Osteogenesis imperfecta (OI) is a rare inherited condition affecting 1:10,000 to 1:20,000 births (Monti et al, 2010). It is caused by a mutation to the gene that controls the production of collagen, which gives strength to the structure of bone and connective tissue and is found in bone, muscle, ligaments, skin, eyes, ears and heart muscle. It causes lifelong brittle bones and fractures.

There are several types of OI based on clinical, radiological and histological criteria, but in practice, there can be significant overlap. Although most OI is autosomal dominant, some recessive genes have been identified.

The effects of the condition vary between individuals, but it has consequences for the whole family, and a multidisciplinary team approach to care is required. Nurses are in a unique position to facilitate the partnership between care providers, patient and family (Steiner et al, 2013).

Clinical features
Table 1, on page 20, outlines the classification of OI. Features can include:
- Minimal or low trauma fractures;
- Progressive hearing loss, as the bones of the middle ear are affected;
- Brittle discoloured teeth, dentinogenesis imperfecta, affecting enamel;
- Blue/grey sclera of the eye and the lens may also be affected;
- Lax muscles and ligaments;
- Scoliosis or kyphosis caused by vertebral crush fractures and associated respiratory problems;
- Early osteoporosis;
- Short stature.

Fractures commonly occur in infancy and childhood, decrease after puberty and cease almost completely by early adulthood. However, risk increases again in old age, exacerbated by age-related factors such as osteoporosis.

Mild OI can be difficult to confirm in children, as blue sclera are common in infants, and other symptoms such as hearing loss (Paterson et al, 2001) and brittle teeth may not occur until middle age (Monti et al, 2010). Early diagnosis ensures patients receive surgical and medical support to maximise bone strength, minimise fractures and maintain their mobility and independence. It can also help dispel suspicions of non-accidental injury in children.
as a repeated history of injury following minimal trauma is typical in OI (Marlowe et al, 2002).

X-ray of the skull confirming the presence of Wormian bones (tiny soft bones found in the sutures between cranial bones) and genetic testing can confirm the condition, but in severe forms of OI, clinical examination is usually sufficient.

Following diagnosis, parents should be given a written confirmation of the diagnosis to carry with them. This can be presented to health professionals as needed – for example, in cases of fractures being caused by non-accidental injury (Osteogenesis Imperfecta Foundation, 2014).

**Genetics**

Most OI is autosomal dominant, but recently mutations in other genes have been reported to cause rare subtypes of recessive OI and unclassified collagen type disorders (Marini and Blissset, 2013). Autosomal dominant OI (classic OI) accounts for 85%-90% of cases, and is associated with mutations in either Col1A1 or Col1A2 genes. Autosomal recessive OI is rare, and causes only 10%-15% of cases and is associated with more severe effects (National Institute of Health Osteoporosis and Related Bone Disease National Resource Centre, 2012).

Up to 60% of type 1 and type 4, and almost 100% of type 2 and type 3 OI cases do not have an obvious family history. Of these 3%-5% may be caused by parental mosaicism (when a change in a gene responsible for OI is present in more than one of a parent’s reproductive cells that give rise to the sperm or the eggs). The parent may be unaffected if the number of these abnormal cells is low but the abnormal gamete can be passed on to the next generation (Steiner et al, 2013).

All patients and families should be referred for genetic counselling, as parents may experience shock, guilt and initial resentment at a child’s diagnosis (Van Dijk et al, 2012). Follow-up of family members can identify mildly affected adults and affected teenagers, who need to understand their disease and implications for starting their own families.

**Pregnancy and neonatal OI**

People with OI should be advised to have genetic counselling before becoming pregnant. Pre-natal and pre-implantation testing is now possible for those who are aware of a genetic mutation (Human Fertilisation and Embryology Authority, 2015).

