Biochemistry User Handbook

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Contents

1. Introduction

1.1 General Information

King's College Hospital was originally opened in 1840 and moved to the Denmark Hill site in 1909. It became part of the NHS in 1948 as a teaching hospital. Following the dissolution of South London Healthcare Trust, King's took over the Princess Royal University Hospital (PRUH) in October 2013.

King's College Hospital NHS Foundation Trust is a large provider of acute and specialist services that serves a population of over 1,000,000 in the economically diverse Greater London boroughs of Southwark, Lambeth, Bromley and Bexley. The trust operates from 5 sites; Denmark Hill (main) site, Princess Royal University Hospital (PRUH) Bromley, Beckenham Hospital, Queen Mary's Hospital Sidcup and Orpington Hospital. The PRUH is in Farnborough, near Orpington, Kent. Beckenham Hospital is about 6 miles to the north of the PRUH and provides outpatient services. Orpington Hospital is 3 miles south of PRUH and provides outpatient services and has 40 intermediate care beds.

The Trust has over 1300 beds including 1050 acute, 125 maternity and 144 critical care beds. The Denmark Hill site has approximately 836 beds including a major critical care service (122 beds) and maternity services (103 beds). Princess Royal University Hospital has 455 acute beds, 22 critical care and 22 maternity beds (plus a midwifery led birthing centre) whilst Orpington provides 29 acute beds. Emergency Department services are provided at both King's College Hospital Denmark Hill and Princess Royal University Hospital.

All core services are provided from King's College Hospital Denmark Hill and Princess Royal University Hospital while outpatient and surgical services are provided from Orpington Hospital.

Synnovis King's College Hospital laboratories are accredited to ISO 15189:2012 Standard by the United Kingdom Accreditation Service (UKAS).

Each department undergoes regular assessments by UKAS to demonstrate that the quality system in place provides a service that meets recognised quality standards (ISO 15189:2012 Standard).

The Blood Sciences Laboratory (BSL) at King's Denmark Hill (DH) undertake routine Biochemistry investigations, which include renal, liver and bone function tests, endocrine analysis and some tumour marker testing.

A list of BSL Biochemistry accredited tests can be found on our schedule of accreditation available on the UKAS website. Copy and paste the link below into your search engine:

https://www.ukas.com/wp-content/uploads/schedule_uploads/00007/9067%20Medical%20Single.pdf

The list can also be found by entering the department's accreditation number (9067) in the search bar of the UKAS website https://www.ukas.com/search-accredited-organisations

This Handbook includes information on:

- Contact details for key staff
- Service levels and hours of operation
- Location of services
- Types of investigation offered
- Types of specimens required and collection conditions.
- Instructions for collecting specimens with a particular emphasis on safety and maintenance of sample validity.

Should any service user have any queries in connection with any aspect of the BSL Biochemistry service, contact should be made with the relevant departmental senior staff, the Operations Manager, Service Delivery Manager or the Department's Quality Manager.

This Biochemistry User Handbook should be user-friendly and intuitive. Suggestions for improving the content for the next edition are welcome.

1.2 Pathology Laboratory

The Blood Sciences Laboratory department includes the following specialties:

Blood Sciences:

- Biochemistry
- Haematology / Haemostasis
- Blood Transfusion

Access to all areas of the Blood Sciences department is restricted to authorised staff only. All entrances into the department are secured by digi-lock or proximity pass access.

The department operates in compliance with the standards laid out by ISO 15189:2012.

The laboratories are registered for training with the Institute of Biomedical Sciences (IBMS).

The qualified health professionals (Biomedical Scientists and Clinical Scientists) employed in the department are registered with the Health and Care Professions Council (HCPC) meeting the standards for their respective training, professional skills, behaviour and health.

1.3 Key personnel and contact details

For Denmark Hill Biochemistry Results phone Customer Services on:

0204 513 7300

For Denmark Hill switchboard dial

020 3299 9000.

