Anatomy of the heart

Robert H Whitaker

Abstract

Despite centuries of writings and research into cardiac anatomy and function, the topic is still advancing, particularly in relation to clinical applications and embryological significance. This article presents the heart with reference to the classical anatomical position and attempts to clarify the nomenclature that is most commonly used by anatomists. We encourage clinicians to use the same terminology. The references are from an excellent compilation on the heart in *Clinical Anatomy*.

Keywords Atrium; cardiac embryology; chambers; coronary arteries; heart; pericardium; venous drainage; ventricle

What's new?

- The anatomy of the coronary sinus has taken on new clinical importance as a result of the expansion of electrophysiological investigations and interventions. There has been a drive to avoid the 'Valentine' approach to cardiac description that has crept into surgical usage and an appreciation of the need to adhere to strict anatomical references[1]
- The embryology of the heart has been revisited in an attempt to gain more insight into congenital anomalies[2] — the classical concepts of cardiac looping and fate of the original heart tubes have been questioned[3]
- New and much improved methods of imaging the heart are now available

The heart is a midline, valvular, muscular pump that is cone-shaped and the size of a fist. In adults, it weighs 300 grams and lies in the middle mediastinum of the thorax. The inferior (diaphragmatic) surface sits on the central tendon of the diaphragm, whereas the base faces posteriorly and lies immediately anterior to the oesophagus and (posterior to that) the descending aorta. The base comprises mainly the left atrium. The left surface (left ventricle) and right surface (right atrium) are each related laterally to a lung and a phrenic nerve in the fibrous pericardium. The anterior surface of the heart lies behind the sternum and the costal cartilages. The constituent parts of the anterior and inferior surfaces are dictated largely by the position of the interventricular septum. Although essentially a midline structure, one-third of the heart lies to the right of the midline and two-thirds to the left.

The interventricular septum bulges to the right because the wall of the left ventricle is much thicker (10 mm) than that of the right ventricle (3—5 mm). It also lies obliquely across the heart, almost in the coronal plane, such that the anterior surface of the heart is two-thirds right ventricle and one-third left ventricle; the proportions are reversed on the inferior surface. The thicker, muscular part of the interventricular septum is formed from the ventricular walls. The muscles of the four chambers and the four valves are attached to, and supported by, a figure-of-eight-shaped fibrous skeleton comprising a central fibrous body and extensions (fila coronaria) that surround the valves. This skeleton both divides and separates the atria electrically from the ventricles and is the remnant of the atrioventricular (AV) cushions. The thinner membranous part of the interventricular septum is formed from the lowest aspect of the spiral valve (neural crest cells), which divides the truncus arteriosus into the aorta and pulmonary trunk.

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Pericardium

The pericardium holds and protects the heart, but provides sufficient potential space for filling and emptying of the chambers. The outer layer is the tough fibrous pericardium, which blends with the adventitia of the aorta, the pulmonary trunk, the superior vena cava and the central tendon of the diaphragm. Within this, there are two layers of serous pericardium:

- a visceral layer, surrounding the heart
- a parietal layer, lining the inner surface of the fibrous pericardium.

These two layers of serous pericardium are continuous with each other as they reflect off the major vessels behind and above the heart. The reflection, posteriorly, between the pulmonary veins is termed the 'oblique sinus' of the pericardium. The plane between the superior vena cava and the pulmonary veins posteriorly, and the aorta and pulmonary trunk anteriorly, made by the folding of the heart, is termed the 'transverse sinus' of the pericardium.

The visceral layer and the heart itself are supplied by sympathetic nerves from the cardiac plexuses; these in turn carry general visceral afferent fibres to the vertebral levels from which the sympathetic supply arises, which are the three cervical sympathetic ganglia and the T1—5 ganglia — this explains why cardiac pain is referred to the neck, chest and arm.

Features of the chambers

Right atrium

The inferior vena cava passes through the diaphragm at the level of T8 and immediately enters the right atrium, which lacks a true valve. In the fetus, however, there is the so-called valve of the inferior vena cava, a fold of tissue that directs caval blood into the foramen ovale. The superior vena cava enters the superior aspect of the chamber. The fossa ovalis (a remnant of the septum primum) and its overhanging limbus (a remnant of the septum secundum) lie on the smooth, interatrial part of the chamber, which developed from the sinus venosus. This smooth area is separated from the muscular part, with its musculi pectinati, by the crista terminalis internally and the sulcus terminalis externally. The muscular part originated from the fetal atrium and is represented in the mature heart as the right auricle.

Between the opening of the inferior vena cava and the AV orifice lies the opening of the coronary sinus, which is protected

in some hearts by a small (Thebesian) valve that prevents regurgitation into the coronary sinus during atrial contraction. The coronary sinus empties during systole. The AV node lies between this orifice and the septal cusp of the tricuspid valve.

