



21st century neuro-rehabilitation

Candesic's **Dr Joe Taylor** considers opportunities to improve ABI services to address 21st century challenges and opportunities in neuro-rehabilitation

The 1,400g of delicate gelatinous tissue lying between your ears is both indispensable to life and susceptible to injury. The brain has seemingly unbounded capacity for innovation and action, but the concentration of such crucial functions – defining who we are and the paths our lives will take – can be our Achilles' heel.

The brain contains little redundancy and sparse potential for repair. It can't be patched up as we would a broken leg, replaced like a dying kidney or compensated for similar to a deficient pancreas. Achieving maximal rehabilitation following significant brain injury is a long journey, with multiple stages and settings (*figure 1*).

The development of neuro-rehabilitation

services in the UK has focused on working-age adults with traumatic brain injury (TBI) – these people are estimated at less than half of the addressable ABI patient population (*figure 2*). At the same time neuro-rehabilitation for children and old people is still poorly conceived and coordinated – we can do much better for these groups.

Too little rehabilitation, too late following injury

There is compelling evidence that early, intensive and specialised rehabilitation results in the best patient outcomes. Improved long-term independence has the potential to result in lifetime cost savings, which are increasingly

attractive in the context of trends towards pooled budgets and integrated commissioning.

Often the rehabilitation potential of people with a brain injury is not accurately judged, even within dedicated services. Underestimation of people's potential for functional and behavioural improvement results in poor long-term outcomes.

Accurate assessment of rehabilitation potential can happen too late, and too infrequently, for a number of reasons:

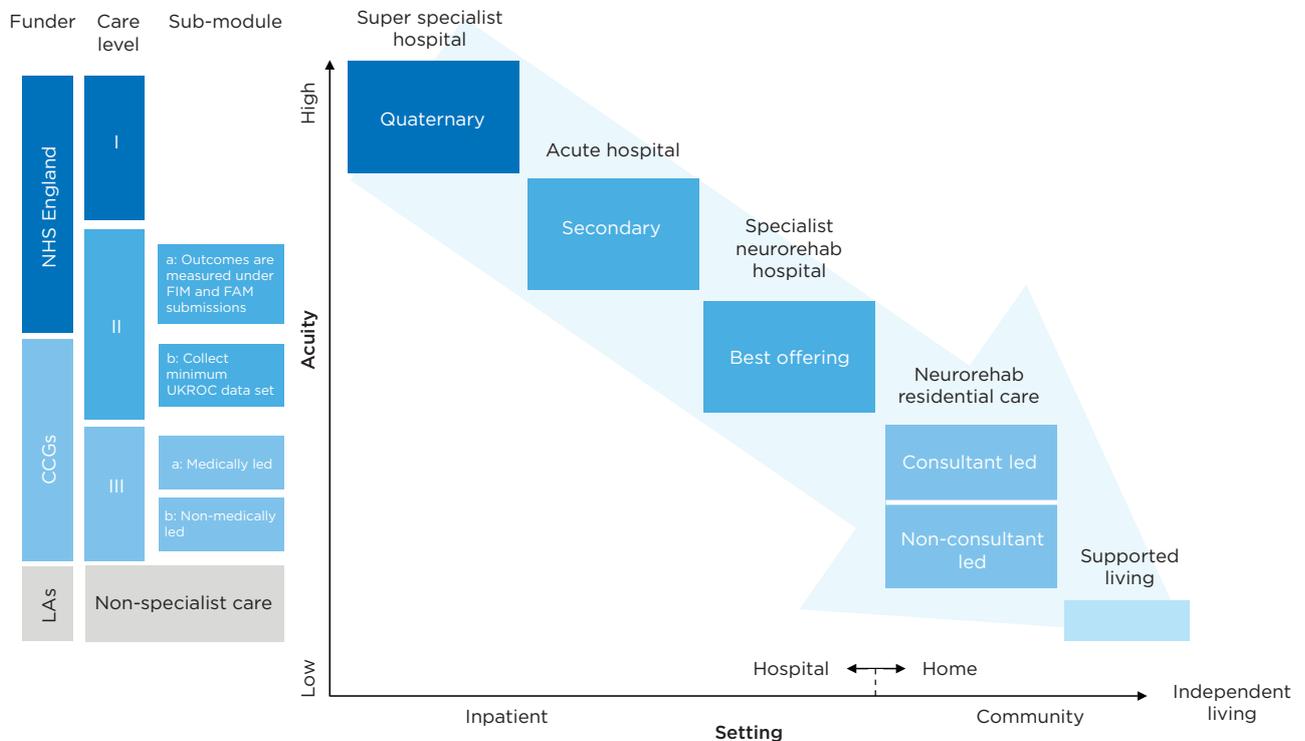
- The ability to support significant acute physical care needs in rehabilitation services is limited, and their resolution considered a crucial step prior to service transition. Rehabilitation specialists and services are seen as the 'next step' following acute stabilisation, not an integrated theme across the full care pathway
- Assessment and identification of rehabilitation potential is ad hoc, so opportunities to support greater independence and improved function come late in the patient's journey; regular reassessment is not always part of care planning
- As people move into lower acuity settings, the expertise of staff in assessment of rehabilitation potential is less and emerging opportunities often missed.

