous

results. Any sample received older than 4-5 hours may not give valid test results.

Before commencing anticoagulant therapy it is advisable to check that the APTT, INR and platelet counts of the patient are normal. Once therapy has commenced please restrict requests to tests specific to monitoring the particular anticoagulant being administered.

A request for coagulation tests should indicate any anticoagulant therapy within the previous 4 days.

Paediatric tubes are available on request from the department. They are small tubes containing 0.1ml of sodium citrate to which must be added exactly 0.9ml of blood to ensure the correct ratio of anticoagulant to blood. These are normally used for capillary sampling or for cases where there is difficulty in obtaining sufficient quantities of blood, i.e. Neonatal and Paediatric wards.

The department has two automated coagulation analysers that are used to routinely test INR, APTT, Fibrinogen and D-dimer.

Prothrombin time (INR, PT)

BLUE capped Vacutainer tube, Sodium Citrate anticoagulant (4 ml)

Samples must be appropriately filled to the black line on the blood tube.

The test gives an indication of levels of vitamin K dependent coagulation factors, or extrinsic coagulation mechanism, produced in the liver and the patient's result is expressed as a ratio to the time produced for normal subjects.

The INR is used to monitor warfarin therapy as warfarin directly reduces the production of the vitamin K dependent factors.

Activated partial thromboplastin time (APTT)

BLUE capped Vacutainer tube, Sodium Citrate anticoagulant (4 ml)

Samples must be appropriately filled to the black line on the blood tube.

The APTT measures the activity of the intrinsic coagulation mechanism and is prolonged in Factor deficiency states, Factors VIII and IX being the most common. It is always reported as a ratio of patient''s result over a normal control value.

The APTT is used to monitor heparin therapy. If the patient is not on a continuous infusion, the timing of the specimen collection should be related to the method and route of heparin therapy. The APTT is not affected by low molecular weight heparin and should not be used to monitor this drug.

It is essential that any relevant history of anticoagulant therapy is included on the request form. Forms indicating heparin therapy will only be tested for APTT, whilst forms indicating Warfarin therapy will only be tested for INR. That is to say, in the interest of economy only tests relevant to monitoring the specific anticoagulant will be performed.

Fibrinogen

BLUE capped Vacutainer tube, Sodium Citrate anticoagulant (4 ml)

Samples must be appropriately filled to the black line on the blood tube.

This is the precursor of fibrin which forms the haemostatic plug. Deficiency states of fibrinogen may occur, particularly in disseminated intravascular coagulation. (DIC).

D-dimer

BLUE capped Vacutainer tube, Sodium Citrate anticoagulant (4 ml)

Samples must be appropriately filled to the black line on the blood tube.

The D-dimer molecule is produced as a breakdown product following the formation of clots. This test can be used as a negative predictor for the occurrence of DVT or PE. It is of little diagnostic value in post-operative, ante-natal, post-natal or post trauma patients and must be used in conjunction with full assessment of the patient. The D-dimer may also be used in patients with suspected DIC, with the D-dimer being massively elevated.

Thrombophilia Screening

At least FOUR BLUE capped Vacutainer tubes, Sodium Citrate anticoagulant (4 ml)

Samples must be appropriately filled to the black line on the blood tube.

This is a group of tests used to determine a patient's predisposition for a thrombotic event such as PE or DVT, consisting of Protein C, Protein S and Anti-Thrombin III. These are factors involved in the fibrinolytic system, the coagulation cascade inhibitor, in which a deficiency can lead to inappropriate clot formation. These tests are directly affected by anticoagulant drugs and should therefore not be requested during this period of treatment.

Molecular Thrombophilia Testing

Genetic testing can also be requested to determine if the Factor V Leiden or Prothrombin Gene Variant is present in a patient's DNA. The presence of these genetic mutations can give a predisposition to thrombotic events. Genetic thrombophilia testing is current sent off site to Haematology at Heartlands Hospital for analysis.

Lupus Anticoagulant Screening

Lupus anticoagulant screening determines the presence of the lupus inhibitor, an anti-phospholipid antibody which can lead to inappropriate blood clot formation. Lupus anticoagulant testing is currently sent off site to Haematology at Heartlands Hospital for analysis. These tests are directly affected by anticoagulant drugs and should therefore not be requested during this period of treatment.

Miscellaneous Tests

Bone Marrow Aspirate / Bone Marrow Trephine

These are arranged directly by the Consultant Haematologist. Equipment for the biopsy will be provided by the department, but the ward will provide a clean dressing trolley, with a medium sterile dressing pack, a disposal bag and a member of staff to be with the patient.

The bone marrow sample is used to produce smears that can be stained for microscopy examination of the bone marrow cells. Special staining can also be used to determine increased iron deposits. These are used by the Haematologist to diagnose a variety of haematological disorders.

Bone marrow samples can also be referred to either the Birmingham Medical School for cell marker analysis or the Regional Cytogenetics Laboratory for genetic profiling to further assist the Haematologist when making a diagnosis.

Common referral tests

Specialised Coagulation Tests

All specialised coagulation requests are usually referred to University Hospital, Birmingham. This includes specific factor assays, inhibitor screening, von Willebrand disease screening. Any specialised test should be discussed with the department prior to taking the samples to ensure that the arrangements have been made.

Anti Factor-Xa

BLUE capped Vacutainer tube, Sodium Citrate anticoagulant (4 ml)

Samples must be appropriately filled to the black line on the blood tube.

This test is used to monitor the use of low molecular weight heparins, such as Clexane or Fragmin. This is particularly important during pregnancy. These samples are referred to Birmingham Women's Hospital, and are analysed on a weekly basis.

Erythropoietin

Red capped plain 6 ml sample (serum) containing no additives.
This sample is referred to Clinical Chemistry, Leeds General Infirmary and is a direct measurement of the patient erythropoietin levels. Used primarily to monitor patients on EPO treatments.

Cytogenetic / Molecular genetic Referrals

These are referred to the West Midlands Regional Genetics Laboratory based at the Birmingham Women's Hospital. There are two different requests forms used depending upon the type of investigation required. The blue cytogenetics referral form for Chromosome analysis and/or FISH Studies i.e. looking for translocations and chromosome re-arrangements. This request requires a Lithium Heparin (Green) sample. This will most commonly be used for Oncology patients. The green molecular genetics form for specific DNA mutations and requires an EDTA sample (Purple)

Conditions for Molecular Genetics Referrals

FAMILIAL CANCER DISORDERS

Birt-Hogg-Dubé
Breast / Ovarian Cancer -hereditary
Carney Stratakis syndrome
Familial Adenomatous Polyposis (FAP)
Familial Platelet Disorder (FPD/AML)
Fumarate Hydratase Deficiency
Gastric cancer
Gorlin syndrome (NBCCS)
Hereditary Leiomyomatosis and Renal Cell Cancer
Hereditary Papillary Renal Carcinoma
Lynch syndrome / Hereditary Non-Polyposis Colorectal Cancer (HNPCC)
Medullary Thyroid Carcinoma
Multiple Cutaneous and Uterine Leiomyomatosis
Multiple Endocrine Neoplasia (MEN 2A & 2B)
MET proto-oncogene analysis
MYH-Associated Polyposis
Paraganglioma / Phaechromocytoma

Peutz Jeghers syndrome
PTEN harmartoma tumour syndrome
Renal Cell Cancer
RET proto-oncogene analysis
von-Hippel Lindau (VHL)