Maternity services need to consider fracture prevention if a foetus is suspected of having OI, or where a diagnosis has been made during pregnancy, including:
- Detailed ultrasound scans for diagnosis in utero and detection of fractures in utero;
- Discussion with obstetricians about the safest mode of delivery;
- Neonatal fracture treatment;
- Teaching safe handling techniques to parents during nappy changing, bathing, cuddling;
- Emotional support for the family to encourage bonding;
- Adapted infant aids such as specially adapted car seats, bathing equipment and cot supports to reduce the risk of fracture;
- Extra input from primary care following discharge home;
- Paediatric services follow-up.

Babies with type 2 (lethal) IO (Table 1, above) are very severely affected, and can have multiple limb deformities and respiratory complications because of chest deformity. The condition usually proves to be fatal within a few hours or days of birth, so palliative care and pain relief are essential (Monti et al, 2010).

**TABLE 1 TYPES OF OSTEOGENESIS IMPERFECTA**

<table>
<thead>
<tr>
<th>Type</th>
<th>Bone fragility</th>
<th>Bone deformity</th>
<th>Stature</th>
<th>Sclera</th>
<th>Hearing</th>
<th>Teeth</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Mild</td>
<td>Mild</td>
<td>None</td>
<td>Normal</td>
<td>Blue</td>
<td>Affected later</td>
<td>Rarely affected</td>
</tr>
<tr>
<td>II Lethal</td>
<td>Lethal</td>
<td>Lethal</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>III Progressive deforming</td>
<td>Severe</td>
<td>Severe</td>
<td>Short</td>
<td>Grey/blue</td>
<td>Affected early</td>
<td>Affected</td>
</tr>
<tr>
<td>IV Common variable</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Short</td>
<td>Normal</td>
<td>Normal</td>
<td>Normal</td>
</tr>
<tr>
<td>V</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Short</td>
<td>Normal</td>
<td>Normal</td>
<td>Normal</td>
</tr>
<tr>
<td>VI</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Short</td>
<td>Normal</td>
<td>Normal</td>
<td>Normal</td>
</tr>
<tr>
<td>VII</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Short</td>
<td>Normal</td>
<td>Normal</td>
<td>Normal</td>
</tr>
<tr>
<td>VIII</td>
<td>Severe</td>
<td>Severe</td>
<td>Short</td>
<td>Normal</td>
<td>Affected</td>
<td>Affected</td>
</tr>
<tr>
<td>IX</td>
<td>Moderate/severe</td>
<td>Moderate/severe</td>
<td>Short</td>
<td>Blue</td>
<td>Affected</td>
<td>Affected</td>
</tr>
<tr>
<td>X</td>
<td>Severe/lethal</td>
<td>Severe/lethal</td>
<td>Short</td>
<td>Blue</td>
<td>Affected</td>
<td>Affected</td>
</tr>
<tr>
<td>XI</td>
<td>Progressively deforming</td>
<td>Progressively deforming</td>
<td>Short</td>
<td>Blue</td>
<td>Affected</td>
<td>Affected</td>
</tr>
</tbody>
</table>

Primary care and social services.

There are four centres of excellence for children and young adults with severe complex and atypical OI, in Birmingham, Sheffield, Bristol and London. These provide a cohesive national clinical service enabling collaboration and research.

Transition from child to adult services is challenging and “stepping stone” clinics to bridge the service gap should also be able to provide practical advice and support for young adults with new challenges such as starting college, a new job or leaving home.

**Treatment**

Mildly affected patients have few symptoms, whereas those who are severely affected require frequent review and intervention. The aims of treatment are to:
- Prevent fractures and minimise deformity;
- Maintain optimum bone mass and muscle strength;
- Adapt daily living to minimise injury;
- Promote independence and mobility;
- Provide holistic support and care (Marini and Gerber, 1997).

Low bone mass and reduced bone strength compound fracture risk, and bone density scans are a useful tool for fracture prediction (Bachrach et al, 2011). Healthy lifestyle advice including a calcium-rich diet, weight management, non-contact sports, benefits of exercise such as swimming and walking are also required.