Providers can best support rehabilitation by proactively engaging earlier in the patient pathway and undertake thorough and regular reviews of rehabilitation plans to ensure they continue to be aligned with the potential for improvement and individual goals. Providers also need to invest in better evidence-based




FIGURE 1: ABI REHABILITATION PATHWAY AND COMMISSIONING

Across multiple settings, and funded by a combination of health and social care commissioners, the ABI neuro-rehabilitation pathway aims to reduce acuity of need and the cost of provision



Sources: Candesic research; Candesic analysis

approaches to care plan design and explain to commissioners the need to fine-tune provision and with it funding to meet evolving patient needs.

New technologies, more ambitious rehabilitation goals

The availability of a range of new technologies is moving the goal posts for what is possible following brain-injury, although many providers are still delivering services built around 20th century expectations of recovery and independence. New technologies have to be integrated into neuro-rehabilitation programmes, requiring knowledgeable staff to gain maximal impact:

- 10 years ago, determining the movement of people's eyes to understand their focus of attention and will was invasive, expensive and the preserve of research laboratories. Today, many companies, such as Inclusive Technology, continue to develop software to maximise the potential of new low-cost eye gaze tracking to support people with neurological disability. Whilst standalone

eye tracking platforms have been around for years, the transformative step is the integration of such technology with other devices. For example, eye tracking can be used to control an electric wheelchair, as in the eyedriveomatic project

- Confusion and uncertainty is a common and ongoing correlate of brain injury. Traditionally human supervision and support have been the mainstay of care – now technology is enabling remote monitoring, providing a safety net that can combine independence with cost-effective intermittent support. The Brain In Hand app is a platform used to enable people to manage their emotions and coping strategies. It supports reflection around potential problems and solutions, as well as combining an alert system that can allow a remote 'mentor' to step-in and give support over the phone when people are struggling to cope with a situation
- Mobile applications to support executive function, from the complex through to simple tasks such as a reminding a person of the steps needed to brew a cup of tea, are becoming numerous. We can anticipate continuing innovation in mobile apps, and there is a

need to curate these and incorporate them into individual patient care plans. MakeChange is an app that helps people use the fewest number of coins when handing over change – a simple tool, but one that can make a big impact to facilitate independence in the community.

A panoply of manifestations, a lack of super-specialist services

Diseases and injuries that effect the central nervous system are categorically different to those arising elsewhere in the body. No two disease courses are the same, but neurological damage takes such multitude of forms and manifests in such a diversity that service planning and standardised care pathways are particularly challenging.

