

# **Role of Neuroplasticity in Stroke Nursing**

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**Keywords:** Neuroplasticity, nursing, stroke rehabilitation, stroke recovery

**Conflict of interest:** No conflicts of interest to report.

## **Abstract**

The focus of this review is on summarising the concept of neuroplasticity and how stroke nursing can utilise it. Neuroplasticity refers to the brain's ability to reorganise and change in response to experience or after brain damage. Neuroplasticity is an imperative component of recovery from stroke, and rehabilitation aims to capitalise on this phenomenon during a patient's recovery. There are several fundamental principles of neuroplasticity, including use it or lose it, repetition, intensity and time. Nurses can play a pivotal role in ensuring optimum conditions for neuroplasticity through a variety of means. These include encouragement of repetition, integration of repetition to everyday tasks, creating a stimulating environment, educating stroke patients as well as their carers about the recovery process and working as part of multidisciplinary team (MDT). Stroke Nursing can help optimise the brain's ability to reorganise, adapt and change after a stroke enhancing recovery and quality of life.

## **Background**

There are more than 100,000 strokes every year in the UK, resulting in over 1.2 million stroke survivors, and stroke is the leading cause of adult disability in the UK (Stroke Association, 2018). Early stroke care and rehabilitation are essential for optimising a patient's

recovery (Langhorne et al., 2011). Neuroplasticity changes and brain reorganisation is associated with stroke recovery (Dimyan & Cohen, 2011). It is, therefore, necessary that all aspects of stroke care, including nursing, capitalises on strategies that enhance neuroplasticity.

Until recently it was thought the brain was fixed and incapable of change by adulthood, but advances in neuroimaging and neurophysiology (Dobkin et al., 2004; Di Pino et al., 2014, Bashir et al., 2010), have allowed for the investigation of neuroplasticity (Alia et al., 2017; Fuchs & Flugge, 2014). These advances have led to an explosion of research and literature into neuroplasticity and its role in stroke recovery (Dimyan & Cohen, 2011; Cramer et al., 2011). This article aims to review and consider the role of neuroplasticity in stroke nursing.

### **What is Neuroplasticity?**

Neuroplasticity is the ability of the brain to change, alter and reorganise its structure in response to experience and learning (Cramer et al., 2011; Woodford, 2009). These adaptations allow the brain to reorganise throughout the lifespan. The brain can modify its structure and functional organisation, with neural connections continuously being strengthened or weakened depending on experiences and activity (Peate, 2019).

Neuroplasticity occurs at many levels across the central nervous system from a molecular or cellular level, to changes in brain structures and impact on behaviour (Bruno-Petrina et al., 2014).

Neuroplasticity appears to occur:

- By forming new connections (synapses) between neurons; as a result of axonal sprouting whereby damaged neurons continue to develop nerve endings which can reconnect with other nerve endings.

- Through the unmasking of existing but unused neural pathways and changes at a synapse level including activation of silent synapses,
- By changes in synaptic neurotransmitters and activity changes at the synapse (Dimyan & Cohen, 2011; Wordward, 2009).

These changes result in improvements in synaptic efficacy, the formation of new connections, utilisation of neural pathways and the change in muscle representations in the brain. These neural mechanisms of change are a process, as opposed to a single event, which can operate simultaneously or separately (Butler & Wolf, 2007). Following injury or brain damage, the uncovering of existing pathways, changes in synaptic activity, including activation of silent synapses, cortical activity changes can begin a few hours after symptom onset. In comparison, structural plasticity changes such as axonal sprouting, synaptogenesis (formation of new synapses) and neurogenesis (generation of new neurons) occur days or weeks after damage (Stinear & Byblow, 2014).