INHERITED NON-CANCER DISORDERS

Achondroplasia
Alpha1 antitrypsin deficiency
Alström syndrome
Angelman syndrome
ARC syndrome
Bannayan-Riley-Ruvalcaba syndrome
Becker Muscular Dystrophy (BMD)
Beckwith Wiedemann syndrome (BWS)
Charcot Marie Tooth Neuropathy Type 1A (CMT1A)
Charcot-Marie-Tooth Neuropathy Type 2A (CMT2A)
CHARGE syndrome
Combined Pituitary Hormone Deficiency
Congenital Adrenal Hyperplasia (CAH)
Cowden syndrome
Cystic Fibrosis
Deafness: connexin 26 & connexin 30
Dentatorubral-Pallidoluysian Atrophy (DRPLA)
DIDMOAD
Disomy studies
Duchenne Muscular Dystrophy (DMD)
Escobar syndrome
Fragile X syndrome
Friedreich Ataxia (FRDA)
Haemochromatosis
Hereditary Neuropathy with Liability to Pressure Palsies (HNPP)
Hereditary motor and sensory neuropathy type 1A (HMSN1A)

Hereditary motor and sensory neuropathy type 2A (HMSN2A)
Huntington Disease
Infantile Neuroaxonal Dystrophy (INAD)
Kennedy's disease
Laron syndrome
LEOPARD syndrome
Marfan syndrome
Mitochondrial disorders
Multiple Pterygium syndrome (CHRNG)
Myotonic Dystrophy type 1
Noonan syndrome
Panhypopituitarism
Prader-Willi syndrome
Proteus syndrome
PTEN hamartoma tumour syndrome
Rett syndrome
Sex determination
Silver-Russell syndrome
Smith Lemli Opitz
Sotos syndrome
Spinal and bulbar muscular atrophy (SBMA)
Spinal muscular atrophy (SMA)
Spinocerebellar ataxia (SCA)
Warburg Micro syndrome
Wolfram syndrome
X-inactivation
Zygosity studies

Immunology

Introduction

Analytical and consultative services are provided by the Immunology Department at New Cross Hospital. Immunology test requests received are referred out to this service to assist clinicians with the diagnosis and management of their patients. Selection and interpretation of tests and the advisory service are provided by the Consultant Immunologist.

Requesting Tests

Requests can be made by either using the order comms system (ICE) or by completing a written request form. Samples should then be sent to the Central Specimen Reception, Pathology, Walsall Manor Hospital. Samples requiring immunology tests are then referred out to the Immunology Department. Additional tests can usually be performed if required by contacting the laboratory.

Clinical Referrals

A written referral is required in line with the referral policy, addressed to Dr. Bhole. Requests for consultations can be made directly or by contacting the departmental secretary.

Specimen Collection

All tests require 5-10 ml clotted blood from adults unless otherwise stated.

Full connective tissue disease screens and multiple allergy tests ideally require 10 ml. In instances where fresh clotted blood is required (e.g. complement assays), samples need to reach the laboratory within 2 hours of collection, clearly labelled for immediate separation.

For very young children, 1 ml is usually sufficient for a small number of tests e.g. ANA and rheumatoid factor. In the case of larger numbers of tests, please contact the laboratory before taking the sample as advice beforehand may save the need for repeat venepuncture.

Specimen requirements for specialist Immunology requests.

Request	Specimen
Aquaporin 4 Antibody (NMO Antibody)	Clotted
Basal Ganglia Antibody	Clotted
C1q	Clotted
Diptheria Antibody	Clotted
Histone Antibody	Clotted
Interferon Neutralising Antibody	Clotted
ISAC (CRD)	Clotted
MUSK Antibody	Clotted
Neuronal Antibody	Clotted
Meningococcal Antibody	Clotted
NMDA Antibody	Clotted
Ovarian Antibody	Clotted
Parathyroid Antibody	Clotted
Pneumococcal serotypes	Clotted
Testes Antibody	Clotted
Thyroglubulin Antibody	Clotted
Voltage Gated Calcium Channel Antibody	Clotted
Voltage Gated Potassium Channel Antibody	Clotted
C4 genotyping	EDTA x 2

Request	Specimen
MBL genotyping	EDTA x 2

The following tests need urgent handling:

After taking, the specimen should be sent to Pathology Specimen Reception as soon as possible.

Lymphocyte marker analysis and cell function studies require prior arrangement before the sample is taken.

Usually an EDTA sample is required for marker studies, but special tubes may be required for cell function. These samples will not be processed after 12.00 on Fridays as artefactual results may arise after weekend storage.

Results

If an urgent result is required e.g. GBM antibody screen, please contact the laboratory who will ensure appropriate results are available as soon as possible. The specimen must arrive in the laboratory by 12.00 to ensure same day results. Results, which are considered urgent are automatically telephoned to the requesting doctor if a bleep or contact number is supplied (the ward or consultant's secretary are notified otherwise).

Turnaround times

The turnaround times (TAT) of the high volume routine tests performed by the department are monitored and reported monthly as part of the key performance indicators for the department. The targets set are:

TEST	Target TAT
Immunoglobulins (IMM)	48 hours
Rheumatoid Factor (RF)*	4 hours

TEST	Target TAT
Anti Nuclear Antibodies (ANA)	7 days
Anti Nuclear Cytoplasmic Antibodies (ANCA)	7 days
Cardiolipin Antibodies (CARD)	7 days
Smooth Muscle Antibodies (SMA)	7 days
Thyroid Peroxidase Antibodies (TPO)	7 days
Tissue Transglutaminase Antibodies (TTG)	7 days

*Analysis performed on the main Clinical Chemistry analyser at Walsall Biochemistry

Results for tests referred to other laboratories, besides New Cross Hospital, will usually take more than 7 days to return and can take up to several weeks. Please enquire about results that appear to be delayed to ensure they have been correctly addressed for return.

Immunology Tests:

Acetylcholine receptor antibody (ACR)

Reported as Negative or Positive (with a numerical result).

Normal range = 0-5 x10-10M

Positive in myasthenia gravis.

(Referred to Immunology dept, Churchill Hospital, Oxford)
Adrenal antibody

Reported as Negative or Positive.

Positive in the majority of cases of autoimmune Addison's Disease and in cases of autoimmune polyglandular endocrinopathies.

(Referred to Immunology dept, Medical School, Birmingham)

Anti-Myelin Associated Glycoprotein (MAG) antibodies

Reported as Negative or Positive.

Anti-MAG can be found in certain sensori-motor neuropathies.

(Referred to Immunology dept, Medical School, Birmingham)

Anti-neutrophil cytoplasmic antibodies (ANCA)

Reported as Positive (and pattern) or Negative. ANCA positive samples are tested for MPO and PR3 by ELISA.

Cytoplasmic ANCA (cANCA) is a test for Wegner's Granulomatosis (80% of cases positive) and Microscopic Polyarteritis (20% of cases positive). Positives may occur in other vasculitic disorders such as SLE and Vasculitis associated with Rheumatoid Arthritis. Perinuclear ANCA (pANCA) is seen in Microscopic Polyarteritis, Churg-Strauss syndrome etc. Both cANCA and pANCA are also seen in some cases of bacterial infection (e.g. TB), some cases of rapidly progressive crescentic glomerulonephritis, vascular damage (e.g. MI, CVA) and inflammatory bowel disease (the latter often having an atypical pattern).

Turnaround time = 7 days

Anti-nuclear antibody (ANA)

Reported as Positive (titre and pattern) or Negative.

Over 95% of patients with SLE have a positive ANA result hence a negative result makes a diagnosis of SLE unlikely. The test is not specific for SLE as a positive ANA can occur in other conditions e.g. rheumatoid arthritis, systemic infections, other connective tissue diseases, chronic active hepatitis, juvenile arthritis, fibrosing alveolitis, and can be induced by drugs such as hydralazine and tetracyclines. Low titre ANA can also be found in the serum of many healthy elderly people.

Different patterns of ANA are associated with different clinical conditions; this is reported where relevant.

Turnaround time = 7 days

Aspergillus IgG (formerly 'precipitins')

Reported as positive or negative.

Positive results only indicate exposure and therefore not diagnostic in isolation. If a diagnosis of Allergic Bronchopulmonary Aspergillosis or aspergilloma has been made then a positive result is supportive of this. Usually done together with Specific IgE to Aspergillus fumigatus.

(Referred to Immunology dept, Medical School, Birmingham)

Avian IgG (formerly 'precipitins')

Reported as positive or negative.