The symptoms of people with ABI are overlapping with other patient groups who experience mental health and progressive neurological disease, but that doesn't mean therapeutic approaches or settings can always be shared by these patients with very different illness aetiologies:

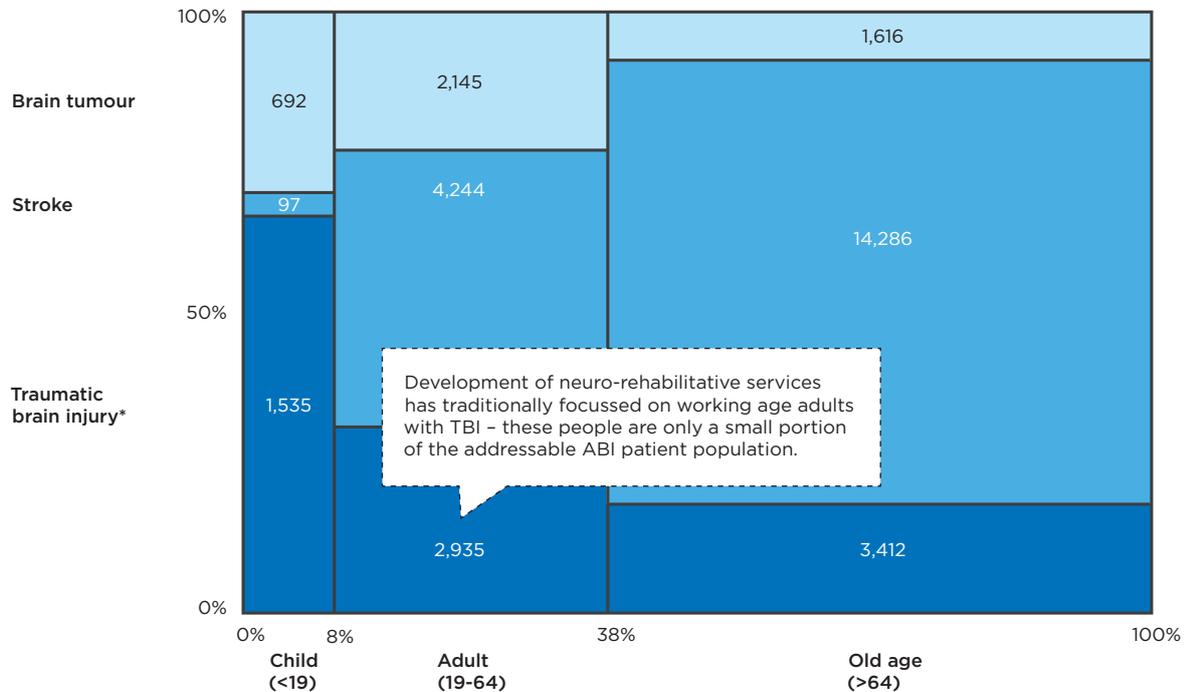
- Whilst children with ABI may face great difficulty in learning, they do not have ►



FIGURE 2: THE ADDRESSABLE MARKET FOR ABI REHABILITATION

Candesic estimates that there are close to 30k individuals with an acquired brain injury each year who would benefit from specialist neuro-rehabilitative care

Service users, 2014-15
N = 30,963



Development of neuro-rehabilitative services has traditionally focussed on working age adults with TBI – these people are only a small portion of the addressable ABI patient population.

* Traumatic brain injury (TBI) is a subset of acquired brain injury (ABI) related to trauma

Sources: Hospital Episode Statistics, Admitted Patient Care, 2014-15, NHS Digital; DW30D, Compendium of National Health Indicators, 2014-15, National Audit Office; ICD-10, WHO; Candesic research; Candesic analysis

- ▶ a learning disability and approaches to supporting these two groups are distinct, as are long-term goals and outcomes
- Although the consequences of stroke and TBI in the elderly often co-exist with the symptoms of progressive cognitive decline, this is not a justification for failure to address the ABI specific elements of support and rehabilitation
- Psychological and psychiatric manifestations of ABI are common, but generalist mental health services are not well-equipped to offer the tailored programme of care required, nor understand the ABI rehabilitation pathway.