### **The role of neuroplasticity in stroke recovery**

The exploitation and promotion of neuroplasticity are crucial to stroke recovery; it is an important underlying rationale for stroke rehabilitation (Stinear & Byblow, 2014; Cheung et al., 2013). Stroke recovery care involves the prevention of complications, relearning of skills lost and the learning of new techniques to manage any disability while regaining independence (Duncan et al., 2005; Woon, 2015). The ability of the brain to adapt and reorganise following stroke is an essential neurobiological mechanism of cortical recovery after stroke that can be capitalised on (Bruno-Petrina et al., 2014). Therefore stroke treatment, care and rehabilitation need to enhance and optimise the brain's ability to reorganise/adapt to improve treatment outcomes and quality of life. Research has demonstrated that

improvements in impairment, levels of function and quality of life occur in parallel or in conjunction with cortical reorganisation (Dobkin et al., 2004; Bütéfisch, 2006; Ward, 2011). Several principles underlie the generation of Neuroplasticity (Kleim & Jones, 2008; Gan & Ramani, 2008). These include; use it or lose it- that neural pathways not actively engaged will degrade (Vance et al., 2012). This has implications following stroke as non-use of the paretic limb, can cause a reduction in the size of that muscles representation in the brain and decrease activity in the neural pathways between brain and muscles (Marzouk., 2017). The induction of neuroplasticity requires repetition (Nudo, 2011) to strengthen neural pathways and connections; the repetition of a task or behaviour is needed to induce lasting changes. Due to limited stroke rehabilitation time, often, the number of repetitions can be low (Lang et al., 2009), which can have an impact on the potential neuroplastic changes. Therefore stroke patients need to be encouraged to practice skills outside of therapy. Time after an injury seems to be a crucial factor in the dynamic changes associated with increased neuroplasticity, as many of the neuroplastic changes start occurring very early/ or within hours of injury. There is evidence to suggest that early provision of rehabilitation improves outcomes and reduces disability (Kwakkel et al., 2004). Therefore stroke care and rehabilitation must start early to build on this. It is relevant to note, that although neuroplasticity is optimised early after stroke, as discussed previously, several neuroplastic processes occur over weeks and months (Su, Veeravagu & Grant, 2016). It has been demonstrated that stroke patients can have induced neuroplasticity changes many years after their stroke (Cramer et al., 2011). Other principles for neuroplasticity include intensity- that the induction of neuroplasticity requires sufficient training intensity (Dimyan & Cohen, 2011). Several techniques are used to help increase the intensity, including weekend therapy, technology such as video games and early supported discharge of patients by increasing contact after hospital discharge. Task-specific practice is necessary, but neuroplasticity in response to a task training experience can

improve the acquisition of similar tasks and skills (Hubbard et al., 2009). It has been demonstrated that Mental Imagery can be useful in rehabilitation therapy or adjuvant. This is the process of an individual repeatedly mentally rehearsing an action or task without actively physically performing the action or task (Barclay- Goodard et al.,2011). This technique has been implemented with stroke patients, as it allows individuals who have severely impaired paretic limbs to mentally practice a movement without having the functional ability to complete it (Page & Peters, 2014). By using neuroimaging, several studies have demonstrated that during motor imagery, activation occurs in brain areas similar to those associated with the implementation of motor tasks (Sharma, Baron & Rowe, 2009), demonstrating similar neuroplasticity changes seen in motor rehabilitation.

### **Role of nurses in stroke recovery**

The role of stroke nursing is key in a patient's recovery. Nurses have a balance of day to day clinical tasks and the assistance of functional recovery through rehabilitation (Clarke,2013). The nursing role in stroke has been described as being involved with "hands-on' care, a role in the coordination of care and having patient-centred components (Burton & Gibbon., 2005). The vital role that nursing assessment and care, has for efficient multidisciplinary working is well established (Long et al., 2002). The interaction between nursing and stroke rehabilitation therapies is significant in ensuring the integration of therapeutic exercises into daily routines (Burton, 2000).