Present in extrinsic allergic alveolitis caused by avian proteins.

(Referred to Immunology dept, Medical School, Birmingham)

NB These antibodies are found in at least 50% of people chronically exposed to the antigen but only a minority of these experiences clinical problems. Please discuss if the interpretation

of these results is in doubt. Only pigeon and budgerigar are available routinely.

Beta 2 Glycoprotein antibodies (B2 GPI)

Numerical result reported. Normal range = 0 - 20 EU/ml.

The ELISA used for cardiolipin antibodies detects B2 GPI antibodies concurrently. In cases of young adults with unexplained thrombotic episodes and no detectable cardiolipin antibodies or lupus anticoagulant,

please contact the laboratory to discuss B2 GPI and IgM cardiolipin antibodies.

(Referred by arrangement only to Immunology dept, Medical School, Birmingham)

Beta 2 Microglobulin

Numerical result reported. Normal range: 0 - 4 mg/L.

Levels are raised with decreased renal function and in many B-cell tumours. This is one of the most important prognostic indicators in myeloma.

(Referred to Immunology dept, Medical School, Birmingham)

C1 Inhibitor

Requires prior discussion with the laboratory/consultants prior to sending sample.

Numerical result reported. Normal Range: 0.18 - 0.30 g/l.

Inherited or acquired defects of this protein usually result in severe angioedema, which is a painless, non-itchy swelling of sub-dermal tissues and is life-threatening if the larynx is affected. Low levels are found in 85% of cases of Hereditary Angioedema. The remaining 15% of cases are associated with a non-functioning protein, an assay for which is available. Normal C4 levels during an acute attack of angioedema virtually exclude C1-inhibitor deficiency. Acute attacks are treated by infusion of C1-inhibitor concentrate or Fresh Frozen Plasma. Clinical assessment by an Immunologist is strongly recommended where this diagnosis is suspected. Please note. C1-inhibitor deficiency is not associated with urticaria.

Fresh clotted blood should be taken.

(Referred to Immunology dept, Medical School, Birmingham)

C3 Nephritic Factor

Requires prior discussion with the laboratory/consultants prior to sending sample.

Reported as Positive or Negative.

This IgG autoantibody stabilizes C3bBb and therefore results in continuous C3 breakdown. The presence of this autoantibody is associated with type II membrano-proliferative glomerulonephritis, with or without partial lipo-dystrophy and causes C3 levels to be very low.

Fresh clotted blood sample should be taken.

(Referred to Immunology dept, Medical School, Birmingham)

Cardiac Antibodies

Reported as Negative or Positive.

Found in Dressler's Syndrome, post cardiac surgery or in acute rheumatic fever but the diagnostic value of these antibodies is low.

(Referred to Immunology dept, Medical School, Birmingham)

Cardiolipin antibody (IgG)

Numerical result reported (* = IgG Phospholipid Units). Reported with interpretation.

Anti-Cardiolipin (ACL) and the Lupus Anticoagulant are members of a family of anti-phospholipid antibodies. Some patients with SLE have modest levels of these antibodies but the most striking associations are with thrombotic episodes and recurrent foetal loss. As the syndromes associated with ACL are treatable, it is appropriate to seek its presence in the following groups of patients:

- Women with recurrent unexplained foetal loss.

- Young patients with stroke, myocardial infarction or transient ischaemic attacks, without other predisposing factors.
- Young patients with recurrent venous or arterial thromboses.
- Patients with unexplained thrombocytopenia.
- Patients with SLE for assessment of thrombotic risk in pregnancy.

Clinical details are essential for the accurate interpretation of the result.

B2 GPI antibodies are detected in addition to ACL in the assay used. This test can be arranged separately if required for specific patients.

NB. Lupus anti-coagulant testing is performed in Haematology; please send a minimum of 2 x 2.5 ml citrated blood and state if the patient is on anticoagulant treatment and if so, which one.

Turnaround time = 7 days

Cardiolipin antibody (IgM)

Numerical result reported (* = IgG Phospholipid Units). Reported with interpretation.

Less specific than IgG cardiolipin, but high titres can be seen in anti-phospholipid syndrome (APS)

Turnaround time = 7 days

Centromere antibody

Reported as ANA positive or negative.

Usually found in CREST variant of scleroderma (limited scleroderma). Patients with severe Raynaud's and other features of scleroderma, especially lung and other organ involvement, should also be screened for Scl-70, which is associated with systemic sclerosis.

Turnaround time = ~7 days for screen

CH50/APH50

Requires prior discussion with the laboratory/consultant prior to sending sample.

Numerical result reported with interpretation.

Functional tests of classical and alternative complement pathways. Very low levels occur if any component is absent. *Any patient with meningococcal disease or severe sepsis should be screened with a CH50/APH50 during convalescence*. CH50 is not suitable for the routine monitoring of patients with SLE. Please seek the advice from the department if you are not fully conversant with these tests.

Clotted sample required by laboratory within 2 hours of venepuncture: please advise laboratory of expected sample.

(Referred to Immunology dept, Heartlands Hospital, Birmingham)

Complement components C3 and C4

Numerical result reported.

Normal Range: C3 0.75 - 1.75 g/l

C4 0.14 - 0.54 g/l

Blood must be taken as atraumatically as is practical and reach the laboratory as soon as possible in order to avoid artefactual breakdown of components. C3/C4 levels are useful in monitoring conditions associated with immune complexes e.g. SLE, systemic vasculitis, SBE. A decrease, primarily of C3, can be associated with gram negative bacteraemias and post-streptococcal GN. A profound decrease in C3 should alert the clinician to the possibility of a C3 nephritic factor (see above). Low C4 levels can be found in individuals with a C4 null allele (these people have an increased risk of developing SLE) and in cases of active connective tissue disease. An isolated decrease in C4,

associated with angioedema, suggests C1-inh deficiency whereas a low C4 with renal disease and/or vasculitic rash suggests the presence of a cryoglobulin. Increased production can maintain normal levels even if consumption is rapid.

Turnaround time = 24 hours

Cryoglobulins

It is important the laboratory is contacted before collection of a specimen for this assay.

Reported as positive or negative, positives are sent to for typing.

When cryoglobulins are associated with Waldenstroms macroglobulinaemia, myeloma or lymphoma they consist of one immunoglobulin isotype but may be mixed or polyclonal in other diseases such as connective tissue disease. Patients with renal disease and a low C4 level or patients with unexplained cutaneous vasculitis should be screened for the presence of circulating cryoglobulins.

Cyclic Citrullinated Peptide (CCP) antibodies

Numerical result reported with interpretation.

Found mainly in Rheumatoid arthritis and more specific than rheumatoid factor with approximately the same sensitivity. Diagnostically useful in acute arthritis, enabling rapid initiation of DMARD therapy but we strongly recommend use in acute arthritis

clinic rather than primary care. Patients with acute of arthritis of more than 3 week's duration should be referred to an acute arthritis clinic.

(Referred to Immunology dept)

DNA antibodies

Reported as Positive or Negative screen then numerical value by ELISA performed. Interpretation given on the report.

This test is confirmatory for most patients with SLE. Only double-stranded antibodies are detected and positive/strong positive results are diagnostic for SLE until proved otherwise. Only 60% of all patients with SLE have these antibodies in their serum hence a negative test does not exclude the diagnosis. Occasionally DNA antibodies may be found in patients with autoimmune chronic active hepatitis. The circulating half-life of IgG means that levels may not be that useful for monitoring disease activity on a short term basis; C3 and C4 levels provide a more useful guide.

Turnaround time = 7 days for screen.

Endomysial Antibodies

Reported as Positive or Negative.

This test is only performed if the IgA Tissue Transglutaminase (TTG) antibody is positive.

So far these antibodies have only been found in cases of coeliac disease / dermatitis herpetiformis and provide a specific test for these conditions. The test will be negative in patients with coeliac disease and IgA deficiency. For these reasons IgG deamidated gliadin assays are available.