Right ventricle

Blood enters the right ventricle via the tricuspid valve, which has anterior, septal and posterior (lying inferiorly) cusps attached to papillary muscles by fibrous chordae tendineae. The ventricular wall is normally 3–5 mm thick and raised internally by interweaving strands of muscle (trabeculae carneae). Some of this muscle joins the anterior papillary muscle, low on the anterior septal wall, as the septomarginal trabecula (moderator band) and carries part of the right bundle branch of conducting tissue, which ensures that the right ventricle contracts simultaneously with the left. Blood passes superiorly to leave this chamber via the smooth conus arteriosus (infundibulum) and the pulmonary valve, which has two anterior cusps and one posterior cusp (PAPA – *P*ulmonary–*A*nterior–*P*osterior–*A*nterior).

Left atrium

The left atrium is a box-shaped chamber that lies posteriorly at the base of the heart and receives blood from the lungs via four large, valveless pulmonary veins into the four quadrants of the chamber. The terminology and development of the smooth and muscular parts of the left atrium correspond to those of the right atrium except that the smooth part arises from incorporation of the pulmonary veins.

Left ventricle

Blood enters the left ventricle via the mitral valve, which has a larger anterior and smaller posterior cusp, each with chordae tendineae and papillary muscles. The mitral valve is an active valve and not simply a flap of tissue.[4] The muscle wall is about 10 mm thick and roughened by trabeculae carneae. The smooth outflow tract is the aortic vestibule, corresponding to the membranous part of the interventricular septum, leading to the aortic valve with its two posterior cusps and one anterior cusp (APAP – *A*ortic–*P*osterior–*A*nterior–*P*osterior). The relationship of these cusps to the ostia of the coronary arteries is described below. The trabeculated pattern of the musculi pectinati in the auricles and the trabeculae carneae in the ventricles is an efficient means of gaining power without excessively thickening the wall of the chamber. A single papillary muscle has separate chordae tendineae to two adjacent valvular cusps, which helps draw them together to prevent valvular eversion during systole.

Conducting system of the heart

Specialized cardiac muscle fibres form the:

- sinuatrial node (in the right atrial wall between the opening of the superior vena cava and the auricle)
- AV node (in the left wall of the right atrium, at the superior limit of the interventricular septum)
- AV bundle (arising from the AV node and descending in the interventricular septum).

Contractions originating from the sinuatrial node (pacemaker) spread through the atrial walls to reach the AV node, and then the left and right bundles. The plexus of Purkinje fibres allows spread of excitation to the ventricular walls so that the inferior aspects of the ventricles contract first. Further autonomic nervous control is via cardiac branches from each of the cervical sympathetic ganglia and thoracic ganglia T1–5; parasympathetic fibres arise from the superior and inferior cardiac branches of the vagus and from the recurrent laryngeal nerve.[5] All autonomic nerves pass via the superficial and deep cardiac plexuses on the lateral and medial aspects of the aortic arch.

Blood supply to the heart

The ostia of the coronary arteries arise in the aortic sinuses superior to the attachment of the base of the relevant cusp – the right from the anterior sinus (also known as *sinus 1* or *right coronary aortic sinus*) and the left from the left posterior sinus (also known as *sinus 2* or *left coronary aortic sinus*). The branches of the coronary arteries are shown in Figure 1 and listed in Table 1. The third sinus is named the right posterior sinus or non-coronary sinus.[6]

Right coronary artery

The right coronary artery passes anteriorly from its origin between the right atrial appendage and the pulmonary trunk to enter first the right anterior AV groove and then the right posterior AV groove, where it anastomoses with the circumflex branch of the left coronary artery. In 90% of individuals, it provides a posterior (inferior) interventricular branch as it reaches the posterior interventricular groove on the inferior surface of the heart; this anastomoses with the termination of the anterior interventricular artery (left coronary) in the groove at the apex of the heart.

Left coronary artery

The left coronary artery arises from the left posterior aortic sinus and passes anteriorly between the left atrial appendage and

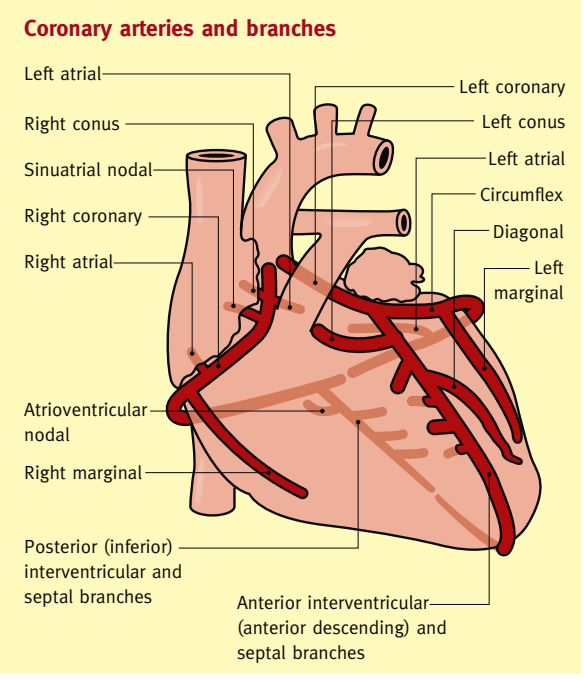

Figure 1

Branches of the coronary artery system

Right coronary artery
- Left atrial
- Right conus
- Sinuatrial nodal (60% of individuals)
- Right atrial
- Right marginal
- Posterior (inferior) interventricular (90%)
  Ventricular branches
  Septal branches
- Atrioventricular nodal (90%)
- Smaller branches to the right ventricle