### **Stroke nursing and neuroplasticity**

Stroke nursing has a pivotal role in ensuring neuroplasticity and cortical reorganisation is optimised during a patient's time on the stroke ward and can impact behaviour throughout the stroke recovery journey (table 1). Given the importance of

repetition in inducing neuroplasticity, nurses can help provide patients with opportunities for informal practice outside formal therapy (Graham et al., 2014; Intercollegiate Stroke Working Party, 2016). Nurses can enhance activities of daily living by introducing a rehabilitation focus, e.g. during a repetitive task such as hair brushing (Aries & Hunter, 2014). They can also help promote the use of paretic or affected limb by involving it and encouraging the patient to use it during the day/personal care/activities of daily living, e.g. washing. This everyday use helps facilitate the brain to relearn patterns of functional movements and utilise neuroplasticity. Correct positioning becomes very important and needs to be put into practice 24hours a day (Burton, 2000; Clarke, 2013; Woon, 2015) to ensure adequate opportunity for use and adequate attention given to affected limb. An enriched environment has been shown to promote neuroplasticity, demonstrated through increased connections between neurons, increased synapses and increased cortical activity (Butler et al., 2008). An enriched environment encompasses a changing environment that encourages socialisation, physical activity, sensory and cognitive stimulation, and task-specific therapy targeting the impairments (McDonald et al.,2018). Nurses can help facilitate an enriched environment by working with the MDT team to enable appropriate stimulation of patients with a variety of physical and cognitive activities and social interactions (table 1).

Clinical studies have shown an association with better functional recovery, improved quality of life and independence with specialised stroke unit care (Saltor et al., 2006). A key part of this success is regular, coordinated multidisciplinary meetings and the importance of specialised nursing being highlighted (Long et al., 2002; Langhorne et al., 2011). The interaction between nursing and therapy is required, with nurses working with other disciplines, to assist in an activity (such as walking practice) and to facilitate all activities of daily living to promote independence and supporting patients in practice (Clarke et al., 2013). Nurses have a fundamental role in day to day care, that constitutes activities of daily living,

from the principles of neuroplasticity it is known that repetition (use it or lose it) is essential for enhancing brain recovery. Nurses, by gradually encouraging increasing independence, integrating repetition into everyday tasks and therefore practice of these day to day activities, it can help promote neuroplasticity in stroke patients. This MDT working also enables goal setting and a goal-directed personalised therapeutic programme. By tailoring rehabilitation to the individual, it can enhance neuroplasticity and optimise the brains plastic ability (Peate, 2019). This occurs as by ensuring the rehabilitation and recovery goals are aligned to an individual, allowing for task specific learning (a component of neuroplasticity) as well as increased motivation to achieve end goal (an important aspect of neuroplasticity). By setting specific goals, it allows the team to work alongside the principles of neuroplasticity to achieve these, including providing encouragement and feedback to reinforce learning and reorganisation of brain pathways.

Nurses have a leading role to play in emotional care, to help stroke survivors adjust and cope with the consequences of their stroke (Long et al., 2002; Burton & Gibbon., 2005). Patient-centred support is always imperative in nursing practice, but arguably in a sudden onset, debilitating condition such as stroke, nurses assistance with the potential impairments is vital. Stroke patients often refer to grief and difficulty coping with the sudden change in their life. Nursing interaction is one of the consistent aspects of their care and therefore is indispensable in helping people accept these emotions. This has implications for recovery as neuroplasticity is time-sensitive, patient acceptance and increased understanding of their condition can affect motivation. Good rehabilitation outcomes (facilitated by neuroplasticity) are associated with high patient motivation and engagement (Langhorne et al., 2011).

A nurse's role as a health educator is substantive in helping patients, and their carers understand the role of rehabilitation in their recovery. They can explain the role that neuroplasticity plays in this (Woon, 2015; Hartigan, 2013). By helping place in context the

reason for high repetition and intensity to boost reorganisation, this may improve adherence. As well as, potentially influencing patient behaviour post-discharge, to encourage activities that facilitate neuroplasticity, e.g. physical activity, learning of new skills, mental imagery (Marzouk, 2017) and lifestyle factors that can reduce neuroplasticity such as poor sleep, inactivity, stress etc. (Shafffer, 2016; Vance, 2012). This central role in family/caregiver liaison can result in improved knowledge about stroke recovery, reduced incidence of depression (Forster et al., 2012) and improved functional outcomes (Langhorne et al., 2011). Good family understanding of stroke can continue the encouragement by carers to carry out activities post-discharge, increasing use of impaired abilities and help empower the patient and carers (Woon, 2016).