Turnaround time = 10 days

Epidermal Antibodies

Reported as Positive (desmosome or basement membrane) or Negative.

Circulating antibodies to epidermal desmosomes are present in the majority of cases of pemphigus and antibodies reactive with the

basement membrane are found in cases of pemphigoid, epidermolysis bullosa aquisita and a minority of cases of herpes gestationis.

Turnaround time = 7 days

Extractable Nuclear Antigens (ENA)

Reported as Positive or Negative and typed if positive.

These antibodies generally give rise to speckled ANAs and recognise cellular antigens extracted by saline. Antibodies to ENAs are found in various connective tissue conditions as listed below. Patients with SLE or Sjögren's should be screened for ENA antibodies if considering pregnancy. Repeated testing for ENA is not indicated unless there is a change in symptoms. Levels do not indicate disease activity.

Ro (SSA): Sjögren's Syndrome (SS), SLE, congenital heart block, neonatal lupus, RA.

La (SSB) : SS, SLE, RA.

RNP: Mixed Connective Tissue Disease, SLE.

Sm: SLE.

Scl-70: Scleroderma.

Jo-1: Myositis, particularly with interstitial lung fibrosis.

The absence of an antibody does not exclude a clinical diagnosis, as ENAs are present only in a variable proportion of patients with the above disorders.

Turnaround time = 7 days for ENA screen; approximately 14 days for ENA characterisation.

Functional Antibodies (FAB)

Antibody levels reported as units/ml. Interpretation supplied with results.

Measurement of isotype-specific antibodies to tetanus toxoid, Strep. *pneumoniae*, and H.*influenzae* type b are available. These antibodies are protective and levels can be enhanced by immunization. The assays are of value in investigating:

- Patients, especially children, with recurrent bacterial sepsis; particularly of the upper and lower respiratory tract.
- Patients with invasive disease caused by the encapsulated organisms listed above.
- Patients undergoing splenectomy or having haemoglobinopathies.
- Patients with antibody deficiency states and in monitoring immunoglobulin replacement therapy.
- Immune reconstitution following BMT.

Interpretation of results and suggested follow up action, e.g. immunization with a relevant vaccine, is given on the report. Detailed clinical information and the patient's age are essential for the interpretation of results.

Functional C1 Inhibitor

Requires prior discussion with the laboratory/consultant prior to sending sample.
Inherited or acquired defects of this protein usually result in severe angioedema, which is a painless, non-itchy swelling of sub-dermal tissues and is life-threatening if the larynx is affected. Low levels are found in 85% of cases of Hereditary Angioedema. The remaining 15% of cases are associated with a non-functioning protein, and the functional assay is available to measure this. Acute attacks are treated by infusion of C1-inh concentrate or

Fresh Frozen Plasma. Clinical assessment by an Immunologist is strongly recommended where this diagnosis is suspected.

Clotted sample required by laboratory within 2 hours of venepuncture: please advise laboratory of expected sample.

(Referred to Immunology dept, Heartland's Hospital, Birmingham)

Ganglioside Antibodies

Reported as Positive (titre) or Negative.

A range of lower motor neuron neuropathies can be associated with the above.

(Referred to Immunology dept, Medical School, Birmingham)

Gastric Parietal Cell Antibodies (GPC)

Reported as positive or negative.

GPC antibodies have a strong association with pernicious anaemia and autoimmune gastritis. Low titres are commonly found in normal elderly females. If positive, testing for Intrinsic Factor antibodies will be carried out.

Turnaround time = 7 days

Glomerular basement membrane (GBM) antibody

Reported as positive or negative. Interpretation provided on the report.

Positive in Goodpasture's syndrome/anti-GBM disease. Contact the laboratory if an urgent result is required. Immunofluorescence of a renal biopsy is the suggested method of diagnosing anti-GBM disease in patients with rapidly progressive glomerulonephritis.

Turnaround time of screen = approximately 7 days

(Any equivocal, weak positives and positives are sent of for further testing).

Glutamic Acid Decarboxylase Antibodies (GAD)

Numerical result reported with interpretation.

GAD can help to differentiate Latent Autoimmune Diabetes in Adults from Type 2 diabetes and gestational diabetes and for risk prediction in immediate family members for Type 1. GAD antibodies are also seen in Stiff Man Syndrome.

(Referred to Immunology dept, Medical School, Birmingham)

Immunoglobulins/Serum protein electrophoresis

Age related normal ranges given with report.

Paediatric ranges given where appropriate.

Essential investigation for 'failure to thrive', recurrent infections and lymphoproliferative diseases including myeloma.

Polyclonally raised IgG can be a feature of chronic infections (notably HIV, TB and trypanosomiasis), connective tissue disease or liver disease.

Polyclonally raised IgA is also found in late stage HIV infection but more commonly associated with liver disease, especially alcoholic in origin.

Low levels always warrant further investigation as serious infective complications can occur. Reduced levels are found in many primary immunodeficiencies but secondary causes (e.g. nephrotic syndrome, lymphoproliferative disorders, and protein-losing enteropathy) are more common, especially in adults. IgA deficiency occurs in 1 in 800 of the population and may not be associated with disease (but can lead to reactions to blood and blood products). All cases of suspected primary immunodeficiency should be discussed with Consultant Immunologist in order that comprehensive investigations can be arranged.

Turnaround time 4 hours for immunoglobulins, 7 days for serum electrophoresis.

IgE (total)

Numerical result reported (KU/L).

Age related normal ranges given with report.

Total IgE may be helpful in diagnosing atopic disease. Total IgE levels may not be elevated even if specific levels are raised. IgE can also be raised in asthma, eczema, parasitic infestations, lymphoma, liver disease and the rare Hyper-IgE syndrome. Raised total IgE is not helpful in diagnosing type I IgE mediated allergy. Specific IgE tesing is more useful.

See Specific IgE testing.

Turnaround time = approximately 5 days.

IgG subclasses

Numerical result reported (g/L). Age related normal ranges given with report.

Measured in cases of suspected antibody deficiency such as patients with recurrent respiratory infections and in cases of severe infection by encapsulated bacteria. Functional antibody levels should also be performed on these patients. Low sub-class levels may not be reflected in low levels of total IgG.

Intrinsic Factor (IF) Antibodies.

Reported as a value with interpretation.

Present in the majority of patients with pernicious anaemia. The presence of IF antibodies virtually excludes other causes of vitamin B12 deficiency. IF antibodies are very rarely found in the absence of GPC antibodies and will not be tested for in GPC negative patients unless B12 deficiency has been demonstrated. IF antibodies are not indicated if the Vitamin B12 level is not low.

(Referred to Immunology dept)

Leukocyte Marker Studies

Report with results.

The principal indications for these tests are haematological malignancy and immunodeficiency either primary or secondary (including known HIV infection). The range of available markers is extensive so it is essential to give as much clinical detail as possible in order that appropriate analysis is performed. Requests for the investigation of haematological malignancy should be addressed to Haematology whilst those for immunodeficiency must be arranged through the Immunology Department.

WBC and differential should be performed at on the same day, as this is essential for correct reporting. An EDTA sample is usually required.

These tests cannot be analysed after 12.00 on Friday as storage can give artefactual results.

(Referred to Immunology dept, Medical School, Birmingham)

Lymphocyte Function Analysis

Report with results.

Tests of lymphocyte function are available in cases of suspected primary immunodeficiency on discussion with consultant Immunologist in the Immunology Department. These tests are particularly relevant in cases of recurrent viral or fungal infection, which are not associated with an overt cause such as HIV infection.

These tests can only be performed by prior arrangement and collection details will be given at this time.

(Referred to Immunology dept, Medical School, Birmingham)

Mast Cell Tryptase

Numerical result reported. Normal range: 2 - 14 mg/l.

This enzyme is released from mast cells during anaphylactic and anaphylactoid reactions. It remains stable after venepuncture. Levels peak at around 6 hours after a reaction and return to normal within 24 hours. Raised basal levels suggest systemic mastocytosis. See Investigation of anaesthetic reactions.