Left coronary artery
- Sinuatrial nodal (40%)

Circumflex artery
- Left marginal
- Left conus
- Posterior (inferior) interventricular (10%)
  Ventricular branches
  Septal branches
- Atrioventricular nodal (10%)

Anterior interventricular artery
- Left conus
- Diagonal
- Ventricular and septal

Table 1

pulmonary trunk, to lie in the left anterior AV groove. Here it divides into the:
- circumflex artery and the
- anterior interventricular artery.

Cardiac veins

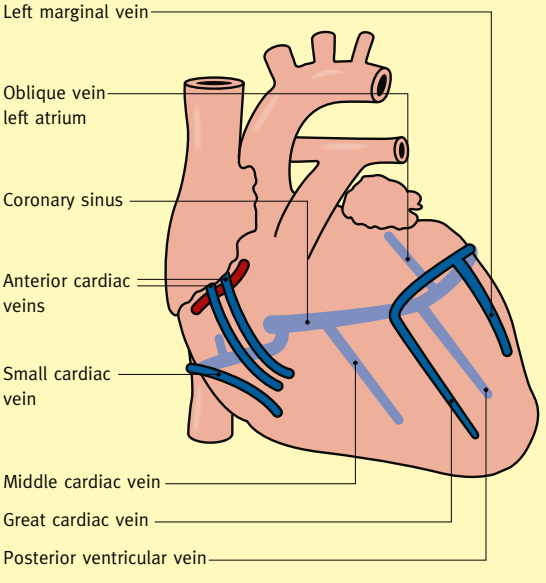

Figure 2

The circumflex artery continues first in the anterior and then in the posterior AV groove, and anastomoses with the terminal branches of the right coronary artery. The anterior interventricular artery (often termed the 'left anterior descending artery' or LAD) passes down the same named groove, around the apex of the heart, and anastomoses with the terminal branches of the posterior (inferior) interventricular artery.

The 10% of individuals in whom most of both ventricles and the septum are supplied by the left coronary artery are said to have left cardiac (coronary) dominance. The presence of collateral communications between the right and left coronary systems has been recently reviewed,[7] suggesting that there is more collateral circulation than classically taught. Note that the coronary arteries fill and distribute blood to the heart during diastole when cardiac muscle is relaxed and vascular resistance low.

Venous drainage of the heart

The distribution of the veins of the heart is much more variable than the arteries.[8] Drainage of both ventricles starts with the great cardiac vein in the anterior interventricular groove (Figure 2), which passes to the left in the anterior AV groove, where it collects the left marginal vein. As it runs in the posterior AV groove, it is joined by the oblique vein of the left atrium, the posterior ventricular vein and, finally, the middle cardiac vein, which lies in the posterior interventricular groove and drains the left and right ventricles posteriorly. The confluence of these veins is the 3-cm long coronary sinus, lying in the posterior AV groove. Just before the coronary sinus enters the right atrium, it is usually joined by the small cardiac vein, which drains the right atrium and right ventricle. The small cardiac vein sometimes drains directly into the right atrium. A couple of anterior cardiac veins drain the anterior aspect of the right ventricle and right atrium before crossing the right coronary artery to enter the right atrium. In addition, 20–30% of all drainage is in the venae cordis minimae (Thebesian veins) – small venous channels seen throughout the myocardium that drain directly into the chambers of the heart. ◆

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Laboratory diagnosis of sexually transmitted infections

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Abstract
The laboratory plays a central role in the accurate diagnosis of sexually transmitted infections (STIs). In countries with sufficient resources the laboratory is usually involved in providing a result to inform individual patient management. In contrast, in resource-poor countries where patients are often treated according to their presenting symptoms (syndromic management), the laboratory has a role in evaluating this approach. Molecular detection of the causative agents of STIs, such as *Neisseria gonorrhoeae*, *Chlamydia trachomatis* and herpes simplex virus (HSV), using highly sensitive and specific tests, has largely replaced classical culture techniques. The detection of the host's antibody response to the infecting agent is still the mainstay for the diagnosis of syphilis and human immunodeficiency virus (HIV). In some instances a combination of antigen and antibody detection is used. In the United Kingdom, where a unique network of open-access specialized clinics exists, some laboratory procedures are performed in a clinic laboratory setting and this is particularly useful for common causes of vaginitis that can be diagnosed using a microscope. This article describes the current methods employed for the major causes of bacterial and viral sexually transmitted infections.

