

Ministry of Defence

Synopsis of Causation

Atrial Fibrillation

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Disclaimer

This synopsis has been completed by medical practitioners. It is based on a literature search at the standard of a textbook of medicine and generalist review articles. It is not intended to be a meta-analysis of the literature on the condition specified.

Every effort has been taken to ensure that the information contained in the synopsis is accurate and consistent with current knowledge and practice and to do this the synopsis has been subject to an external validation process by consultants in a relevant specialty nominated by the Royal Society of Medicine.

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1. Definition

- 1.1. **Atrial fibrillation (AF)** is a condition of disorganised electrical conduction in the [atria](#), resulting in ineffective atrial pumping action and irregular contractions of the [ventricles](#) with loss of cardiac efficiency.
- 1.2. AF is the commonest sustained [cardiac arrhythmia](#).¹
- 1.3. Recent guidelines suggest classification of AF based on the temporal pattern of the arrhythmia. AF is considered **recurrent** when a patient develops two or more episodes. These episodes may be **paroxysmal** if they terminate spontaneously, defined by consensus as seven days, or **persistent** if the arrhythmia requires electrical or pharmacological [cardioversion](#) for termination. Successful termination of AF does not alter the classification of persistent AF in these patients. Longstanding AF (defined as over a year) not successfully terminated by cardioversion, or when cardioversion is not pursued, is classified as **permanent**.
- 1.4. AF is associated with a substantial risk of [thromboembolism](#). When the emboli involve the brain, they cause [transient ischaemic attacks](#) (TIAs) or [stroke](#), but systemic thromboembolism may also occur.
- 1.5. The [prevalence](#) of AF increases with age, occurring in almost 5% of the population older than 69 years.^{2,3,4}
- 1.6. AF is more common in males.^{2,3}

2. Clinical features

- 2.1. The ineffective pumping action of the fibrillating atria results in overall cardiac [haemodynamic](#) disturbance in which the heart rate is rapid and the beat irregular.
- 2.2. A patient with AF may be [asymptomatic](#) (silent AF),⁵ especially if elderly. In paroxysmal AF, only 1 in 12 paroxysms may be symptomatic.⁶ Others may complain of a wide variety of symptoms, many of which may be nonspecific:
- [palpitations](#)
 - tiredness, especially on exercise
 - [dyspnoea](#)
 - chest pain due to [angina](#)
 - [syncope](#)
- 2.3. Examination findings may include:
- irregularity of the pulse often described as irregularly irregular, both in timing and strength. The pulse rate is usually raised
 - [hypotension](#) and reduced [perfusion](#) of tissues
 - signs of [congestive cardiac failure](#) – (for example, [rales](#), raised [jugular vein](#) pressure and [peripheral oedema](#))
 - signs of embolism – TIAs, stroke or, less commonly, arterial obstruction to limbs
- 2.4. Investigation findings may include:
- typical [electrocardiographic](#) (ECG) abnormalities during an AF episode
 - typical ECG abnormalities detected amongst normal ECG tracings on monitoring over a period of time, either on a 24-hour Holter monitor or patient event recorder (cardiomemo). This type of monitoring is used for investigating intermittent arrhythmias
 - [echocardiography](#) images obtained by various techniques to assess cardiac structural and functional abnormalities

3. Aetiology

- 3.1. The causes of AF are many and varied, each contributing to the complex disturbances that occur in the atrial tissues.
- 3.2. **In the normal heart in [sinus rhythm](#)** the [excitation](#) spreading through the atrial [myocardium](#) from the [sinus node](#) stimulates contraction in [myofilaments](#) that have reached the end of their [refractory period](#). At the normal rate of [conduction](#) the spreading wave produces coordinated muscular action and effective pumping.
- 3.3. **AF** can result if the excitation wave is slowed, if myofilament refractory periods are shortened or if the route travelled by the wave is lengthened, as in atrial dilatation. Different models of this process of **functional re-entry** have been described but details are still not fully understood.⁷

- 3.4. **Causative factors can promote functional re-entry** in the atria by effects on:

- electrical functions
- contractile functions
- atrial structure

- 3.4.1. Indeed, **AF itself** has been shown to produce effects in all three categories, a process known as **atrial remodelling**:

- rapid atrial rates cause incomplete restoration of [ion-exchange](#) processes between contractions of myofilaments causing **shortening of the refractory period** ^{6, 8}
- **myocytes undergo change in form and chemical properties**, reducing contractility and contributing to [cardiomyopathy](#) ^{6, 9, 10, 11}
- in long standing AF, **increase in atrial fibrosis** is induced ^{6, 12, 13, 14}

This process is referred to as “**AF begets AF**” ^{1, 6}

- 3.5. Until the late 1990s it was considered that re-entry mechanisms were solely responsible for AF. However, it is now considered that **trigger foci** other than the sinus node exist,⁶ mainly in the muscular sleeve of the [pulmonary](#) veins,^{15, 16} but also in other cardiac veins,¹⁷ the [ligament of Marshall](#) in the left atrium¹⁸ and the [superior vena cava](#).^{19, 20} These foci act as sources of [tachyarrhythmias](#) and atrial [premature beats](#).⁶