Patients require effective fracture and pain management to maintain mobility, and surgical intervention for repeated fractures to prevent deformity and short stature. Insertion of intramedullary rods can have benefits for long bone strength.
and alignment. Non-surgical intervention such as orthotic devices, splints and braces are invaluable in treating joint laxity and instability.

Regular hearing checks, hearing aids and surgery may be required, along with regular specialist dental checks. School, social and primary care services should be involved in supporting the whole family. Many patients also need management of chronic musculoskeletal pain.

**Drug therapy**

Bisphosphonate drugs inhibit bone resorption and improve bone strength (Russe11, 2011). Studies show that they increase bone density in children and adults (Dwan et al, 2014). Bishop et al (2013) found that oral risedronate (a bisphosphonate) decreased fracture frequency by up to 50% in conjunction with specialised nursing, physiotherapy and occupational therapy in children.

Risedronate has also been used in adults with osteogenesis imperfecta type 1, resulting in increased bone mineral density and decreased bone turnover, but high fracture rates persisted (Bradbury et al, 2012).

Growth hormone therapy may be useful to help increase height in children, in conjunction with bisphosphonates (Antoniuzzi et al, 2010).

**Comorbidities**

Patients who are required to use a wheelchair may develop health problems associated with severely restricted mobility, including kyphosis and scoliosis. Respiratory problems are common in those with chest or spinal malformations, who need timely intervention and management to prevent serious complications. Anaesthesia needs to be carefully managed in this group.

Some patients also have neurological problems such as macrocephaly (large head) and basilar invagination (brain stem distortion), and cardiac problems such as mitral valve prolapse and aortic root dilatation (Hopto1 et al, 1986).

Neurology and vascular surgeons should be aware of tissue fragility before undertaking any procedures.

**Prognosis**

The condition is highly individual: patients may have few or multiple complex issues, and prognosis will vary. Promoting mobilisation, independence and normal living is key, as is the ongoing partnership between health professionals, patient and family.

**BOX 1: PATIENT CASE STUDY**

I am the only person with osteogenesis imperfecta (OI) in my family. I have type 3 OI, so I have a short stature. My parents suspected something was wrong after I was born, as my arms and legs were bowed.

I spent a lot of my childhood in hospital, being in plaster and learning how to walk again after every break. I wasn’t able to play outside with other children and had to be very cautious and careful. My leg once broke when I was just being picked up.

I was about 13 when I started to receive treatment with a new drug, pamidronate, which made a dramatic difference to my bone density. I also had two rodding operations when I was a teenager and had no breaks from then on.

I am Sikh, and in general within Asian communities, disability is looked down on and shunned. As a teenager I was often treated like a child, which I found challenging. People often stared at me, yet used to talk to my mother about me as if I could not hear them or I was unable to respond myself.

Quite a few people still underestimate me and are surprised at what I’ve achieved. I graduated from university with a degree in event and venue management, and now work for the Royal Institute of British Architects. I also started up my own events management company and serve as a trustee of a charitable hospital in India.

Gursharan Kaur

Most patients lead active and successful lives (Case study, above), within the limitations of their condition.

**Role of the nurse**

Patients with OI will go through the same ageing process and be subject to the same disease processes as the general population, so nurses may encounter this rare condition in any sphere of practice.

It has a broad phenotype: patients may have unrestricted or highly compromised mobility and quality of life, but the need for increased awareness of potential bone fragility applies to them all. They can sustain fractures without any trauma, so safe, unhurried and planned manual handling is crucial.

Patients should advise on the amount of physical help needed and how they prefer this to be done. It is essential to maintain mobility, dignity and independence during an inpatient stay to facilitate the patient’s return home.

Communication with family, carers and community services and adequate forward planning for discharge are vital if mobility is compromised.

**References**


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What do nurses need to know about genetics?

Bit.ly/NTGeneticKnowledge