Keywords Bacterial vaginosis; *Chlamydia trachomatis*; herpes simplex virus; human immunodeficiency virus; laboratory; lymphogranuloma venereum; *Neisseria gonorrhoeae*; syphilis; *Treponema pallidum*; *Trichomonas vaginalis*

What's new?

- Fourth-generation HIV Ag/Ab tests are now standard of care, reducing the usual 'window' to detect infection to just 4 weeks
- Point-of-care testing for HIV, syphilis and, more recently, trichomoniasis has the potential to transform the role of the laboratory in the clinical service. Point-of-care molecular amplification tests are in development
- Dual nucleic acid amplification tests for the detection of *Chlamydia trachomatis* and *Neisseria gonorrhoeae* are highly sensitive and specific and are the method of choice for the laboratory diagnosis of both these infections at any affected site. Culture is an essential adjunct to maintain antibiotic resistance surveillance
- Detection of *Trichomonas vaginalis* by culture, molecular methods or a validated point-of-care test are more sensitive than microscopy and preferable where resources allow.

Introduction

The laboratory plays a central role in the diagnosis of sexually transmitted infections (STIs) either by the direct detection of the causative organism or by detection of the host's response to the infection or a combination of these.[1] The delivery of diagnostic tests is currently changing with centralization of laboratory facilities in many areas, use of automated technology and the focus on the development of point-of-care tests (POCTs) for many STIs. However, the laboratory still plays a pivotal role either in primary or confirmatory testing and that is unlikely to change for a number of years.

Neisseria gonorrhoeae

The isolation of *N. gonorrhoeae* was formerly the gold standard for the diagnosis of gonorrhoea, but the development of nucleic acid amplification tests (NAATs) with a high sensitivity and specificity has heralded a change in approach. Cultural methods that use a well-taken specimen, inoculated on a highly nutritious medium, transported from the patient to the laboratory quickly and incubated in appropriate conditions can still yield a positive result in most infected patients. However, this methodology is intolerant of delays or inadequacies in this process, and the sensitivity can be low particularly when used for patients attending clinics or settings distant from the laboratory, and for certain anatomical sites.

In contrast, NAATs are more tolerant of variable storage conditions and delays in reaching the laboratory, and their high sensitivity allows use with samples taken non-invasively, such as urine samples and self-taken vaginal swabs, although urine in women is not the optimal sample for gonorrhoea.[2] The specificity of NAATs for gonorrhoea (GC NAATs), due to cross-reactivity with other species of *Neisseria*, has been a concern but recent generations of these tests have shown a marked improvement. Compared with culture, NAATs are known to detect more cases of gonorrhoea and are becoming the method of choice for the laboratory diagnosis,[3] the technology being easily automated and combined with the detection of *Chlamydia trachomatis*. It is essential to retain the expertise for culture as a viable organism is necessary to perform susceptibility testing, for surveillance purposes and to detect emerging resistance. In many instances, NAATs and culture are performed on symptomatic patients and NAATs alone for screening asymptomatic individuals, followed

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by culture when the patient is recalled for treatment. A positive predictive value (PPV) of >90% is desirable when using this approach; this can be a challenge in low-prevalence populations and may require supplementary testing of positive tests with a NAATs with a different target for this to be achievable.[4]

Detection of *N. gonorrhoeae* in extragenital samples has always been difficult: rectal samples are contaminated with large numbers of normal flora and pharyngeal samples with commensal species of neisseria. NAATs are now recognized to be superior at these sites and give significantly more positive cases than culture. None of the GC NAATs has been approved by the FDA (Food and Drug Administration) for use on samples from extragenital sites, but there are validation data to support the use of these tests and comply with accreditation requirements.

Chlamydia trachomatis

Molecular detection using NAATs is the gold standard method for the detection of *C. trachomatis* infection because they are both highly sensitive and specific when testing a range of different clinical specimen types.[5] The increased sensitivity of NAATs for *C. trachomatis* (CT NAATs) over traditional methods of chlamydia detection (e.g. culture and enzyme immunoassay) allows detection of low levels of infectious agent, which means that they can be used to test non-invasive specimens such as urine and self-taken vaginal swabs, as well as standard clinician-taken genital swabs. As a consequence of this increased test sensitivity, testing in primary care or community settings is possible. As with GC NAATs, there is no commercially available CT NAAT that is approved by the FDA for use on samples from extragenital sites. However, NAATs have been shown to be very reliable for the detection of chlamydia infection in rectal swabs, which is important when testing men who have sex with men (MSM).

Commercially available CT NAATs are usually combined with GC NAATs and these dual NAATs are widely used as they offer testing for two STIs at little or no extra cost compared with the single test. There is a range of dual NAATs approved by the FDA but as with the single analyte tests for CT and GC alone, none is approved for use on samples from extragenital sites.