Even if delivered regionally, further specialisation of ABI rehabilitation has the potential to reap benefits through improved downstream outcomes.

Stable prevalence, changing incidence patterns

The profile of ABI incidence is changing models of rehabilitation and support will be required. Two groups where specialist services are lacking

are children and older people (figure 3).

Industrial accidents and road traffic accidents (RTA) related cranial injury have reduced markedly in recent years. We can expect fewer working-age adults to acquire brain injuries, although prevalence is likely to decline more slowly as people live longer following injury.

Whilst we're seeing a reduction in the incidence of ABI among working age adults, at polar ends of the age spectrum – children and older people – both incidence and prevalence are expected to continue their rise:

- Young adults are most at risk of TBI resulting from reckless behaviour, RTAs and workplace risks. These have fallen over previous decades, although for those involved they can require many decades of ongoing care
- Older people are at danger of TBI resulting from falls, which will increase in number of are population becomes both more aged and ambulatory. The risk of vascular neurological injury rises with age, and many old people

are surviving strokes with an expectation of further years of independent living

- Children suffer ABI through a variety of causes, including TBI, encephalopathy and brain tumours. More effective and aggressive approaches to treatment will increase the numbers growing up with the sequelae of neural insult.

Children and older people are two groups for whom services are poorly developed in the UK; the reason for this is that it's clinically very difficult to identify their needs, and to address neuro-rehabilitation requirements in the context of other health and social issues.

Older people

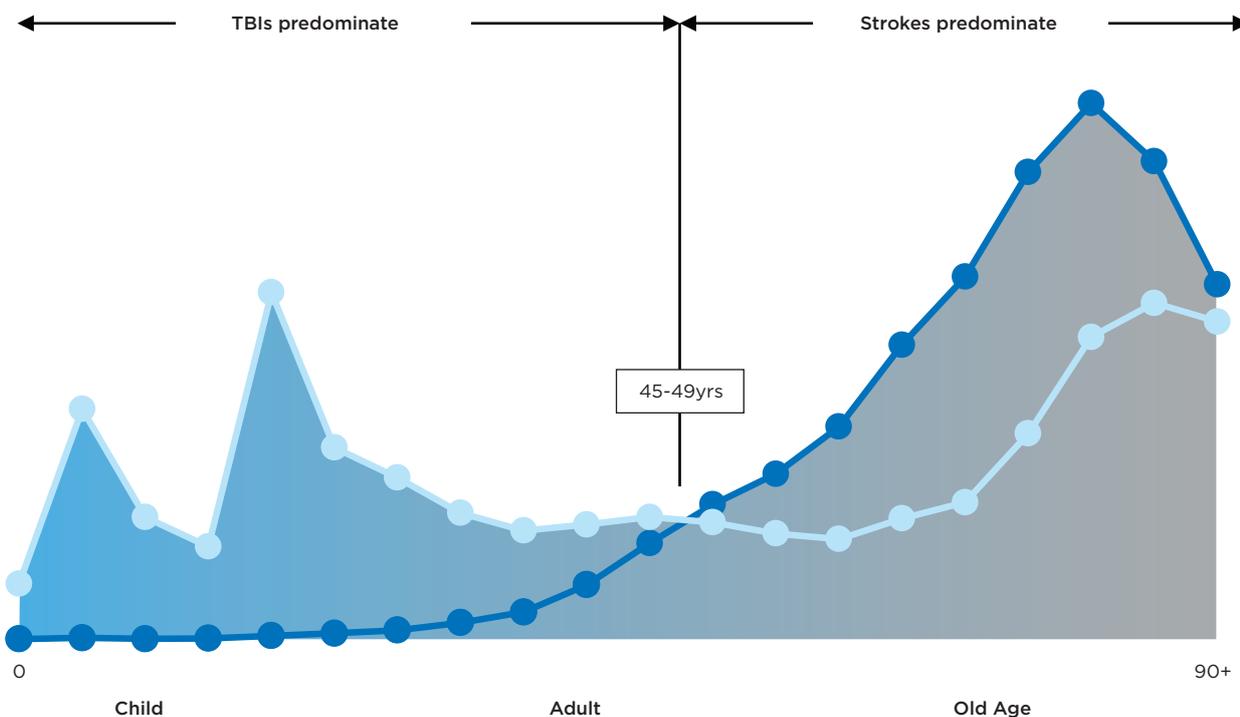
The age of people suffering from an ABI continues to rise, but so have our expectations for life quality and independence in the older population. Traditionally older people with ABI have been most likely to enter generalist nursing homes after immediate post-acute rehabilitation.



