Stroke is the second-leading single cause of disease in the world, closely behind ischaemic heart disease, and the fourth in the UK, with first-time stroke occurring worldwide every two seconds (World Health Organization, 2017). It is also one of the largest causes of disability: half of all stroke survivors have a disability and over one-third are dependent on carers (Stroke Association, 2016; Moorley et al, 2014).

The media have played a crucial role in raising public awareness of the personal and societal consequences of stroke. Our society has become more cognisant of the function and complexity of the human brain, thanks to enhanced multidisciplinary and international communication, expanding research, increasing media coverage, and high-profile cases such as those of Andrew Marr and Sharon Stone.

**Definition**

The term ‘stroke’ was coined and introduced to medicine by William Cole in the late 17th century (Cole, 1689), and has remained a generic definition since. Physiologically, stroke is an acute, focal injury of the central nervous system (CNS) of a vascular origin, contributing to a local or systemic neurological insult. Technological advances (Adams et al, 2007) have proved beneficial in terms of identifying the origins of the injury and determining whether it is a cerebral infarct, subarachnoid haemorrhage or intracerebral bleed. However, despite these improvements, the definition of stroke remains inconsistent (Sacco et al, 2013).

The WHO describes stroke as a clinical syndrome typified by “rapidly developing clinical signs of focal or global disturbance of cerebral function, lasting more than 24 hours or leading to death, with no apparent cause apart that of vascular origin” (Hatano, 1976, WHO 1965).

This definition is no longer accurate, as it does not take into account the advances that have been and continue to be made in imaging techniques and diagnostics. The detrimental and permanent effects of stroke can occur much earlier, so the 24-hour inclusion criteria is not accurate. Equally, the deterioration of global
cerebral function can be the result of stroke, but also of other direct or indirect cerebral pathologies.

Stroke is different from transient ischaemic attack (TIA) as its symptoms last longer than 24 hours and it carries an increased risk of mortality; diagnosis is supported by evidence of focal infarction or haemorrhage on imaging. Conversely, a TIA is a dysfunction of vascular origin lasting less than 24 hours, with no evidence of infarction on imaging.

A group of experts convened by the American Heart Association and American Stroke Association (Sacco et al, 2013) has produced consensus definitions in an attempt to accurately describe the different types of stroke (Table 1).

### Epidemiology and cost

While the incidence of stroke is declining in many developed countries, it is likely that, with a globally ageing population, the absolute numbers of stroke will increase worldwide. Stroke affects 15 million people worldwide every year; it is estimated that five million of these will die and a further five million will be left with a permanent disability (WHO, 2002). This makes stroke the second-leading cause of death worldwide behind ischaemic heart disease.

In the US, 795,000 strokes occur each year (Benjamin et al, 2017) while in the UK there are more than 100,000 (Royal College of Physicians, 2017). Worldwide, someone has a stroke every two seconds – in the UK it is every five minutes; in the US every 40 seconds – and worldwide, a stroke leading to death occurs every four minutes.

In the UK, first-ever stroke affects about 230 people per 100,000 population each year and accounts for 11% of all deaths (Rothwell et al, 2005). In England and Wales alone, over 80,000 people are hospitalised with acute stroke each year (Inter-collegiate Stroke Working Party, 2016).

Approximately 85% of strokes are due to cerebral infarction, 10% to primary haemorrhage and 5% to subarachnoid haemorrhage. The risk of recurrence is 26% within five years and 39% within 10 years of a first stroke (Mohan et al, 2011). Most strokes occur in people over 40 years of age, but children are also affected. Approximately 400 childhood strokes occur in the UK each year (Stroke Association, 2017). Children with sickle cell disease are 333 times more likely to be at risk than a normal, healthy child (Ohene-Frempong et al, 1998). In the UK, more people are surviving stroke than ever.
**Risk factors**

There are many risk factors that predispose people to stroke, some of which are modifiable. Lack of exercise, poor diet, smoking and excessive alcohol intake are common risk factors that can be countered by cost-effective patient education, and there is an urgent need for government-led strategies aimed at improving public health.

Box 1 and Box 2 feature modifiable and non-modifiable risk factors, respectively (Romero, 2008). Gender, ethnicity and socioeconomic group are further discussed below.