Lymphogranuloma venereum (LGV)

In some instances it may be clinically necessary to undertake testing for LGV.[6,7] At the present time, although all commercial CT NAATs report LGV infection as positive for chlamydia, there is no commercial test available that can detect LGV-specific DNA, or distinguish LGV serovars from non-LGV serovars of chlamydia. However, several LGV specific in-house real-time PCR assays do exist and have been extensively validated for the detection of LGV. Due to its specialist nature, LGV testing is generally confined to national or specialist reference centres.

Syphilis

The laboratory diagnosis of syphilis infection (caused by *Treponema pallidum* spp. *pallidum*) is most commonly achieved using serological tests, which can detect the presence of treponemal antibodies in a patient's serum. In order to unequivocally detect either a previous or current treponemal infection a battery of serological tests is required ('STS'). In most situations a serum specimen will be first screened using an enzyme immunoassay (EIA) or a chemiluminescent assay (CIA), which have the advantage of being both sensitive and automated. Sera giving EIA-positive results are then further examined using a more specific confirmatory assay, such as the Treponemal Particle Agglutination Assay (TPPA). Employing such a testing approach enables the differentiation of patients with a true history of treponemal infection from patients who may produce false positive results using the EIA or CIA screening test, which can lack specificity if used alone.[8] Even the most modern serological tests cannot distinguish between the causative agent of syphilis and the closely related agents that cause endemic syphilis, pinta or yaws. Thus, positive serological tests for syphilis always require careful clinical interpretation including a detailed patient history.

Patients with a past history of treponemal infection usually mount an immunological response for life, even following treatment, and this can make the differentiation between past and active infection difficult. In order to overcome this either a Rapid Plasma Reagin (RPR) or a Venereal Disease Reference Laboratory (VDRL) test can be used. The RPR and VDRL tests are often referred to as non-treponemal tests as they do not directly detect treponemal antibody in a patient's serum, but detect antibody to lipoidal antigens that are present in both treponemal and host cells. These antibodies fall in titre with time and after specific syphilis treatment, and rise again with relapse or re-infection. Active treponemal infection is suspected in patients who produce a reactive RPR/VDRL test against serum, especially with a titre of >1:16, although interpretation of lower titres should take into account clinical presentation to detect early cases.

Treponemal IgM EIA tests are also available, but they tend to be technically more complex to perform than the RPR/VDRL tests; their use is controversial but they are more commonly performed in specialist centres. Detection of treponemal IgM is most useful in congenital cases as IgM does not pass through the placenta, so its presence indicates infection in the baby rather than transfer of maternal antibody. It is also useful in early syphilitic infection, although positive results should be interpreted with caution, as treponemal IgM can persist for 1–2 years after treatment.

Genital ulcer disease

In the UK the main cause of genital ulcer disease is **herpes simplex virus** (HSV). The standard method for the diagnosis of HSV infection is detection of HSV DNA from the site of infection. NAAT tests are usually duplexed to detect HSV-1 and HSV-2. Commonly practitioners fail to send appropriate swabs for HSV detection, in spite of the implications for the patient of recurrence and transmission.

HSV type-specific serology can also be useful in some circumstances:

- when the sexual partner is known to have genital herpes
- where the patient presents with genital ulceration compatible with genital herpes, but attempts to detect HSV DNA have been unsuccessful
- testing pregnant women with a history of genital ulceration but no previous virological confirmation of infection

The laboratory diagnosis of genital ulcer disease caused by ***T. pallidum*** or ***Haemophilus ducreyi*** (the causative agent of

chancroid) is fraught with problems because of difficulties or inability to culture these organisms. Direct detection of *T. pallidum* using dark-field microscopy must be performed near to the patient and requires a high level of skill and experience. In the UK, patients with a suspected chancre should be referred to a specialist sexual health clinic. In most resource-poor settings, where these infections are most prevalent, diagnosis is made by clinical presentation and treated syndromically, and the laboratory has little or no role in individual patient management.

When laboratory facilities and resources are available, the method of choice is molecular detection using polymerase chain reaction (PCR) tests, either as single tests or as a multiplex.[9] Swabs, either dry or stored in bacterial or viral transport media, are used to extract DNA and primers specific to each organism (*T. pallidum*, 47Kd lipoprotein gene; *H. ducreyi*, haemolytic cytotoxin gene; HSV, glycoprotein) used for detection. Where possible, any positive reactions should be confirmed using a single PCR such as Tp Pol A for *T. pallidum*.[10] The multiplex PCR has a high sensitivity and specificity and is particularly useful for atypical genital ulcers. Some UK units now use a multiplex PCR assay as their primary test for all genital ulcers.[11]

Vaginal discharge

Bacterial vaginosis (BV) is probably the most common cause of abnormal vaginal discharge. BV is a change in vaginal ecology from a predominantly lactobacillary to a mixed microbial flora.[12,13] Current UK guidelines support syndromic management in typical cases without laboratory testing.[14] If required, definitive diagnosis is best achieved by assessing the microbial flora on a Gram-stained vaginal smear. Methods vary in detail but all assess or score the bacteria present and classify into normal or grade I (large numbers of lactobacillary flora), intermediate or grade II (reduced numbers of lactobacillary and increased numbers of mixed flora) or 'consistent with BV' or grade III (mixed bacterial flora with absent or few lactobacillary flora). This approach is often used in a clinic or outpatient setting but swabs sent to the laboratory can be used to make a smear, perform a Gram stain and obtain a grading.[15] Isolation of commonly associated organisms, such as *Gardnerella vaginalis* and anaerobes, has been discontinued because these organisms are also found in normal women in small numbers, making interpretation of qualitative cultures difficult. Alternative tests such as BV Blue can be used as near-patient tests.