(Referred to Immunology dept)

Mitochondrial Antibodies (AMA)

Reported as Positive or Negative.

Present in the vast majority of patients with Primary Biliary Cirrhosis and commonly associated with a polyclonal elevation in IgM. Also seen in connective tissue disease e.g., Sjogren's Syndrome, scleroderma, and rheumatoid arthritis.

Turnaround time = 7 days

Myeloperoxidase Antibodies

Numerical result reported. Negative <3 iu/ml, Equivocal 3.5 - 5, Positive >5.

Found in MPA, Churg- Strauss syndrome and infrequently in Wegner's Granulomatosis and some other systemic vasculitides.

(Referred to Immunology dept)
Neutrophil Function Analysis

These tests are useful in diagnosing uncommon primary neutrophil defects that usually present in childhood with recurrent deep-seated bacterial or fungal infections and poor wound healing. These tests can only be performed after prior arrangement with the department.

(Referred to Immunology dept, Medical School, Birmingham)

Oligoclonal Banding

Restricted IgG bands are seen in the CSF of cases of multiple sclerosis, neurosarcoidosis, syphilis, SSPE and CNS lymphoma but not in serum. IgG bands can also be seen in SLE hence a serum sample is required to run in parallel as in SLE bands are present in serum and CSF.

(Referred to Immunology dept, Medical School, Birmingham)

Pancreatic Islet Cell Antibodies

Reported as Positive and Negative.

Usually present in type I diabetes mellitus at presentation but their main use is in predicting IDDM in siblings of affected patients. The persistence of these antibodies is often found in diabetes mellitus that is associated with polyendocrine disease.

(Referred to Immunology dept, Medical School, Birmingham)

Paraneoplastic antibodies

Reported as Positive (titre) or Negative.

A range of autoantibodies that can be seen in neurological conditions associated with neoplasia are available. Advice from a consultant neurologist should guide testing.

(Referred to Immunology dept, Medical School, Birmingham)

Paraprotein Measurement

Performed by the Immunology Department at Dudley. Please send a clotted blood for analysis.

Paraproteins are detected on electrophoresis of serum and are found in most cases of myeloma and some cases of other B-cell tumours. They can also arise in immunocompromised patients in instances of infection.

Low levels of paraprotein are seen in up to 20% of patients over the age of 75 years. Measurement is useful for monitoring the treatment of myeloma and other lymphoid malignancy where a paraprotein is present. For the diagnosis of myeloma, blood and urine samples must be sent.

PR3

Numerical result given. Negative <2, Equivocal 2-3, Positive >3 IU/ml.

PR3 antibody is a marker for Wegener's granulomatosis and is occasionally detected in microscopic polyarteritis. The quantity of PR3 antibody is generally parallel to disease activity.

(Referred to Immunology Dept, Dudley Hospital)

Specific IgE TESTS

Reported in units (kU/L) and Graded 0 (Negative) and 1-6 (Positive).

Specific IgE tests are available for a wide range of allergens, but must be interpreted in light of the history. Clinical details and suspected allergens must be stated on the request.

In cases of drug sensitivity (e.g. antibiotic, anaesthetic agents) it is advisable to discuss the case with the Consultant. Specific IgE to penicillin is very specific and therefore is suggestive of penicillin allergy when positive. It is, however, not very sensitive and therefore may be negative in truly allergic individuals.

ON NO ACCOUNT SHOULD A CLINICAL CHALLENGE WITH AN AGENT SUSPECTED OF CAUSING ANAPHYLAXIS BE UNDERTAKEN WITHOUT FULL RESUSCITATION EQUIPMENT AND TRAINED STAFF AT HAND.

(Referred to Immunology dept)

Rheumatoid Factor (RF)

Numerical result reported. Normal <20 IU/mL.

Only >40 is likely to be significant.

In Rheumatoid Arthritis, the presence of a high titre RF at onset is of some predictive value as these patients have a worse prognosis than seronegative patients. Low titres may be found in normal elderly people and in cases of viral infection, chronic bacterial infections, connective tissue disease, and lymphoproliferative disorders and are of low diagnostic value. This test is of no value in monitoring RA. A negative test for RF can be helpful in the differential diagnosis of rheumatic diseases as they are not usually detected in rheumatic fever, gout, Reiter's syndrome, ankylosing spondylitis, osteoarthritis, psoriatic arthritis and Juvenile Chronic Arthritis.

Turnaround time = ~4 hours.

Salivary Gland Antibodies

Not available: ENA antibodies are a more sensitive test for Sjögren's Syndrome.

Smooth Muscle Antibodies (SMA)

Reported as Positive or Negative.

Present in up to 75% of cases of autoimmune chronic active hepatitis. Low titre antibodies are found in a few patients with other liver diseases such as viral hepatitis, cholelithiasis and in infections.

Turnaround time = 7 days

Striated Muscle Antibodies

Not available: Acetylcholine receptor antibodies are a more specific and sensitive test for myasthenia gravis.

Thyroid Peroxidase (TPO) Antibodies

Numerical result reported. Normal <34 IU/ml.
Present almost exclusively in cases of autoimmune thyroid disease (Grave's disease, Hashimoto's thyroiditis and primary myxoedema). These antibodies can be present without overt thyroid dysfunction in cases of autoimmune polyendocrine disease.

Turnaround time = 4 days.

Tissue Transglutaminase (IgA) Antibodies (TTG)

Numerical result reported.

Negative <7 U/ml

Equivocal 7-10 U/ml

Positive >10 U/ml

Tissue transglutaminase is the major autoantigen in coeliac disease. IgA antibodies against TTG are highly disease specific serological markers for coeliac disease and dermatitis herpetiformis. The test will be negative in patients with coeliac disease and IgA deficiency. For these reasons IgG gliadin antibodies are available on specific request. Weak levels without associated endomysial antibodies are seen in liver disease.

Positive TTG results will be confirmed with the anti-endomysial antibody test.

Turnaround time = 7 days

Tissue Transglutaminase (IgG) Antibodies

Numerical result reported with interpretation.

This assay can be used in patients who are IgA deficient and where coeliac disease is suspected. In cases where the Total IgA level is <0.05 g/l, the IgA TTG test can be negative and an IgG TTG test is suggested.

This test is only available when specifically requested.

(Referred to Immunology Dept)

Urine Electrophoresis

Reported as normal or abnormality described.

Used to detect urinary free monoclonal light chain associated with myeloma and some cases of lymphoma. Polyclonal free light chains may occur in the urine of healthy normal individuals and in patients with chronic infections or inflammatory disease such as Rheumatoid Arthritis.

(Referred to Immunology Dept)

Suggested test profiles for particular conditions

Medical and laboratory staff are always happy to discuss suitable tests for various circumstances. Given below are some recommended test profiles that can be of help in diagnosing or excluding the listed conditions. All cases of suspected primary immunodeficiency, angioedema and anaphylaxis should be discussed with the consultant.

Diagnosis of Immunodeficiency

The pattern of infections provides the largest degree of help in diagnosing immunodeficiency:

Bacterial infections, particularly with encapsulated organisms, suggest antibody or complement deficiency. Useful initial investigations are Immunoglobulins, FAB, CH50.

Viral and/or fungal infections suggest a T cell abnormality. Useful initial investigations are a lymphocyte count, Immunoglobulinss, FAB. Lymphocyte function tests and surface markers are required to fully assess T cell immunity and are available only by prior arrangement with Consultant Immunologist.

Staphylococcal skin sepsis, deep-seated fungal infections, poor wound healing and severe periodontal problems suggest a neutrophil abnormality. Neutrophil function tests and surface marker analysis are required to fully assess neutrophil activity and are available only by prior arrangement.