**Sex**

Men have a higher risk of a stroke than women and often experience stroke at a younger age (RCP, 2017). However, women are more likely to die from stroke, as they tend to live longer and have strokes at an older age (Stroke Association, 2017).

**Ethnicity**

White people are more likely than non-white people to have atrial fibrillation with a history of smoking or alcohol use, while black people are more likely than white people to have sickle cell disease, hypertension and diabetes – all of which are risk factors for stroke. People of South Asian origins are more likely the rest of the population, to have hypertension, high cholesterol and diabetes (Banerjee et al, 2010).

**Socioeconomic group**

People from more deprived areas and backgrounds are more likely to have a stroke, and the strokes they experience are likely to be more severe (Marshall et al, 2015). Fifty years ago, stroke was associated with higher socioeconomic groups, but this trend has been reversed as risk factor profiles have changed (WHO, 2011). This reversal is largely due to higher levels of smoking, hypertension and diabetes in lower socioeconomic groups.

**Diagnosis**

Given the above statistics showing the personal and societal cost of stroke, it is imperative that stroke is efficiently and effectively diagnosed and treated globally. It still carries a high morbidity and mortality and, despite lower incidence, much remains to be done to improve patient outcomes and prevention.

Diagnosis is only possible through a combination of thorough clinical examination, critical review of the patient’s history and careful investigations with multi-imaging techniques. Each step adds to the clarity of the eventual diagnosis, consequently improving the chances of patients receiving the right treatment and experiencing better outcomes.

**‘Time is brain’**

Stroke is a medical emergency requiring urgent diagnosis and treatment: the phrase ‘time is brain’ stressing that human nervous tissue is rapidly lost as stroke progresses (Saver, 2006).
Box 1. Modifiable risk factors for stroke

<table>
<thead>
<tr>
<th>Risk Factor</th>
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<tbody>
<tr>
<td>High blood pressure</td>
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<tr>
<td>Abnormal blood lipids</td>
</tr>
<tr>
<td>Smoking</td>
</tr>
<tr>
<td>Physical inactivity</td>
</tr>
<tr>
<td>Obesity</td>
</tr>
<tr>
<td>Unhealthy diet</td>
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<tr>
<td>Diabetes</td>
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</table>

Most people experience stroke outside the acute hospital environment, so it is crucial to improve the recognition and immediate management of acute stroke, both among the public and first-responding health professionals.

The publicising of the FAST checklist (Harbison et al, 2003) and widespread media coverage of what to do in case of a TIA or stroke have had an informative and encouraging impact in stimulating public awareness about stroke and its symptoms.

FAST provides a quick checklist of signs and symptoms of stroke and prompts people to urgent action. The acronym stands for:

- **F**ace – has the face fallen to one side?
- **A**rms – can both arms be raised and held raised?
- **S**peech – is speech slurred or difficult to understand?
- **T**ime – call 999 if any of these signs of stroke are present.

However, while the FAST checklist can help identify the onset of TIA and stroke, it does not take into account certain clinical presentations such as sudden-onset visual disturbance or unilateral and widespread brain dysfunction.

Box 2. Non-modifiable risk factors for stroke

<table>
<thead>
<tr>
<th>Risk Factor</th>
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<tbody>
<tr>
<td>Advancing age</td>
</tr>
<tr>
<td>Heredity or family history</td>
</tr>
<tr>
<td>Sex</td>
</tr>
<tr>
<td>Ethnicity</td>
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</table>

TIAs as a warning sign of stroke

The UK Stroke Association recommends that TIAs – also called mini strokes (Moorley et al, 2014) – are taken as seriously as strokes. A TIA can be viewed as a warning of a forthcoming stroke – approximately 15% of ischaemic strokes (the most common type) are preceded by a TIA, and there is a 5% risk of stroke in the 48 hours following a TIA. It is estimated that 10,000 strokes in the UK could be prevented if TIAs were treated in time (Stroke Association, 2017).

Scan within one hour of hospital arrival

In 2016, the RCP published a revised version of its national clinical guideline for stroke (RCP, 2016b), which highlights how stroke care should be provided in the UK and the importance of reducing the time it takes to diagnose and treat the condition to optimise patients’ outcomes.

The guideline includes revised recommendations for patients with suspected acute stroke. One of the main recommendations that differs from the earlier version of the guideline is that all patients with suspected stroke should receive a brain scan within one hour of arriving at hospital.