Trichomoniasis is caused by the protozoan, *Trichomonas vaginalis* (TV). Wet mount microscopy, the examination of a clinical smear for the presence of motile flagellated protozoa, is the most accessible and widely carried out method for the detection of TV. Wet-mount microscopy is routinely performed in most sexual health clinics on vaginal specimens obtained from symptomatic women. However, it has now been shown to be insensitive when compared with TV culture, molecular methods and some rapid POCTs.[16] Molecular methods now include commercially available and in-house tests that show high sensitivity and specificity. However, these can be costly if the prevalence is low. Point-of-care testing is also highly sensitive and specific and offers many advantages for use in specialized clinics.

Vaginal discharge due to infection can also result from:

- candida infection ('thrush'),
- 'aerobic vaginitis' where a BV-type picture is accompanied by significant inflammation and overgrowth of predominantly aerobic bacteria,
- group A streptococcus (causing desquamative vaginitis),
- cervical infection with *C. trachomatis* and/or *N. gonorrhoeae*.

Human immunodeficiency virus

Diagnosis of HIV infection in adults, and in children of older than 18 months, is usually made by detection of antibodies in serum from a venous blood sample. Capillary blood, saliva and urine may also be used, but confirmatory tests must be carried out on a serum sample.

Currently the most sensitive screening tests are so-called fourth-generation assays (Ag/Ab assays), which detect both HIV antibodies and p24 antigen simultaneously and thereby shorten the window period during which an individual may be infected but antibodies are not detectable. Current BASHH guidance (2010) states that although a negative fourth-generation HIV test 4 weeks after a risk exposure is 'very reassuring', an additional HIV test should be offered at 3 months. In addition, patients taking 28 days post-exposure prophylaxis (PEP) following a significant risk need to wait the usual 12-week window period, as the PEP may suppress p24 antigen production. A number of POCTs are available for near-patient use, but to date only one fourth-generation POCT is available. Evaluation reports on some of the available assays have been performed by the Microbiological Diagnostics Assessment Service.[17] Principles behind introducing POCTs into clinical practice include ensuring adequate training of end users and a sound quality control process.[18] Most health organisations will have a local POCT governance process in which the laboratory should advise and assist with implementation and ongoing quality control.

All samples found reactive on a screening test should be submitted for confirmatory tests, preferably retesting from the original clot. The confirmatory test algorithm should include a test that discriminates HIV-1 from HIV-2. Infection status must always be confirmed on a second sample collected at a different time, to confirm the identity of the sample. Discordant results between different assays on a single sample may arise in early acute infection, for example if p24 antigen but not antibody is detected. Tests on a follow-up sample taken at least 2 weeks later are required to monitor evolving pattern of reactivity. If the pattern is unchanged the reactivity can be assumed to be unrelated to HIV infection.

Measurement of HIV RNA (viral load) is not usually recommended as a diagnostic assay due low-level false-positive results. However it is used to monitor therapeutic response and can be useful in the diagnosis of early infection before the production of antibodies.

Diagnosis of infection in infants requires the use of NAAT tests since antibodies detected may be of maternal origin. Using fourth-generation assays these antibodies may be detected beyond 18 months of age. DNA or RNA/viral load assay may be used. The current testing schedule recommended by the British HIV Association for infants born to HIV-positive mothers is to test the infant

at birth, 6 weeks and 3 months by DNA/RNA PCR, using primers known to amplify the maternal virus.[19] A final antibody test at 18 months of age is required to exclude postnatal infection.

Specialized tests can be used as part of a clinical algorithm to distinguish recent from long established HIV infections by measuring the maturity of the antibody response (avidity tests, 'detuned' assays). They are used primarily as an epidemiological tool, but in the UK have been communicated to patients to help with the clinical assessment of duration of infection.

In conclusion, the laboratory test is one of a number of tools in the diagnosis of the patient and so the clinician should always be aware of the tests the local laboratory offers and the results of any tests should be interpreted in the clinical context. POCTs are likely to become more common in the future to enable rapid diagnosis but should be used with the support of the laboratory. ◆

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Management of sexually transmitted infections in non-genitourinary specialist settings

Peter Nall

Abstract

The UK has well-developed sexually transmitted infection (STI) services based in genitourinary medicine (GU) clinics. Nevertheless, non-specialists will encounter STIs, especially in emergency department and primary care settings and need know how to select, perform and interpret tests for common STIs and deal with common problems in a syndromic fashion. Non-specialists should also know about post-exposure prophylaxis for sexual exposure (PEPSE) for HIV and conditions encountered in medical specialities that should lead to the offer of HIV testing. Clinicians working in primary care need to adopt a pragmatic approach to investigation and treatment of STIs as referral is not always practicable.