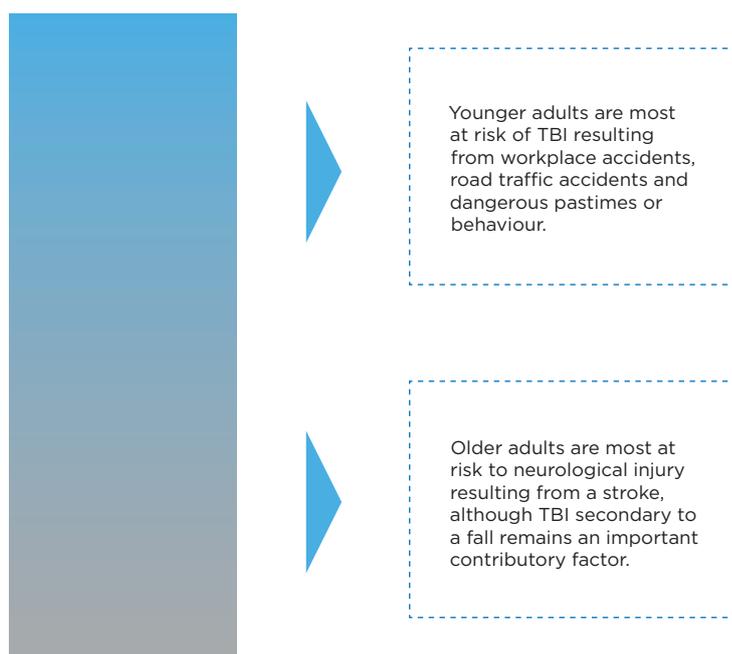
FIGURE 3: AGE DISTRIBUTION OF ABI BY PRINCIPAL AETIOLOGY

ABIs principally occur in the young and old, with strokes coming to dominate the aetiology of ABI as people enter their 50s

Age at time of traumatic brain injury* and stroke**
 % of total incidences



* ICD-10 codes S01 - S09
 ** ICD-10 codes I60 - I69



Sources: Hospital Episode Statistics, Admitted Patient Care, 2014-15, NHS Digital; Candesic analysis

This pathway is likely to change as specialist neuro-rehabilitation services for geriatric patient groups develop and the integration of funding puts pressure on commissioners to improve outcomes.

Stroke service redesign has proven a great success over recent decades, and combined with safer and more effective early pharmacotherapies mean that more people are surviving after their first and subsequent strokes.

Specialist post-acute stroke rehabilitation services are under growing pressure, and there is an opportunity for development of a new model of residential care for this patient cohort. Recognising that general health may be on a downward trend, specifically addressing ABI rehabilitation can support maintenance of function and quality of life.

Outside of ABI specialist residential services it is important that generalist providers of old age care recognise the neuro-rehabilitation needs of people in their services. In elderly residential and nursing homes, staff need to be trained to ►



► recognise the particular needs of people with ABI, liaise closely with community rehabilitation teams and work to ensure through assessment and regular review.