Clinical Lead		
Dr Royce Vincent Consultant Chemical Pathologist Royce.vincent@nhs.net 020 3299 4100		
Biochemistry Core Laboratory Scientific Staff		
Name	**Designation**	**Contact details**
Dr Katharine Bates	Consultant Clinical Scientist	020 3299 3726/01689 864282 katharine.bates@nhs.net
Victoria Treasure	Principal Clinical Scientist	020 3299 3726/01689 864282 victoria.treasure@nhs.net
Phil Crook	Senior Clinical Scientist	020 3299 5168 Philip.crook@nhs.net
Devon Buchanan	Senior Clinical Scientist	Devon.buchanan@nhs.net
Duty Biochemist (for clinical advice) Mon-Fri 9:00-5:30 Out of hours contact the on-call Consultant Chemical Pathologist through the Denmark Hill switchboard.		020 3299 0359 kch-tr.biochemistryresults@nhs.net

Biochemistry Core Laboratories Operations Staff		
Name	**Designation**	**Contact details**
Ian Roney	Service Delivery Manager	020 3299 1687 ian.roney@nhs.net
Azzaya Munkhtsetseg	Biochemistry Operations Manager	020 3299 4477 azzaya.munkhtsetseg@nhs.net
Volha Klimovich	BSL Quality Manager	020 3299 4671 v.klimovich@nhs.net

Postal address:

BSL Biochemistry, Blood Sciences
King's College Hospital NHS Foundation Trust
Ground Floor, Bessemer Wing
Denmark Hill
London
SE5 9RS

2. Laboratory Service

The department provides a wide range of analytical services for diagnosis, monitoring, screening and follow-up of patients. Clinically qualified members of the laboratory are available on-site during normal working hours (and by air-call at other times).

Successful laboratory diagnosis depends greatly upon the selection, timing and method of collection of specimens. Medical staff are urged to discuss with the Duty Biochemist any problem regarding the choice of investigation, the nature and method of specimen collection and interpretation of results.

2.1 Normal laboratory opening times

Monday - Friday: 09:00 – 17:30

The Central Specimen reception is open 24h and 7 days a week for specimen drop off.

2.2 Out of hours service (including Bank Holidays)

The out-of-hours service runs outside of the routine lab hours listed above. At least one Biomedical Scientist (BMS) is on at all times and should be contacted on:

0203 299 2286

Clinical advice out of hours can be obtained from the Consultant Chemical Pathologists who can be contacted through the hospital switchboard.

Specialist investigations may be available following discussions between the requesting clinician and a senior member of clinical staff.

3. Use of the Laboratory

3.1 Patient Identification and Specimen Labelling

Either an EPR-based or a paper-based request must accompany all specimens sent to the laboratory. It should clearly state the following information. Those in bold are a minimum requirement and without them the sample could be discarded or delayed:

- **Patient name**
- **Hospital number/NHS number**
- **Date of birth (age if DOB not known)**
- **Sex**
- **Ward or Address for report**
- **Requesting Medical Officer/GP name and number**
- **Date and time specimen taken**
- **Tests required**

Other useful data:

- Contact number or bleep for requesting clinician
- Patient address
- All relevant clinical details.

It is the responsibility of the person collecting the sample to ensure it is correctly labelled.

Under no circumstances is it possible to change the details once the sample has been sent to the laboratory.

The following will be rejected:

- Unlabelled specimens
- Inadequate patient information
- Mismatched samples and forms
- Grossly leaking specimens

Specimens are accepted only when they are correctly labelled and collected as per instructions provided within this handbook and other related policies to ensure validity of the results.

The Biochemistry department will strictly enforce this policy. The requested analyses will **NOT** be performed on any samples where there is any discrepancy with patient identification.

3.2 Urgent tests

All urgent requests for routine blood tests that are performed in-house will be reported within 1 h of receipt of the specimen into the laboratory. Other specialist assays may be prioritised if there is a valid clinical indication, please contact the Duty Biochemist or one of the Clinical Scientists to discuss individual cases.

3.3 Transportation of Specimens

Samples must be delivered to the department in a way to protect the integrity of the sample. Samples must not be exposed to extreme temperature or prolonged transport. If samples are in danger of being exposed to conditions where sample integrity can be compromised, please contact the laboratory to discuss the most appropriate method of transport.

When receiving samples from an external institution or laboratory, it is the responsibility of the sender to ensure that the samples are packed in accordance with the current postal regulations, contain appropriate paperwork and are labelled correctly. Courier/taxi/suitable transport should be arranged by the sending institution or laboratory.

All pathological samples must have:

3.3.1 Primary receptacle

Primary receptacle - a primary watertight leak-proof receptacle containing the specimen. The receptacle must be packaged with enough absorbent material to absorb all fluid in case of breakage.