Keywords HIV; primary care; STIs

Introduction

The UK has well-developed and comprehensive services for sexually transmitted infections (STIs) dating from the time of the First World War. Nevertheless, STIs are often managed in non-specialist settings, principally in primary care general practitioner (GP) services but also in secondary care, notably in emergency departments but also within other hospital-based specialities.

Improved funding and therefore better patient access and easier referral (including self-referral), to genitourinary medicine (GU) services in recent years has led many UK GPs to be less willing to manage STIs in a primary care setting.

Also GPs are busier with core general medical services (GMS) work and therefore less willing to take on what they may see as non-core activity. Of course there are circumstances in which STIs present either as core GMS work or outside GU hours as emergencies.

Some primary care clinicians may feel inadequately trained or de-skilled, despite the wide availability of training that can provide the background theoretical knowledge and practical skills to enable them to manage common problems in primary care settings. A full sexual health history and examination is time consuming and does not fit in to a standard NHS 10-minute primary care appointment. There may therefore be some reluctance to explore the issues fully.

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Staff in non-GU specialist settings may equally be less comfortable taking a sexual history (see Table 1). STI foundation courses are widely available across the UK to help clinicians acquire the skills necessary for taking a sexual history, performing a genital examination and swab-taking.

Equally some patients may feel hesitant attending GU clinics. A clinic attached to city centre pharmacies may be more acceptable than a GU clinic or the GP surgery. Nevertheless, primary care has an important role to provide education and prevention, including pointing out opportunities for screening.

Another difficulty is lack of access to health-advising services so that contact tracing is more problematic if STIs are managed in primary care. For instance, it is difficult to provide epidemiological treatment for contacts if the contact is not registered with the same practice as the index patient.

Nevertheless many GP practices do manage a range of STIs and GU conditions competently without referral to specialist services, and newer areas such as HIV testing and chlamydia screening give GPs a specific role. Community contraception clinics are also involved in screening for and treating STIs, as are clinics providing termination services. There is a movement towards greater integration of contraceptive and GU services, which have hitherto been largely separately managed and run. Clearly, emergency departments, NHS walk-in centres and GP out-of-hours services also have a role to play in management of common STIs and developing the necessary skills in staff who work in these settings to provide a satisfactory service is clearly a challenge.

Emergency departments have an important role in delivering post-exposure prophylaxis for sexual exposure (PEPSE) to individuals potentially exposed to HIV infection, and this requires a basic knowledge of sexual history taking and the antiretroviral drugs (ARV) used in PEPSE. Clinicians working in non-GU specialities should have a knowledge of guidelines for HIV testing, and in particular the indicator conditions that should prompt the offer of a test.

Specific conditions presenting to non-specialist providers of sexual health services

Vaginal infections

With the exception of trichomoniasis, common vaginal infections are not generally sexually transmitted and lend themselves well to management in primary care using a syndromic approach (see Table 2).

Sexual history taking — the basics

Last sexual activity —
- Oral/genitogenital/orogenital/genitoanal/oroanal
- When?
- Where? — UK? Abroad? Sex tourism?
- Who? — Regular/casual partner, frequent changes of sexual partner
- Protection? — consistent or intermittent use.
- Sexual orientation?
- Buying or selling sex?
- Previous STIs?
- Previous testing including HIV testing?

Table 1

Clinical features of vaginal infection syndromes

	Discharge	Odour	Itch	Other
Physiological	+	–	–	
Vulvovaginal candidiasis	+	–	+	
Bacterial vaginosis	++	++	+/–	
Trichomoniasis	++	+	+/–	
Cervicitis/PID	+	+/–	–	Pain Intermenstrual or post-coital bleeding

Table 2

Management of vaginal infections is commonly required in primary care and thrush and bacterial vaginosis (BV) can be pragmatically managed, usually without access to further investigations, based on a syndromic approach to history taking as outlined. Patients with sexually transmitted cervicitis or pelvic inflammatory disease (PID) will have other symptoms that should be sought as part of the syndromic approach and will lead to further inquiry, looking for risk factors for STIs. A screen for STIs should be offered to all those who are potential risk of infection.