Diagnosis of SLE and other connective tissue disorders

SLE should be considered as a potential cause of symptoms such as small joint arthropathy and rashes or symptoms of serositis (e.g. unexplained pleuritic chest pain, mouth ulcers). Useful initial investigations are ANA, RHF, and ESR. Patients with a significantly positive ANA will automatically be screened for DNA and ENA antibodies. It is recommended that the advice of a Consultant Rheumatologist be sought in cases where a connective tissue disorder is suspected.

Women with SLE who are or are likely to become pregnant should be checked for Cardiolipin antibodies, Ro (SSA) antibodies and La (SSB) antibodies.

Monitoring of patients with SLE:

Tests that are of use in monitoring patients with SLE include ESR, C3, C4 and DNA as well as FBC and renal function assessment.

Investigation of renal failure

Immunological investigations of value in assessing patients with renal failure include ANA, C3, C4, Igs, CRP, cryoglobulins and ANCA if the cause is not apparent. Other tests available are GBM antibodies and C3 nephritic factor (the latter is indicated in cases of a low C3).

Investigation of severe angioedema

It is advisable to seek clinical assessment by an Immunologist in all cases of severe angioedema. C1 inhibitor deficiency needs to be excluded by testing for C1 inhibitor and C4 levels. Severe urticaria is

never associated with C1-inh deficiency and only associated with raised IgE levels in a minority of cases. Type I ACE inhibitors are a well-recognized cause of angioedema.

Investigation of vasculitis

If a diagnosis of vasculitis is suspected, then it is advisable to ask for a clinical assessment by a physician experienced in managing this group of disorders. Laboratory investigations are of limited value in arriving at a diagnosis but investigations which may be of some use include CRP, ANCA, ANA, RF, C3, C4, Immunoglobulins, and cryoglobulins.

Allergy Testing and Specific IgE

The department offers a skin prick testing service for common inhalant and food allergies by appointment on Mondays. Appointments can be made by contacting the laboratory directly or sending in a referral. An appointment will then be sent out to the patient.

Specimens may be taken for total IgE and Specific IgE if it is felt that this is indicated from the results of the skin prick test.

NB: If a request for Specific IgE tests is received by the department without prior skin prick testing the specimen will be separated and divided into two aliquots, one of which will be analysed for total IgE and the other stored at -70°C, to await the result. The Specific IgE is an expensive investigation and can produce false positive results at high total IgE levels. If the total IgE level is >2000 IU/ml the patient can be considered atopic. An IgE >2000 IU/ml may lead to false positive results and should be viewed with caution.

Specialist Tests

Specialist tests are expensive and are only available after discussion with a Consultant from the relative specialty.

Neurology:

- Aquaporin 4 Abs (or 'NMO' Abs)
- Basal Ganglia Antibody
- Interferon Neutralising Antibody
- MUSK Antibody
- Neuronal Antibody
- NMDA Antibody
- Voltage Gated Calcium Channel Antibody
- Voltage Gated Potassium Channel Antibody

Immunology:

- C1q
- C4 genotyping
- Diptheria Antibody
- ISAC (CRD):
- IgE testing against an array of purified allergens is available when history and conventional IgE testing does not provide sufficient information for patient management eg there is no history of recent exposure to suspected allergic triggers. This test is available with prior discussion with a Consultant Immunologist and will be charged to the appropriate directorate.
- Lymphocyte surface markers
- MBL genotyping
- Meningococcal Antibody
- Neutrophil function tests
- Pneumococcal serotypes

Metabolic Medicine:

- Ovarian Antibody
- Parathyroid Antibody
- Testes Antibody
- Thyroglubulin Antibody

Miscellaneous:

- Histone Antibody

Specimen requirements for specialist Immunology requests.

Request	Specimen
Aquaporin 4 Antibody (NMO Antibody)	Clotted
Basal Ganglia Antibody	Clotted
C1q	Clotted
Diptheria Antibody	Clotted
Histone Antibody	Clotted
Interferon Neutralising Antibody	Clotted
ISAC (CRD)	Clotted
MUSK Antibody	Clotted
Neuronal Antibody	Clotted
Meningococcal Antibody	Clotted
NMDA Antibody	Clotted
Ovarian Antibody	Clotted
Parathyroid Antibody	Clotted
Pneumococcal serotypes	Clotted
Testes Antibody	Clotted
Thyroglubulin Antibody	Clotted

Request	Specimen
Voltage Gated Calcium Channel Antibody	Clotted
Voltage Gated Potassium Channel Antibody	Clotted
C4 genotyping	EDTA x 2
MBL genotyping	EDTA x 2

The below tests need urgent handling:

After taking the specimen it should be sent to Pathology Specimen Reception as soon as possible.

On receipt, the specimen should go directly for analysis.

Request	Specimen
Lymphocyte surface markers (CD3/CD4CD8, LFA markers etc) (B, NK, memory markers etc)	EDTA x 2
Lymphocyte proliferation test (Lymphocyte stimulation/ function)	Lithium Heparin
Neutrophil function tests (Respiratory burst)	Lithium Heparin
CH50/APH50	Clotted (frozen immediately after separation)
C1 inhibitor function	Clotted (frozen immediately after separation)

Transfusion Services

Introduction

The primary purpose of this department is the provision of safe, compatible blood and blood components for transfusion.

Blood Products

Red Blood Cells

The preferred product supplied for adult transfusion is packed red cells in a CPD anticoagulant additive solution (volume approx. 250-300 ml per unit). This replaces whole blood or concentrated cells, which are no longer routinely available. The laboratory stocks all blood groups with the exception of Group AB RH D Positive, the volume of each group corresponding to the prevalence of the blood group in the regional population; AB Rh D Positive Patients are provided with AB Rh D Negative blood, this is to reduce stock wastage. The shelf life of a standard bag of red cells is approximately 30 days.

Blood for neonatal and paediatric transfusion is also kept in stock however, blood for exchange purposes is not. This is available on request but there will be a short delay before issue as it will need to be delivered from the National Blood Service Centre in Birmingham. Only blood group O RhD Negative is kept in stock for neonates due to low demand, though this is suitable for all groups. All units are also irradiated in case of intra-uterine transfusion history.

Plasma

A stock of fresh frozen plasma is held in the department, stored at -25°C. The laboratory stocks all blood groups, the volume of each group corresponding to the prevalence of the blood group in the regional population. The stock is kept frozen to improve the shelf life of the product, which can be up to two years. Once thawed, the shelf life reduces dramatically to 24 hours (refridgerated) and 4 hours (un-refridgerated) respectively. There will be an inevitable delay between request and supply while the plasma is thawed, which is approximately 30 minutes.

Plasma for neonatal and paediatric patients is available on site. Plasma for these patient groups is now sourced from the USA and is treated with methylene blue as part of a vCJD risk reduction strategy.

For patients born after 01/01/1996, Octaplas will be issued instead of standard FFP. Octaplas is a solvent-detergent treated FFP (SD-FFP) and is also used as a precaution to reduce transfusion transmission of prion-associated diseases. SD-FFP is recommended for plasma exchange in patients with thrombotic thrombocytopenic purpura (TTP).

Plasma is no longer the preferred therapy for treating warfarin reversal, please see Octaplex.

Cryoprecipitate

A small stock of pooled cryoprecipitate (volume approx. 150-200ml per unit) is held in the department, stored at -25°C. Cryoprecipitate is available in all blood groups. The stock is kept frozen to improve the shelf life of the product, which can be up to two years. Once thawed, the shelf life reduces dramatically to 24 hours (refrigerated) and 4 hours (un-refrigerated) respectively. There will be an inevitable delay between request and supply while the cryoprecipitate is thawed, which is approximately 30 minutes.

Platelets

The life span of platelets is short and therefore no stock is maintained by the department, appropriate units are ordered in as required for individual patients on a day to day basis. The department receives regular routine deliveries from the NHS Blood and Transplant Centre in Birmingham, so all routine requests will arrive via this route (see times below). Urgent requests for platelets will still need to be delivered from Birmingham, so there will be an inevitable delay between request and supply. Requests for multiple bags of platelets must be made through the Consultant Haematologist.