The transition from acute hospital care to the community is a well-documented problematic time for stroke patients and their families, with a large proportion reporting feeling abandoned after their hospital stay (Stroke Association, 2018). Stroke nurses can play a considerable role in preparing patients and their families for the next stage in their recovery, with information, education and enhancing their knowledge of stroke recovery (Burton & Gibson, 2005). By ensuring that patients and their carers have a good understanding of neuroplasticity, they can incorporate the principles into their day to day life at home. This understanding can also help empower the patient with a better understanding of brain recovery and the simple things they could be doing at home to facilitate neuroplasticity.

## **Conclusions**

Neuroplasticity plays an essential role in stroke recovery. Nurses are ideally placed to ensure that neuroplasticity is optimally utilised during a patient's hospitalisation and beyond (figure 1). Nurses play a pivotal role in stroke care, are perfectly placed to help further promote neuroplasticity and improve patient outcomes.

**Key words-** Neuroplasticity, nursing, stroke rehabilitation, stroke recovery

### **Key points**

- Neuroplasticity is the ability of the brain to adapt and change in response to inquiry and is essential in stroke recovery.
- There are fundamental principles of neuroplasticity that can be incorporated into stroke care.
- All individuals, including nurses, have a role to play in utilising neuroplasticity in stroke patients.
- Nurses can enhance neuroplasticity by providing an enriched and stimulating environment; encouraging repetition, encouraging the use of impaired abilities, patient and carer education.

### **Reflective questions**

What could I do to improve/enhance neuroplasticity in my practice?

What aspects of stroke care am I carrying out that already utilises Neuroplasticity?

Do you think rehabilitation is carried out solely by other members of the multidisciplinary team?

How could you use principles of neuroplasticity in your day to day care?

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Figure 1: How nurses can enhance neuroplasticity