- 3.6. **Many conditions can contribute** to the aetiology of AF and can be considered in three groups:

- **reversible** causes
- disease or treatment **incidents that may resolve**
- conditions **associated with cardiac disease** affecting the atria

3.6.1. **Reversible** causes include:

- [thyrotoxicosis](#)
- intoxication with alcohol, some drugs (prescribed or illicit), some herbal remedies or carbon monoxide
- [electrolyte](#) imbalances

3.6.2. Causes due to **incidents that may resolve** include:

- acute myocardial [infarction](#)
- pulmonary diseases including pneumonia and embolism
- [pericarditis](#)
- cardiac surgery
- any pyrexial illness

3.6.3. Causes **associated with cardiac disease** include:

- congestive cardiac failure
- [hypertensive](#) disease, especially if of long duration
- [coronary artery](#) disease
- [diabetes mellitus](#)
- pulmonary diseases such as [chronic bronchitis](#)
- [rheumatic heart disease](#) including [valvular disorders](#)
- other structural heart diseases including left ventricular [hypertrophy](#) and cardiomyopathies
- [congenital](#) heart disease
- [infiltrative diseases](#) such as amyloid²¹

3.6.4. Some of these causes may induce AF in several ways, their effects not necessarily being confined to one group only. Indeed it is thought that [autonomic nervous system mediated activity](#) can play a part in [induction](#) of AF.^{22, 23, 24}

3.6.5. AF occurring in the absence of any known causative condition is termed **lone AF**. This diagnosis can only be made by exclusion after thorough, detailed assessment. However, it has been shown that certain cellular changes can occur in the atria during lone AF²⁵ and these may be associated with increased morbidity and mortality in patients over 65.

3.6.6. AF can be associated with the [Wolff-Parkinson-White](#) and [sick sinus syndromes](#) but

the precise nature of these associations is not clear.^{26, 27}

3.6.7. **Smoking tobacco** can be a factor in the aetiology of AF where smoking contributes to causing any disease which can induce AF, such as chronic lung disease and vascular disease.

4. Prognosis

- 4.1. In general, the prognosis for a patient with AF depends greatly on the age of onset, the number and duration of AF episodes, the severity of other disease processes, the types of treatment that have been used and which further treatment options are available.
- 4.2. A recent large scale study ²⁸ has shown that **factors associated with an increased risk of death in AF** are:
 - increasing age
 - coronary artery disease
 - congestive heart failure
 - diabetes
 - stroke or TIA
 - smoking
 - left ventricular [dysfunction](#)
 - [mitral regurgitation](#)
- 4.3. AF can cause atrial remodelling and is associated with risk of stroke and thromboembolism through various mechanisms. Treatment of AF aims to minimize these adverse conditions by appropriate use of anticoagulants while restoring sinus rhythm (cardioversion) or controlling the heart rate. Anticoagulant drugs have their own associated risks and assessment of the need for them is one of the many factors the clinician has to consider.²⁹ Choice of “rhythm control” or “rate control” is also difficult as each has its own set of advantages and disadvantages.
- 4.4. Development of new drugs continues as does assessment of a variety of non-pharmacological techniques involving [open heart surgery](#), radiofrequency catheter [ablation](#), implanted defibrillators, implanted pacemakers and other devices to reduce the risk of development of cardiac thrombus.
- 4.5. The best approach for each patient has to be assessed individually and the prognosis varies accordingly.

5. Summary

- 5.1. AF is the most common sustained arrhythmia in adults and is produced by abnormal patterns of excitation in the atria triggered by foci usually outwith the sinus node.
- 5.2. It can be caused by many factors, the main ones being advancing age, hypertension, arterial and cardiac diseases.
- 5.3. The prognosis for each patient depends on many factors including age, general state of health, AF duration characteristics, and suitability for cardioversion procedures, thromboembolism risk being one of the major influences on the choice of treatment.
- 5.4. New drugs and new technologies are being developed which may improve the prognosis for many.