3.3.2 Secondary packaging

Secondary packaging - a second durable, watertight, leak-proof packaging to enclose and protect the primary receptacle(s) i.e. the specimen bag.

All samples must be placed in individual plastic 'kangaroo' type sample bags to avoid cross contamination. Any documentation e.g. request forms are to be placed in the separate pocket on the outside of the bag.

- Bags must not be sealed using staples, pins or paperclips.
- Several cushioned primary receptacles may be placed in one secondary packaging, but sufficient additional absorbent material shall be used to absorb all fluid in case of breakage.

3.3.3 Outer packaging

The secondary packaging is placed in outer shipping packaging with suitable cushioning material. Outer packaging protects contents from outside influences, such as physical damage, whilst in transit.

- For postal specimens this will be a UN3373 box.
- For cross-site or GP transport this will be a Daniels box.

Any specimens that are received leaking or in a dangerous condition will not be processed but will be discarded. In this event the clinician will be informed via a report generated electronically on the pathology computer system.

3.4 Transport of specimens by road

The transport of most specimens from the General Practitioner's surgeries or outreach clinics to the hospital laboratory is provided by designated Courier service providers who will be familiar with their responsibilities.

If for any reason, pathological samples have to be transported via a contracted transport supplier, the following guidelines must be adhered to:

- The box must not be transported in the same compartment as passengers – but must be placed in the boot of any vehicle or the rear compartment of any van used and firmly secured.
- Mail must not be transported in the same carrier box as specimens.
- The container must be secured using appropriate means whilst being transported in the vehicle.
- Specimens must be transported in a secure transport box with a fastened leak proof lid (compliant with IATA Packaging Instruction 650 or 621 and UN3373 or UN3291).

It is the responsibility of those sending specimens from locations within the Trust but outside the laboratory site that the correct procedures are observed and that they obtain and utilise the approved and correctly labelled transport boxes.

Each box must display a biohazard warning sign and must also state that the box must not be tampered with or opened and a telephone contact number included for emergency purposes.

Carriage of pathological specimens between hospitals and/ or GP clinics and the hospital by road comes under the remit of 'The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009, as amended (CDG Regs)' – ADR regulations.

4. List of examinations performed in BSL Biochemistry

Analyte	Units	Range		Sample type
Alanine Aminotransferase (ALT)	U/L	5-55		Serum (SST)
Albumin	g/L	35-50		Serum (SST)
Alkaline Phosphatase (ALP)	U/L	Age and sex specific ranges.		Serum (SST)
Alpha-foetoprotein (AFP)	kIU/L	≤6		Serum (SST)
Amikacin	mg/L	<5		Serum (SST)
Ammonia	µmol/L	12-50		Plasma (EDTA) Delivered to the lab on ice and within 30 min of venepuncture
Amylase	U/L	<100		Serum (SST)
ACE	U/L	8-52		Serum (SST)
Aspartate Aminotransferase (AST)	U/L	0-2y 3-6y 7-13y 14-18y 19y+	10-77 8-43 7-36 3-35 10-50	Serum (SST)
Bicarbonate	mmol/L	22-29		Serum (SST)
Bile Acids	µmol/L	<14		Serum (SST)
C-Peptide	pmol/L	370-1470		Serum (SST) or EDTA
C-Reactive Protein	mg/L	<5		Serum (SST)
CA125	kU/L	<35		Serum (SST)
CA199	kU/L	<37		Serum (SST)
Caeruloplasmin	g/L	0.15-0.30 (males) 0.16-0.45 (females)		Serum (SST)
Adjusted Calcium	mmol/L	2.15-2.60		Serum (SST)
Carbamazepine	mg/L	4.0-12.0		Serum (SST)