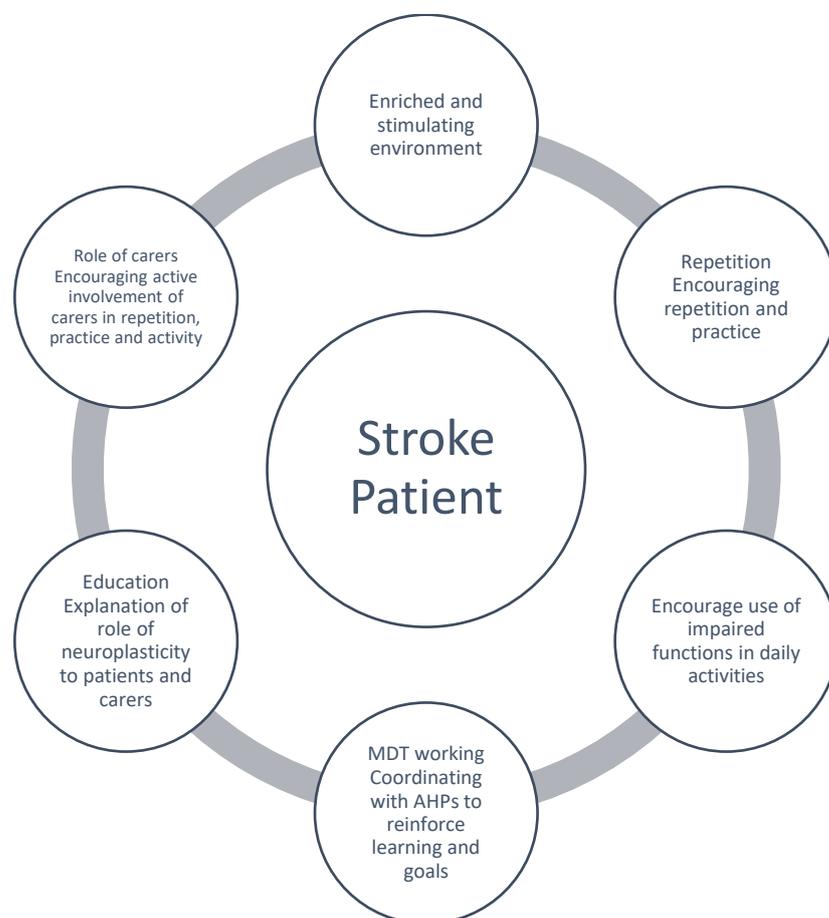


Table 1. Day to day methods of incorporating principles of neuroplasticity into clinical practice

<p>Enriched /stimulating Environment</p>	<ul style="list-style-type: none"> <li>• Help encourage cognitive stimulation by asking questions incorporating memory and attention such as ‘how many, how often or can you remember questions’</li> <li>• Encourage social stimulation by talking to patient, narrating activities, encouraging patient communication.</li> <li>• Encourage social interaction between patients on the ward or help direct visitors to encourage conversation communication resources could facilitate this.</li> <li>• Ensure that environmental stimulation also targets neglected or visual deficit side</li> <li>• Although sleep is important for brain recovery, encourage the patient to try and participate in activities to encourage cognitive and physical stimulation</li> </ul>
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<p>Multidisciplinary working</p>	<ul style="list-style-type: none"> <li>• Work with other team members to create a stimulating environment, is there any resources on the ward/unit that could help this- posters, puzzles, picture books</li> <li>• Ensure all team members are aware of patients specific goals and encourage affected limb use/repetition in all opportunities</li> </ul>
<p>Repetition (use it or lose it)</p>	<ul style="list-style-type: none"> <li>• If actual movement is difficult, encourage mental imagery of moving the impaired limbs to promote neuroplasticity</li> <li>• Encourage stroke patients to ‘attend’ or pay attention to their impaired limbs to encourage interaction between impaired limbs and the rest of the body.</li> <li>• Encourage sensory stimulation of impaired limb this could include stroking of the paretic arm with non-paretic arm</li> <li>• Encourage patients to keep active while not in a therapy session while being safe. This could include some basic bed exercises or simple muscle movements such as hand opening and closing.</li> </ul>
<p>Education of neuroplasticity principles</p>	<ul style="list-style-type: none"> <li>• Use all patient contact as an opportunity to repeat what neuroplasticity is and that the brain is capable of reorganisation restating the principles including use it or lose it, repetition etc.</li> </ul>
<p>Role of carers</p>	<ul style="list-style-type: none"> <li>• Explain what neuroplasticity is to carers, encouraging them to play a role in patient recovery by encouraging repetition, helping create a stimulating environment, creating an opportunity for learning and reinforcing the importance of capitalising on neuroplasticity</li> <li>• Encourage carers to address patient from neglected or affected side to help patient pay attention to their affected side</li> </ul>
<p>Use of impaired</p>	<ul style="list-style-type: none"> <li>• Encourage use of affected limbs in everyday tasks, for example, get patient to try brushing hair with both hands, or to attempt a button or zip if cannot do by self, then utilise hand over hand enablement</li> </ul>

functions in daily activities	<ul style="list-style-type: none"><li>• Ensure the positioning of impaired limbs, facilitates patients awareness of the limb, ensuring any visual deficits are considered</li><li>• Encourage out of bed and early mobilisation- sitting on chair, transferring to toilet to increase the opportunity to encourage repetition and use of affected limbs</li></ul>
Goal Setting	<ul style="list-style-type: none"><li>• Encourage patients to think about their specific goal and to break these down into more manageable small goals to help patients see improvements and keep motivated on end personal goals.</li><li>• Encourage patient and family input to goals of therapy and working together in participation of these goals</li></ul>