6. Related Synopses

Cerebral Infarction

Cerebral Haemorrhage

Subarachnoid Haemorrhage

Atherosclerosis

Cardiomyopathies

7. Glossary

ablation	The removal of diseased or unwanted tissue from the body by surgical or other means.
angina	Chest pain due to inadequate delivery of oxygen to the heart muscle.
anticoagulants	Agents that reduce blood clotting.
arrhythmia	An abnormal rhythm of the heart beat.
asymptomatic	Without obvious symptoms of disease.
atria	The two heart chambers that pump blood into the two ventricles, the more powerful chambers that pump the blood throughout the body.
autonomic nervous system	Nerves that are not under conscious control, responsible for regulating key functions including activity of the heart muscle, smooth muscles (e.g. of the gut) and glands.
cardiac	Pertaining to the heart.
cardiomyopathy	Disease primarily of heart muscle.
cardioversion	Conversion of abnormal heart rhythm to normal.
catheterisation	Insertion into an artery of a very thin and flexible instrument which is then guided into specific arteries of the heart.
chronic bronchitis	A longstanding inflammatory disease of the bronchi (main tubes of the lungs).
conduction	The transfer of waves of electrical activity.
congenital	Pertaining to conditions present at birth.
congestive cardiac failure	A condition where there is inefficient pumping action of the heart leading to accumulation of fluid in the lungs and other areas of the body.
coronary artery	One of the arteries that supply the heart with oxygenated blood.
defibrillator	A device which delivers a measured electrical shock to arrest fibrillation of the heart.
diabetes mellitus	A disease due to deficiency of insulin which regulates the body's use of sugars.

dysfunction	Disturbance, impairment or abnormality of the functioning of an organ.
dyspnoea	Difficulty in breathing or laboured breathing.
electrocardiography	A technique which records the electrical activity of the heart muscle. Hence <i>electrocardiographic</i> .
echocardiography	A technique which uses ultrasound waves to make images of the heart chambers, valves and surrounding structures.
electrolyte	A substance that dissociates into ions (chemical radicals bearing an electric charge) in solution and thus becomes capable of conducting electricity.
excitation	A stimulating action.
fibrosis	A process whereby normal tissue is replaced by scar tissue.
haemodynamic	Pertaining to movement of the blood.
hypertensive	Pertaining to increased blood pressure.
hypertrophy	Abnormal over-growth, e.g. of a muscle.
hypotension	Abnormally low blood pressure.
induction	The process of causing to occur.
infarction	Death of tissue due to interruption of blood supply.
infiltrative disease	Disease causing accumulation in a tissue of substances not normal to it.
invasive	Involving puncture or incision of the skin or insertion of an instrument or foreign material into the body.
ion-exchange	A process involving the passage of charged chemical radicals across a cell membrane.
ischaemic	A low oxygen state usually due to obstruction of the arterial blood supply or inadequate blood flow.
jugular vein	A vein in the neck.
ligament of Marshall	A bundle of muscle fibres within the left atrium.
mitral regurgitation	The back flow of blood from the left ventricle to the left atrium through a defective mitral valve.
myocardium	The muscular layer of the heart wall.

myocytes	Muscle cells.
myofilaments	The ultramicroscopic threads of filamentous proteins making up myofibrils (muscle fibres) in muscle cells.
open heart surgery	An operation performed through an incision which exposes the required area of the heart.
pacemaker	A device that stimulates the heart to contract at a rate set by the device.
palpitations	Unpleasant sensations of irregular and/or forceful beating of the heart.
perfusion	The passage of a fluid through the vessels of tissues.
pericarditis	Inflammation of the pericardium, the outer layer of tissue covering the heart.
peripheral oedema	An abnormal build up of fluid between tissue cells in the parts of the body away from the centre.
pharmacological	Pertaining to drugs.
premature beat	An abnormally early contraction of the heart due to an abnormal impulse.
prevalence	The proportion of individuals in a population having a disease.
pulmonary	Pertaining to the lungs.
rales	Medically significant sounds accompanying normal respiratory sounds.
refractory period	The interval after a contraction during which the muscle fibres are incapable of responding to another electrical stimulus.
rheumatic heart disease	The effects on the heart of rheumatic fever, a generalised disease believed to be an autoimmune reaction to streptococcal bacterial infection.
sick sinus syndrome	Dysfunction of the sinus node causing abnormal triggering of the heart beat.
sinus node	The impulse generating tissue located in the right atrium.
sinus rhythm	The normal regular heart rhythm stimulated by the sinus node.
stroke	Damage to brain nerve cells due to interrupted blood flow.

superior vena cava	The major vein draining the chest and head which ends in the right atrium.
syncope	A temporary loss of consciousness due to reduced blood flow to the brain.
syndrome	A set of signs or a series of events occurring together that point to a single disease or condition as the cause.
systemic	Affecting the body as a whole.
tachyarrhythmia	Excessive rapidity of heart action associated with irregularity in the normal heart rhythm.
thromboembolism	The sudden blocking of an artery by a clot carried by the blood flow.
thrombus	Blood clot formation within blood channels.
thyrotoxicosis	A condition resulting from the effect of excessive quantities of the thyroid hormones.
transient ischaemic attack	A temporary paralysis, numbness, speech difficulty or other symptom of brain dysfunction that starts suddenly and recovers within 24 hours.
valvular disorder	Disease of a heart valve.
ventricles	The powerful muscular chambers of the heart that pump the blood throughout the body.
Wolff-Parkinson-White syndrome	A condition in which various disordered heart rhythms can occur due to an abnormal pathway between the atria and the ventricles.

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