Human Albumin

Stocks of 20% (100ml volume) and 5% (100ml volume) human albumin are maintained by the department. This will only be issued on receipt of a written or order-comms request (X-Match form).

Anti-D Immunoglobulin

Anti-D immunoglobulin is used to prevent RhD negative women of child-bearing age becoming sensitised to RhD positive red blood cells. This is to protect a RhD baby's red blood cells either during the current or future pregnancies. Stocks of 1500IU are maintained in the department and are available on request.

Factor VIII (Haemate)

Haemate is used to prevent or to stop bleeding caused by the lack of von Willebrand factor and factor VIII (Haemophilia). Haemate is not stocked in the department but is available on request from the Haemophilia Centre, Birmingham. Haemate can also be used in the management of acquired factor VIII deficiency and for treatment of patients with antibodies against factor VIII.

FEIBA (Factor VIII inhibitor bypassing activity) is another product that can be used to control bleeding in haemophilic patients who have developed inhibitory antibodies against factor VIII or IX.

Prothrombin Complex Concentrate (Octaplex)

Octaplex is made from human plasma and contains human coagulation factors II, VII, IX and X. It is used for the prevention (during surgery) and treatment of bleeding caused by the acquired or congenital lack of vitamin K-dependent coagulation factors, particularly those caused by warfarin overdose. Stocks of 250IU and 500IU are kept in the department and are available on request. All issues of Octaplex will be referred to the Consultant Haematologist for approval. An Octaplex dose calculator is available on the ICE ordering system and administration advice can be obtained from the laboratory.

Novoseven

Recombinant activated factor VII (Novoseven) is indicated for the prevention of bleeding in surgical interventions or treatment of bleeding episodes in haemophilia A or B patients with inhibitors to FVIII or FIX, patients with acquired haemophilia or patient with congenital FVII deficiency. A small stock is held on site which is available on

request. All issues of Novoseven will be referred to the Consultant Haematologist for approval.

Request Forms for Blood Transfusion

The blood transfusion department operates a strict sample acceptance criteria in line with current BCSH guidelines.

The Blood Transfusion Department will accept either order comms request forms or standard pink blood transfusion request forms. Order comms request forms must be printed off and signed by the requesting clinician. Standard pink request forms must be completed in full and signed by the requesting Doctor or Nurse. The following patient information must be completed:

(a) Surname (correctly spelt)

(b) First name (correctly spelt)

(c) Date of birth

(d) Gender

(e) Hospital identification number/NHS number

(f) Address

(g) Consultant

(h) Ward or department

(i) Date and signature of person taking the sample

Pre-printed labels may be used on the request form but must be present on all three copies. Full demographics are required to minimise the risk of patients with the same or similar names being given the incorrect blood component. Any incomplete or incorrectly labelled forms or specimens will not be accepted. Details on the request form must match the enclosed blood sample.

The following clinical information is required on the request form:

(a) Diagnosis/ Reason for request; this should include details of any surgical procedure

(b) Number and type of components requested

(d) Any special requirements, such as irradiated, CMV negative or HbS negative

(e) If group and screen only

(f) Date and time required

Requests for infant cross-matching (four months or younger), should ideally be made on a paediatric cross-match form, as they carry infant and maternal details. If requested on order comms, please place a request for the infant and a group and screen request for the mother. Please state the volume of any product required.

For AAE requests for patients whose details are unknown or incomplete, the following data is required at minimum:

1. Casualty number (111….)
2. The words 'UNKNOWN MALE' or 'UNKNOWN FEMALE'
3. Date and signature of person taking the sample

This information must be present on both the specimen and form.

All requests for blood transfusion should be sent directly to the laboratory and not left at specimen collection points.

Specimens Required

All samples for the Blood Transfusion Department should be completed in full by hand, signed and dated at the bedside by the person collecting the sample.

PRE PRINTED LABELS MUST NOT BE USED ON BLOOD SAMPLES FOR BLOOD TRANSFUSION.

TEST	SAMPLE REQUIREMENTS
Group and screen / crossmatch	1 x 6ml EDTA (pink) For adult transfusion, 4 ml of blood For infants transfusion, 1 ml of blood For neonatal transfusion (under 4 months of age) 4 ml of maternal blood with 1 ml of blood from neonate. For patients known to have complex transfusion needs, please send two full cross-match tubes.
Ante-natal Kleihauer	1 x 6ml EDTA (pink)
Delivery Kleihauer	Mother - 1 x 6 ml EDTA (pink) Infant cord - 1 x 6 ml EDTA (pink)
Cold agglutinin screen	1 x 4 ml EDTA (purple) completed by hand, signed and dated.
DAT	1 x 4 ml EDTA (purple)
Transfusion Reaction Investigation	1 x 6ml EDTA (pink) post transfusion. Also take samples for FBC, PT/APTT, U&E, LFT and urine sample.
Red cell antibodies	2 x 6ml EDTA (pink)
HLA B27	2 x 4 ml EDTA (purple)
Heparin-induced thrombocytopenia (HIT) test	6ml EDTA (purple) and 6 ml clot (red)
Neonatal alloimmune thrombocytopenia (NAIT)	Maternal: 3 x 6ml EDTA and 6ml clot Paternal: 3 x 6ml EDTA Neonate or cord blood, if possible: 1 ml EDTA

Investigations for white cell or platelet antibodies will only be referred to the National Blood Service after discussion with the Consultant Haematologist. For individual tests not listed here, please contact the blood transfusion laboratory for specimen requirements.

Routine Requests for Transfusions / Group and Screen

Wherever possible, requests should arrive in the department allowing at least one full working day for the work to be carried out in case any irregularities are found. If it is planned to admit a patient for routine surgery then specimens should be sent to the department well in advance of admission if possible e.g. on the day the patient is seen in pre-assessment clinic.

Two Sample Rule

In line with current BCSH guidelines, two samples will be required to determine the blood group of a patient before a crossmatch is released.

- If a patient has a historical blood group on record, just one sample for the current request is required.
- If a patient has no blood group on record, two samples (with two request forms) are required. These samples should be taken by two different people, or if bled by the same person must be taken 30 minutes apart.
- In life-threatening cases where there is insufficient time to take a second sample, only O RhD Negative (females under 60 years) or O RhD Positive (males and females over 60 years) blood will be issued until a second blood group sample is received.

Sample Timing

The validity of a sample for use in transfusion depends on the history of the patient. If a patient is pregnant or has received a transfusion recently, the patient may have developed clinically significant antibodies. We therefore need a sample much closer to the transfusion date to ensure we have the most up to date information for cross-matching.

- For patients transfused or pregnant within the previous 3 months, a fresh sample must be taken within 72 hours of the next transfusion.
- For all other patients, a fresh sample is required up to 7 days before the next transfusion.

Samples for all routine group and screens will be stored for 7 days before discard.

Urgent Requests for Transfusion

For all urgent requests or requests where a full working day's notice cannot be given, the requesting Medical Officer must telephone the department to explain the degree of urgency in order that other routine matching can be re-scheduled.

Location of Blood Banks

Matched blood will be found in one of the following places:

1. In the Pathology Laboratory Issue Blood Bank prior to removal to satellite issue banks, on route 021.
2. West Wing satellite blood bank on the hospital corridor, level 2 of the West Wing. For AAE, West Wing and Modular Block patients.
3. Maternity satellite blood bank located on Delivery Suite. For Maternity and NNU patients.

Locations 2 and 3 each contain 2 units of O RhD negative 'Flying Squad' blood for emergency use.

Tests Performed by Laboratory

Group and screen

A group and screen (previously known as group and save) is performed if a patient is at risk of bleeding. The sample is tested for blood group and a general antibody screen, and held in the department for use in the event that blood is required.

Crossmatch

The majority of red cells issued from the department are cross-matched. This involves taking a sample of blood from the donor bag and incubating it with the patient sample, to ensure each donor bag is a perfect match. When a cross-match is requested, a blood group and antibody screen are also performed.