CEA	µg/L	<20y 20-39y 40y+	None 0.0-3.4 0.0-6.1	Serum (SST)
Chloride	mmol/L	95-108		Serum (SST)
Total Cholesterol	mmol/L	1.0-5.0		Serum (SST)
Conjugated Bilirubin	µmol/L	<4		Serum (SST)
Cortisol	nmol/L	133-537 (06:00-10:00) 68-327 (16:00-20:00)		Serum (SST)
Creatine Kinase (CK)	U/L	<150		Serum (SST)
Creatinine	µmol/L	0-2m 2m-4y 5-7y 8-10y 11-12y 13-15y 16y+	27-77 15-42 23-51 31-63 34-71 41-85 61-123 (males) 47-99 (females)	Serum (SST)
Cystatin C	mg/L	0-3m 3m-50y 50y+	<1.71 <1.00 <1.40	Serum (SST)
CSF Glucose	mmol/L	-		CSF (fluoride oxalate)
CSF Protein	g/L	0.25-0.45		CSF (plain)
CSF Lactate	mmol/L	0.7-2.0		CSF (fluoride oxalate)
Digoxin	µg/L	0.5-2.0		Serum (SST)
Ethanol	mg/L	-		Plasma (fluoride oxalate)
Ferritin	µg/L	30-400 (males) 13-150 (females)		Serum (SST)
Folate	µg/L	3.0-20.0		Serum (SST)

FSH	IU/L	1.5-12.4 (males) 3.5-12.5 Follicular 4.7-21.5 Mid-cycle 1.7-7.7 Luteal 25.8-134.8 Post-menopause		Serum (SST)
Free Androgen Index	None	35.0-92.6 (males) <6.0 (females)		Serum (SST)
Free T4	pmol/L	11.0-21.2		Serum (SST)
Free FT3	pmol/L	3.1-6.8		Serum (SST)
Gamma GT	U/L	1-55		Serum (SST)
Gentamicin	mg/L	0-4w 4w+	<2 <1	Serum (SST)
Plasma Glucose	mmol/L	Normal fasting glucose: 3.0 - 6.0 mmol/L Impaired fasting glucose: 6.1 - 6.9 mmol/L Diabetes mellitus: >6.9 mmol/L (fasting) OR >11.0 mmol/L (random) Pregnant: >6.7 mmol/L (random) - consider glucose tolerance test		Plasma (fluoride oxalate)
Globulins	g/L	20-35		Serum (SST)
Haptoglobin	g/L	0.3-2.0		Serum (SST)
HbA1c	mmol/mol Hb (%)	20-41 (4.0-5.9)		Whole blood (EDTA)
HDL Cholesterol	mmol/L	>1		Serum (SST)
HCG	IU/L	<2 (males) ≤ 1 Non-pregnant pre-menopausal ≤7 Post-menopausal		Serum (SST)
Insulin	pmol/L	18-173		Serum (SST) or EDTA
Iron	µmol/L	14-30		Serum (SST)
Plasma Lactate	mmol/L	0.5-2.2		Plasma (fluoride oxalate)
Lactate Dehydrogenase (LDH)	U/L	<240		Serum (SST)

LDL Cholesterol	mmol/L	1.0-3.0	Serum (SST)
Lipase	U/L	13-60	Serum (SST)
Lithium	mmol/L	0.4-1.0	Serum (SST)
Luteinising Hormone (LH)	IU/L	1.7-8.6 (males) 2.4-12.6 Follicular 14.0-95.6 Mid-cycle 1.0-11.4 Luteal 7.7-58.5 Post-menopause	Serum (SST)
Magnesium	mmol/L	0.7-1.0	Serum (SST)
NT-proBNP	ng/L	<400	Serum (SST)
Oestradiol	pmol/L	<160 (males) Follicular: 114-332 Ovulatory 222-1959 Luteal 220-854 Post-menopause <506	Serum (SST)
Osmolality (plasma)	mOsm/kg	280-295	Serum (SST)
Paracetamol	mg/L	-	Serum (SST)
Parathyroid Hormone (PTH)	ng/L	15-65	Plasma (EDTA)
Phenobarbitone	mg/L	10.0-40.0	Serum (SST)
Phenytoin	mg/L	5.0-20.0	Serum (SST)
Phosphate	mmol/L	Age and sex-related paediatric ranges. 19y+ 0.80-1.40	Serum (SST)
Potassium	mmol/L	3.5-5.3	Serum (SST)
Procalcitonin	µg/L	0.00-0.05	Serum (SST)

