Cerebral palsy is the commonest cause of childhood physical disability. The prevalence is 2 to 2.5 per 1,000 live births. It is a non-progressive neurological condition resulting from damage to the developing brain. As with stroke in adulthood the brain injury is static, however the clinical manifestations in cerebral palsy vary over time as children grow and develop. It encompasses a range of movement, development and posture difficulties. Spasticity is the dominant impairment in over 80% of children. Spasticity is defined as a motor disorder characterised by a velocity-dependent increase in the tonic stretch reflexes (muscle tone). It is considered to be the main contributor to reduced longitudinal muscle growth and impaired function in children with cerebral palsy and other neurological disorders associated with spasticity.

The treatment aims for children with cerebral palsy depend on the type and severity of their condition. The management of spasticity involves a multidisciplinary team approach including physiotherapy, orthotic services, orthopaedic surgery and anti-spasmodic drugs. Botulinum toxin is a treatment modality used for children which may potentiate or even delay the need for some of these interventions.

**Mode of action**

Botulinum neurotoxin is produced by the gram negative anaerobic bacterium, clostridium botulinum. It is a potent neurotoxin and causes muscle weakness through neuromuscular blockade. Seven types have been identified but only botulinum toxin type A (BtA) is available therapeutically in the U.K. BtA is available as Dysport and Botox, with Botox being three times stronger.

**Clinical effects**

The clinical effects of botulinum toxin have been recognised since the end of the 19th century. It was first used therapeutically by Alan Scott during the early 1980s for treating strabismus. Its use in cerebral palsy and spasticity came almost a decade later, aiming to improve movement and function.

Botulinum toxin works as a local muscle relaxant and is highly selective for peripheral nerve terminals containing acetylcholine, preventing its release. As a result botulinum toxin causes reduced muscle contraction which reduces dynamic tone. This muscle relaxation enables longitudinal muscle growth. Botulinum toxin is therefore a key treatment option as it is the muscle shortening in cerebral palsy, arising as a consequence of spasticity, which leads to deformity.

**Patient selection**

It is important to select the correct group of children for treatment. Botulinum toxin is predominantly used for children with cerebral palsy but it is also indicated in post traumatic brain injury, neurodegenerative disorders, genetic and metabolic conditions. A child should be considered for botulinum toxin injections when they have focal,
dynamic spasticity and/or dystonia. Botulinum toxin can be used as therapy for an ambulant child who has a poor, unstable walking gait. It can also be used in non-ambulant children to help improve seating and personal care. Botulinum toxin is also a useful treatment modality for children experiencing pain and spasms due to spasticity. Setting clear functional goals prior to injections helps to give an objective measure of whether a child has responded.

Botulinum toxin can be used in all ages but research suggests a better response in children less than eight years of age. This is because younger children are less likely to have fixed contractures or have developed compensatory patterns of movement. Botulinum toxin is used in older children but has more success in those who have a dynamic component to their spasticity and when it is used in conjunction with other treatment modalities.

Timing of use
Growth of children makes managing spasticity a challenge. Ongoing growth spurs in childhood are a key difference when comparing methods used to assess spas ticity using objective measures. The Tardieu scale measures intensity and duration of muscle tone at different specified velocities.

Gross Motor Function Classification System (GMFCS)
Level I: Walks without restrictions; limitations in more advanced gross motor skills.
Level II: Walks without devices; limitations walking outdoors and in the community.
Level III: Walks with assistive mobility devices; limitations walking outdoors and in the community.
Level IV: Self mobility with limitations; children are transported or use power mobility outdoors and in the community.
Level V: Self-mobility is severely limited even with the use of assistive technology.

Which muscles to target
In spastic hemiplegia, injecting the gastrocnemius can improve dorsiflexion and targeting the elbow and wrist flexors helps to improve reach. Injecting botulinum toxin into the pectoralis muscle can help reduce hip flexion in children with spastic diplegia. In quadriplegia, the aim is to reduce secondary deformity, particularly in the hips and spine. The hip adductors and hamstrings are usually injected first.

Adverse effects
Botulinum toxin has an excellent safety profile. Adverse events are rare but need to be relayed to parents and children prior to the procedure. They include mild generalised weakness, urinary incontinence, constipation or dysphagia in vulnerable children. Despite its use there remain concerns regarding the role of botulinum toxin in childhood spasticity. These relate to which muscles are best to target, optimum dose and the age at which maximum benefit is achieved. Most importantly, controversy surrounds whether there is a reliable evidence base for its effect.

Effectiveness of injections
Lower Limb
There has been substantial research assessing botulinum toxin use for the lower limb in children with cerebral palsy. Despite the limitations of studies, current evidence does suggest a role in reducing lower limb spasticity and improving gait. Extensive studies show clinical improvement and functional outcome with the most commonly injected sites, gastrocnemius and soleus. Although fewer studies focus on injection of these muscles, significant improvements have been seen using botulinum toxin for tibialis posterior, peronei, hamstrings, hip adductors and flexors. Research also suggests that injection of hip adductors reduces rate of hip dislocation.

Upper Limb
The first clinical trial using botulinum toxin for the hemiplegic upper limb was conducted in 1997 with 14 children participating. A significant improvement in wrist/elbow tone and elbow extension was demonstrated in the botulinum group at two weeks and twelve weeks post injection. Subsequent studies focusing on injecting botulinum toxin to the upper limb have not been as promising. They suggest some improvement in cosmesis following botulinum but little change in function. There is currently insufficient evidence to support or reject the effectiveness of botulinum toxin use in the upper limb.
Drooling
Children with spasticity often have poor oral motor control which can manifest as drooling. Saliva can irritate the face, damage clothing and be a source of stigma. By injecting the salivary glands, neuromuscular blockade prevents secretion of saliva. The evidence for this intervention in children is limited as botulinum toxin has only recently emerged as a treatment option for drooling. However, results from a study on 50 children in 2008 showed a significant improvement in drooling a month after intervention with botulinum toxin.6

Conclusion
The use of botulinum toxin is becoming a recognised treatment modality in cerebral palsy. It is surprising not to see a clearer evidence base for botulinum toxin given its physiological effects. This may be attributable to the diversity of children with cerebral palsy included in studies in respect to distribution and severity of tone disturbance. Problems measuring muscle tone and imprecision of assessment tools may also contribute. Future studies need to address these factors to produce more consistent, reliable evidence.

REFERENCES