Type Specific Blood Issue

In an emergency scenario, type specific blood can be issued from the department in 10-15 minutes. A sample must be sent to the laboratory immediately, and a blood group will be performed. Donor bags of the patient blood group will then be released, and cross-matched retrospectively. Type-specific blood is still unmatched, but should be switched to once the patient blood group is determined.

Flying Squad Blood Issue

Flying squad blood is unmatched O RhD negative blood which is held around the hospital site in the satellite blood banks. Flying Squad blood should only be used when there is insufficient time to determine the blood group of the patient. Once the blood group of the patient is known 'type specific' unmatched blood can be issued. When units of flying squad are removed from the blood bank, the staff in the Blood Transfusion department MUST be informed immediately. Fresh units will be issued and placed in the appropriate blood bank as soon as possible to replace the removed units.

Flying squad blood is located:

- 2 adult units in West Wing satellite blood bank on the hospital corridor, level 2 of the West Wing.
- 2 adult units in Maternity satellite blood bank located on Delivery Suite.

The administration of blood and blood components is the responsibility of the medical and nursing staff. Before commencing blood transfusion, ALL details on the bag label must be confirmed with the patient wristband to ensure that they are correct and pertain to the patient concerned. This must be performed by a member of staff who has completed their blood transfusion administraton training.

ANY DISCREPANCIES MUST BE RESOLVED BEFORE TRANSFUSION COMMENCES

Kleihauer

The kleihauer test is an acid elution technique used to quantitate feto-maternal haemorrhage. Is is performed on RhD negative mothers for potentially sensitising episodes, and at delivery, to determine if prophylactic anti-D is required.

Direct Antiglobulin Test (DAT)

The department offers a polyspecific and a monospecific direct antiglobulin test. The direct antiglobulin test (also known as the direct Coombs test) is used to detect if antibodies or complement system factors have bound to red blood cell surface antigens in vivo. The DAT is used primarily to help diagnose haemolytic anaemia, a condition in which red blood cells (RBCs) are being destroyed more quickly than they can be replaced, due to antibodiesattached to RBCs. The cause may be an autoimmune disorders such as systemic lupus erythematosus, malignant diseases such as lymphoma and chronic lymphocytic leukemia, and infections such

as mycoplasma pneumonia and mononucleosis. It can also occur in some people with the use of certain medications, such as penicillin. A DAT is used to help diagnose haemolytic disease of the newborn (HDN) due to an incompatibility between the blood types of a mother and baby, and is also used to investigate a suspected transfusion reaction.

Cold Agglutinins

The department offers a test to screen for cold agglutinin disease. Cold agglutinin disease is an autoimmune disease characterized by the presence of high concentrations of circulating antibodies, usually IgM, directed against red blood cells. It is a form of autoimmune haemolytic anaemia, specifically one in which antibodies only bind red blood cells at low body temperatures, typically 28-31°C. Specimens received for cold agglutinin analysis will be subjected to an investigation of haemolysis, samples with a positive DAT will be forwarded to the RCI Laboratory at Birmingham NBS, where antibody titre levels are also performed.

NHS Blood & Transplant Referrals

Red Cell Antibody referral

Patients can develop red cell antibodies through transfusion or pregnancy. These red cell antibodies need to be identified to enable the issue of compatible blood.

NAIT

Neonatal allo-immune thrombocytopenia (NAIT) is caused when there are genetic differences between the foetal and maternal platelet antigens, and the mother has developed platelet antibodies, resulting in thrombocytopenia in the neonate.

HIT test

Heparin-induced thrombocytopenia (HIT) is the development of thrombocytopenia (a low platelet count), due to the administration of various forms of heparin, an anticoagulant.

HLA B27

HLA B27 is a blood test to look for a specific protein found on the surface of white blood cells. The HLA-B27 test is primarily ordered to help strengthen or confirm a suspected diagnosis of ankylosing spondylitis, reactive arthritis, juvenile rheumatoid arthritis, or sometimes anterioruveitis.

Donor HLA Typing

All specimens for donor HLA typing are referred to NHS Blood and Transplant, Birmingham. Specimen requirements vary and should be discussed with the laboratory when HLA typing is being arranged.

Deliveries from NHS Blood & Transplant

The department has two routine deliveries every day, Monday to Friday. The deliveries arrive at 12 pm (orders must be in by 9 am), and 4:30 pm (orders must be in by 1 pm). There is a facility for ad-hoc orders, but this will result in additional cost to the Trust and should be avoided for non-urgent cases.

Transfusion Reactions

Most blood transfusions go very smoothly. However, mild problems and, very rarely, serious problems can occur.

Acute Haemolytic Reaction

Acute immune haemolytic reaction is very serious, but also very rare. It occurs if there is a mismatch between the patient blood group and that

of the donor. The transfused red blood cells will be haemolysed in vivo, and the by-products damage the kidneys.

The symptoms include chills, fever, nausea, pain in the chest or back, and dark urine. The transfusion must be stopped at the first sign of this reaction.

Allergic Reactions

Allergic reactions to the blood given during transfusions can happen even when the blood given is the right blood group.

Allergic reactions can be mild or severe. Symptoms can include:

- Anxiety
- Chest and/or back pain
- Trouble breathing
- Fever, chills, flushing, and clammy skin
- A quick pulse or low blood pressure
- Nausea (feeling sick to the stomach)

The transfusion should be stopped at the first signs of an allergic reaction. The health care team should determine how mild or severe the reaction is, what treatments are needed, and whether the transfusion can safely be restarted.

Delayed Haemolytic Reaction

This is a haemolytic reaction occurring more than 24 hours after transfusion. It may be caused by an antibody which is undetectable to routine blood bank screening. Symptoms occur usually within 1-14 days of transfusion.

Additional information on different types of transfusion reaction and Transfusion transmitted infections

On suspecting a blood transfusion reaction, contact the blood bank immediately. You will be required to send to the laboratory:

1. The remnants of all bags of blood or products given to the patient, spigotted in a sterile manner and giving times of administration.
2. Venous samples for full blood count, PT/APTT, LFT, U&E taken away from the site of transfusion.
3. The first urine voided by the patient after the incident.
4. Completed transfusion reaction investigation form.

For advice on the clinical management of the patient, please contact the Consultant Haematologist.

Acute Transfusion Reaction Management FlowChart

http://www.transfusionguidelines.org/docs/pdfs/htm_edition-4_all-pages.pdf p74

Information on different types of transfusion reaction and Transfusion transmitted infections

http://www.transfusionguidelines.org/docs/pdfs/htm_edition-4_all-pages.pdf p72

Haemovigilance

All transfusion reactions must be reported to the Blood Bank for haemovigilance monitoring. The Blood Bank is responsible for alerting the MHRA SABRE (Serious Adverse Blood Reactions and Events) and SHOT (Serious Hazards of Transfusion) of all incidents relating to the blood transfusion, from the initial sample being taken to the administration of the blood product.

Patient consent

As with all treatments, a blood transfusion should only be prescribed when necessary. The risks of having a transfusion need to be balanced against the risk of not receiving one. The clinician should discuss treatment options with the patient before reaching a decision to prescribe blood components. You should give the patient information on the benefits and risks of transfusion as well as any alternatives. Consent and the reason for transfusion should be documented in the patient record.

Patient information leaflets are available from the National Blood Service website

www.blood.co.uk/hospitals

Patients who do not Consent to Transfusion

Clinical Practitioners must be aware of Jehovah's Witness patients' beliefs in relation to receiving blood or blood products and of the non-blood, medical alternatives to transfusion that may be applicable.

Jehovah's Witnesses are encouraged to always carry a document which details their wishes about medical care. Please forward a copy of this directive to the blood bank to ensure the patient's wishes are strictly honoured.

Please see Trust policy for patients refusing blood products.

Transfusion Alternatives.

For further details on the alternatives to transfusion, including cell salvage, please contact the Transfusion Laboratory or the Transfusion Practitioner who will be happy to discuss any individual cases.