Progesterone	nmol/L	≤0.6 (males) Follicular < 0.7 Ovulatory <13.3 Luteal 13.1-46.3 Post-menopause <0.6		Serum (SST)
Prolactin	mIU/L	86-324 (males) 102-496 (females)		Serum (SST)
Prostate Specific Antigen (PSA)	µg/L	(males only) 0-40y 40-50y 50-59y 60-69y 70y+	 0.00-1.40 0.00-2.00 0.00-3.10 0.00-4.10 0.00-4.40	Serum (SST)
Salicylate	mg/L	-		Serum (SST)
Sex Hormone Binding Globulin (SHBG)	nmol/L	Age and sex related ranges. 50y+ 20.6-76.7 (males) 27.1-128.0 (females)		Serum (SST)
Sodium	mmol/L	135-145		Serum (SST)
Soluble Transferrin Receptor (STFR)	mg/L	1.71-4.13		Serum (SST)
Testosterone	nmol/L	Age and sex related ranges. 0-6m 0.4-13.9 (males) 6m+ 8.6-29.0 (males) 0-49y 0.4-1.7 (females) 50y+ 0.4-1.4 (females)		Serum (SST)
Theophylline	mg/L	10.0-20.0		Serum (SST)
Thyroid Stimulating Hormone (TSH)	mIU/L	0.27-4.20		Serum (SST)
Tobramycin	mg/L	<1.0		Serum (SST)
Total Bilirubin	µmol/L	<21		Serum (SST)

Total Iron Binding Capacity (TIBC)	µmol/L	50-72		Serum (SST)
Total Protein	g/L	60-80		Serum (SST)
Transferrin Saturation	%	20-50		Serum (SST)
Triglyceride	mmol/L	0.5-2.0		Serum (SST)
Troponin T	ng/L	<14		Serum (SST)
Uric Acid	µmol/L	200-430 (males) 140-360 (females)		Serum (SST)
Urea	mmol/L	0-4w 4w-1y 1-16y 17y+	0.8-5.5 1.0-5.5 2.5-6.5 2.5-7.8	Serum (SST)
Valproate	mg/L	50-100		Serum (SST)
Vancomycin	mg/L	10.0-20.0		Serum (SST)
Vitamin B12	pg/mL	197-771		Serum (SST)
Vitamin D	nmol/L	Deficiency <25 nmol/L Insufficiency 25 to 50 nmol/L Therapeutic Target >50 nmol/L		Serum (SST)
Urine Albumin: Creatinine ratio (ACR)	mg/mmol	<3.0		Random Urine (plain universal)
Urine Protein: Creatinine ratio (PCR)	mg/mmol	<15.0		Random Urine (plain universal)
Urine Calcium: Creatinine ratio	mmol/mmol	-		Random Urine (plain universal)
Urine osmolality	mOsm/kg	-		Random Urine (plain universal)

4.1 Turnaround times

Urgent	Within 1 h of receipt
Inpatient	Within 4 h of receipt
GP, outpatient and external locations	Within 24 h of receipt

All turnaround times stated are for tests performed on-site in the BSL.

4.2 Minimum sample volumes

	Adult Samples	Paediatric samples
Blood (serum or plasma)	6 mL	0.5 mL
Urine and CSF	Minimum of 100 µL	Minimum of 100 µL

4.3 Therapeutic drug monitoring (TDM)

The aim of the TDM service is to optimise and individualise the therapeutic effect of drugs by measuring blood concentrations during patient treatment. The half-life of a drug will determine the time that it will take, with repeated dosing, to reach the "steady state" concentration. It is generally accepted that steady state is reached by the time that 4 half-lives of the drug have elapsed.

The optimum sampling time is immediately pre-dose (trough) for most TDM. The exceptions are:

- Digoxin (minimum 6h post dose)
- Phenobarbitone (due to the long half-life samples can be collected at any time).

A comment on the therapeutic range and whether it applies to the trough sampling time is applied to each TDM result where applicable.

Please refer to the Antimicrobial Prescribing Guide on the clinical guidelines section of the Trust intranet for further info on antibiotic results.

4.4 Add ons

Add-ons are accepted within specified timeframes according to analyte stability. Add ons are handled by Customer Services on 0204 513 7300, who can advise if the add on is not appropriate. If an add-on is required urgently a separate sample is advised.

5. Complaints

Official complaints from users of the service may be received by the KCH complaints team, PALs office, Synnovis Customer services or directly by the laboratory/department.

Complaints from patients will be dealt with according to the Trust official Complaints Policy (see KCH website for the current version). The Complaint's Office gives clear deadlines for dealing with complaints and providing investigation reports.

A complaint may be raised by:

- A patient
- A relative or carer
- An advocate on the patient's behalf, e.g. an MP or a local councillor
- A member of the public.
- Hospital Medical / Clinical staff
- GP Practises /Clinical Commissioning Group (CCG)