Male dysuria/urethral discharge

There is no inherent difficulty in diagnosing uncomplicated chlamydial urethritis in men given that most laboratory services give primary care access to up-to-date NAAT (nucleic acid amplification test) diagnostics for chlamydia and gonorrhoea using urine samples rather than swabs (genital swabs are recommended in female patients). Dysuria in younger men should be assumed to be due to STI and not urinary infection until proved otherwise. For this reason, two samples, a first-pass urine for combined gonorrhoea/chlamydia NAAT, and a mid-stream urine for flow cytometry and culture should be sent before any treatment is offered. Older men are more likely to have urinary infection and the situation can be clarified by taking a sexual history. Men with urethritis should be advised to encourage their partners to undergo testing and epidemiological treatment (preventive treatment of all exposed persons).

If uncomplicated chlamydial urethritis is suspected, treatment can be offered without waiting for the result. Screening and epidemiological treatment of the partner should be advised but there is usually little more that can be done other than to give advice, without access to health advising services through the GU clinic.

Positive gonorrhoea NAAT test results are more problematic. In most areas, primary care will encounter gonorrhoea only rarely and there is the problem of false positive results in this low prevalence population. Ideally positive gonorrhoea results should be confirmed by culture to obtain antibiotic sensitivities. *Neisseria gonorrhoeae* is a fragile organism and does not survive well in transport media, which mitigates against cultures being taken in primary care. In GU settings, discharge can immediately be plated on to specific gonorrhoea culture medium and incubated.

Positive gonorrhoea results should be referred to GU for further management, as should clinically suspected cases of gonorrhoea (patients presenting with marked purulent urethral discharge).

The testing of men who have sex with men (MSM) for STIs with oral and rectal swabs should probably be done in a specialist GU setting. Patients with recurrent non-specific urethritis (NSU) – recurrent symptoms of dysuria with or without discharge, or symptoms that do not respond to first-line treatment – require investigation for *Mycoplasma genitalium* and should be referred for specialist testing.

Genital warts and molluscum contagiosum

Non-genital warts are widely treated by cryotherapy in primary care, and many clinicians may be willing to do the same for genital warts and sexually acquired molluscum. GU clinics, however, are well set up to provide these services. Podophyllotoxin cream and lotion or imiquimod cream can be prescribed outside specialist care for human papilloma virus. Imiquimod is not licensed for the treatment of molluscum contagiosum though is widely used.

Acute pelvic pain/pelvic inflammatory disease

Acute pelvic pain is an emergency and assessment of any patient with abdominal pain is part of GMS. PID is only one possible cause and, as the diagnosis is a clinical one made on the basis of history and examination without waiting for results of swabs, primary care clinicians should have a low threshold for diagnosing the condition and treating it with appropriate antibiotics, and many will do this without referral. This requires up-to-date knowledge of antibiotic recommendations, and a need to follow up the patient and arrange contact tracing. Basic gynaecological history taking is important here. It is important to enquire about chronic pelvic pain and to take a menstrual history if thinking about endometriosis as a possible cause. Acute gynaecological conditions such as ovarian cyst rupture or torsion can present to emergency departments or primary care, and can be confused with acute PID.

Acute epididymo-orchitis

This is essentially the male equivalent of PID and can also be managed with confidence in primary care. The same provisos apply as when managing dysuria, in distinguishing between STIs and urinary infection. A careful sexual history should therefore be taken and, as with PID, follow up should be arranged.

Acute genital ulceration

Primary acute genital herpes frequently presents in primary care, often out of hours. It is a very painful and distressing condition, needing immediate treatment with anti-virals without waiting for swab results. It frequently affects young women and can be managed satisfactorily in primary care without referral. These patients are clearly at risk of other STIs, but are usually in too much discomfort to have a speculum examination for screening at the time of presentation with primary herpes, and must be asked to return for this to be done a few days later.

Other causes of acute genital ulceration such as suspected syphilis should be referred. Patients with recurrent genital herpes can be managed in primary care or via GU services with suppressive therapy, provided confirmatory laboratory tests are done before commencing prolonged courses of treatment and there is an agreement with the patient as to how long the period of suppressive therapy will last.

Management of HIV patients in primary care

Many GP practices frequently offer HIV testing as part of general STI screening or to patients presenting with symptoms suggesting of immunosuppression and HIV infection. There is a move towards offering testing to all new patients, especially in areas with high prevalence (>2/1000).

HIV itself however is almost exclusively managed in secondary care and requires close liaison with primary care. There remains an unwillingness amongst a minority of HIV patients to divulge their status to their primary care provider. The reason usually cited for this is fear over confidentiality. This can compromise care and all patients in HIV clinics should be strongly encouraged to inform their GPs. Equally, GPs are encouraged to manage the non-HIV related comorbidities of their HIV patients. There are moves nationally to improve communication with GPs, for example, by providing information about drug interactions and ensuring that primary care clinical systems are updated, with anti-virals being prescribed and entered in such a way on clinical systems that potential interactions with medications prescribed for non-HIV associated conditions are highlighted. ◆

FURTHER READING

British Association for Sexual Health and HIV— management guidelines, education and training including Sexually Transmitted Infection Foundation Courses http://www.bashh.org/.

British HIV Association - guidelines for HIV management and HIV testing. http://www.bhiva.org/.

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