Children

The brains of children are far more plastic than those of older people, and this ability to reshape the way young people's brains process information is of importance in approaching paediatric neuro-rehabilitation. Over time the rehabilitation goals and potential of children are likely to change, and therapeutic approaches must be regularly re-focussed to meet the developing capabilities of the brain.

In addition to a greater capacity to compensate for injury, the consequences of children's brain-injuries may not become apparent for many years. Children can 'grow into' their difficulties as higher functions fail to develop as expected. The delay in the manifestation of neurocognitive problems (the 'sleeper effect') means the needs of many children are not appropriately attributed to ABI therefore do not receive valuable neuro-rehabilitation.

The impact of paediatric brain injury is a combination of physical disability, development, access to education, as well as social and vocation outcomes. With ongoing rolling introduction of education, health and care plans (EHCPs) there are opportunities for child ABI service providers to access multiple statutory funding streams. Providers who can demonstrate their ability to address the needs of children across all domains will be best positioned to meet new integrated commissioning priorities.

An additional important factor in paediatric ABI rehabilitation is the transition from children to adult services, and the transfer of commissioning responsibility that frequently

accompanies it. The success of rehabilitation depends on continuity of approach, environment and staff. Providers that can follow paediatric patients through their complete rehabilitation pathway will likely achieve better outcomes, and under the Children & Families Act can expect to access continuity of funding through to 25 years of age.

In the UK, only a handful of providers have developed services specialised to address the needs of children with ABI. Without access to specialist paediatric neuro-rehabilitation services many children will continue to have costly ongoing care needs.

Functional neuro-restoration, a medium-term opportunity in ABI

In this, the 'Century of the brain' our understanding of the complex patterns of activity taking place inside our heads is set to evolve more quickly than at any other time in human history. Far from being science fiction, real-world surgical, bioelectronic and cellular therapies are being deployed with the potential to completely re-write ABI rehabilitation pathways.

- The implantation of electrode arrays (neuroprostheses) within the brain can monitor a person's intentions and thoughts, signals which can then be passed on other parts of the body that have been cut off from central executive function through injury. Vocalisation, movement of a prosthetic limb and navigation of wheel chair are all now possible, but the future holds much more. A chip to hold memories when our brain's have become amnesic, an electrical impulse that stops our most out-of-control behaviours and autocorrecting implants that halt epileptic neural activity in its tracks are all likely

within the next 5 to 10 years

- Pharmacotherapy to support increased plasticity – that amazing capacity of the brain to redesign itself in the face of damage and destruction – has not been the focus of the pharmaceutical industry to date. However, fundamental advanced in neuroscience offer the promise of hijacking the brain's own plasticity mediating chemicals to drive this process, and there are already established agents looking for a new home – antidepressants among them
- The holy grail of neuro-regeneration is the use of stem cells to repopulate the damaged tissue using its building blocks – neurones. These super specialised cells have effectively become too streamlined to duplicate themselves under most circumstances, and from the time we're born only a few tiny clusters of cells can produce new neurones in their own image over local regions
- Neuro-rehabilitation will become the most scientifically advanced, technologically specialised and painfully expensive clinical discipline mankind has seen. For the industry as much as for patients, this will be a true 21st Century revolution
- We will move from getting by with a low-paid workforce to demanding the very best and the brightest working alongside patients to deliver restorative medicine
- The confluence of technology and care will expand the range of expertise needed within the provider space, and require collaboration across the rehabilitation network
- For some, ABI may become a curable condition, reducing demand for long-term support.

Conclusions

Neurological injury can be a devastating experience for patients and their families; it often carries with it life-long support needs and can change the very nature of a person.

The human brain is still the most enduring mystery in the universe, whilst providing excellent quality care in ABI needn't be. The Candesic team takes pride in continuing to support NHS, third sector and independent providers of high quality neuro-rehabilitation services. ■

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