The 2012 edition recommended scanning only certain patients (such as those who may be eligible for thrombolysis) within one hour and all others within 12 hours. Box 3 contains the key recommendations from the new guideline.

Imaging as a guide to treatment

Computed tomography (CT) and magnetic resonance imaging (MRI) are the two main approaches used for brain imaging studies in the hospital setting. They can be further divided into several types of CT and categories of MRI studies.

With the introduction of better techniques, the goals of brain imaging have shifted to include the detailed evaluation of the intravascular thrombus, identification of hypoperfused tissues and irreversibly infarcted tissues, and evaluation of thrombotic and thromboembolic treatment approaches (Latchaw et al, 2009).

Therapy is often guided by the use of either CT or MRI. The primary goal of imaging in patients with suspected stroke is to rule out haemorrhage. The current first-line treatment of acute ischaemic stroke, after ruling out haemorrhage, is recombinant tissue plasminogen activator (rt-PA) (Hacke et al, 2008).

Choosing the imaging technique

One key difference between imaging techniques is that CT can provide static images whereas MRI can deliver static or dynamic cerebral vascular images results rich in diagnostic information. Another important difference is the risk of radiation. Longer exposure to CT scanning carries an increased risk of radiation. With MRI, there is no exposure to harmful ionising radiation, which means its use is favoured over that of CT in clinical settings. Whether detailed CT images are needed for diagnosis is a matter for collaborative clinical judgement.

MRI also has a higher specificity for detecting neurological and vascular malformations, toxic and metabolic disorders, abnormal tissue growth and infection (Hagmann et al, 2007). Thanks to new approaches in medical biophysics used in various MRI techniques, MRI helps differentiate between stroke abnormalities with incredible accuracy and anatomical detail. Between CT and MRI, the latter prevails as the superior imaging technique due to its high sensitivity, increased definition of results and multimodal functions. However, clinicians are often forced to use CT because of a lack of MRI equipment, patients’ fears of the MRI procedure, its high cost, and contraindications linked to...
the presence of ferromagnetic and other metallic substances in patients’ bodies.

Ultimately, the choice of brain imaging technique depends on the availability of instruments, speed of image acquisition, patient stability, potential risks and clinical expertise available on site.

Stroke assessments

The brain and neurological system constantly produce signs and symptoms that provide clues to diagnosis. There are many technological tools to aid diagnosis, but it can also be achieved by thorough bedside clinical assessment by clinicians with an in-depth understanding of brain anatomy and neurological function.

Stroke requires a patient-centred, culturally appropriate and evidence-based approach to care and treatment (National Institute for Health and Care Excellence, 2017). Stroke assessments should focus on the disabilities and needs of patients and be conducted with relatives and carers, to promote both holistic treatment and collaborative decision-making. It is important to acknowledge spiritual beliefs and cultural specificities to ensure care is delivered sensitively (Moorey et al, 2016).

Conclusion

If left untreated, stroke is a debilitating disease that can lead to death. Current statistics reflect the negative impact of unhealthy lifestyles and genetic and environmental predispositions, and the consequent burden on healthcare systems.

Refining the definitions of the different types of stroke has helped us better understand the disease, improve its diagnosis and tailor its treatment. For all the advances in brain imaging techniques, thorough bedside clinical assessment is key in reaching an accurate diagnosis, which then allows appropriate treatment. The importance of good clinical assessments of patients with suspected stroke cannot be overstated.

Box 3. Diagnosis and treatment guidance

● Patients with suspected acute stroke should receive brain imaging urgently and no later than one hour after arrival at hospital

● Patients with suspected acute stroke should be admitted directly to a hyperacute stroke unit and assessed for emergency treatment by a specialist physician without delay

● Interpreting acute stroke imaging to decide whether to give thrombolytic treatment should only be made by health professionals who have received appropriate training

● Patients with ischaemic stroke who are eligible for endovascular therapy should immediately have a CT angiogram from aortic arch to skull vertex – this should not delay the administration of intravenous thrombolysis

● MRI with stroke-specific sequences (diffusion-weighted imaging, T2) should be performed in patients with suspected acute stroke when there is diagnostic uncertainty

Source: Adapted from Royal College of Physicians (2016b)

References