

Neurovascular assessment

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Summary

The ability to carry out a neurovascular assessment on a patient's limb is an important skill for all registered nurses. All nurses, whether working in primary or acute care environments, are exposed to patients who have sustained injury or trauma to a limb or have a cast or restrictive bandages in place. The ability to detect a compromised limb through careful observation enables prompt referral and subsequent treatment, which may otherwise result in a permanent deficit. This article discusses the importance of undertaking neurovascular observations providing a step-by-step guide for the reader.

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Compartment syndrome

The muscles of the limbs are grouped in compartments divided by thick inelastic tissue (fascia). Each compartment contains the nerves and vessels supplying the limb (Middleton 2003). Both the arm and the leg have four compartments. If the pressure in any compartment rises, capillary blood flow is compromised resulting in inadequate perfusion and oxygenation of the tissue (Goldie 1998, Bongiovanni *et al* 2005). If pressure is not relieved within hours, irreversible damage to the tissues and nerves may result in contractures, paralysis, loss of sensation and, in some cases, amputation (Bongiovanni *et al* 2005, Judge 2005).

Patients who have sustained fractures to the tibia, particularly the proximal third and supracondylar fractures of the humerus, are most at risk of developing compartment syndrome (Solomon *et al* 2005). Any injured tissue will swell (Dandy and Edwards 2004), and patients who have undergone orthopaedic surgery, sustained crush injuries or have their movement restricted by casts or bandages are at risk. Symptom onset occurs from as little as two hours to as long as six days after the trauma or surgery (Schoen 2000). Thus, the nurse plays a vital role in minimising the risk of deficit and detecting early signs of compartment syndrome so that prompt treatment can be instigated (Lucas and Davis 2005).

Neurovascular observations

Neurovascular assessment involves the evaluation of the neurological and vascular integrity of a limb. Through a systematic assessment the recognition of any neurovascular deficit can lead to appropriate treatment and minimise delays which may lead to amputation of the limb and even death.

Assessment for the signs and symptoms of neurovascular deficit should take into consideration the classic 'five Ps'; pain, paralysis, paraesthesia, pulses and pallor (Dykes 1993, Brinker and Miller 1999, Crowther 1999, Judge 2005, Solomon *et al* 2005). In addition, assessment should take into account the warmth

INDIVIDUALS MAY have their movement restricted through the application of a plaster cast or bandages or they may have undergone internal or external fixation (Lucas and Davis 2005). Restricting movement can cause damage to nerves and blood vessels. This damage causes a deficit in function, referred to as a neurovascular deficit, which may be temporary or permanent. Such deficits can have a significant effect on the patient's functional ability and overall outcome, with severe cases at risk of amputation of the affected limb.

Acute compartment syndrome is of particular concern and is the focus of this article. The syndrome occurs when there is a progressive build up of pressure in a confined space – muscle compartment – which compromises circulation and diminishes oxygen supply and therefore the functioning of the muscles in that area (Judge 2005). To detect compartment syndrome the nurse should carry out simple but regular neurovascular observations, documenting findings and acting to minimise further damage.

of the limb and evidence of swelling. Box 1 demonstrates a step-by-step guide to undertaking neurovascular observations.

Pain Pain considered out of proportion to the injury is usually the earliest and most important presenting symptom of compartment syndrome (Duckworth 1995, Lucas and Davis 2005). However, it is frequently overlooked because nurses are unable to differentiate between poorly controlled post-operative pain and pain that may indicate something more serious (Crowther 1999). Pain associated with compartment syndrome tends to be poorly localised, persistent, progressive, often not relieved by analgesia and often enhanced on passive extension of the

affected muscles and touch (Duckworth 1995, Goldie 1998, Middleton 2003, Lucas and Davis 2005). There is much controversy about the management of pain in patients at risk of developing compartment syndrome (Whitesides 2001). Patients who have undergone orthopaedic surgery should be given pain relief for their own welfare and comfort as well as to prevent other physiological mechanisms being affected, for example, the maintenance of respiratory rate, pulse rate and blood pressure to within normal limits. However, there are concerns that the use of analgesia to alleviate pain may mask the symptoms of compartment syndrome (Middleton 2003).

Nurses should ensure that patients at risk of developing compartment syndrome receive appropriate pain management. It is also important that nursing staff are able to identify unusual patterns of pain (Middleton 2003). The first part of neurovascular observation should involve a thorough assessment of the patient's level of pain. However, research has highlighted inconsistencies in the way that these assessments are made (Harrison 1991, Scott 1992, Closs *et al* 1993, Woodward 1995, Colley and Crouch 2000, Pasero and McCaffery 2005).

Pain assessment tools should be used to obtain accurate pain scores, which can then be used as a direct measure of the patient's condition (Colley and Crouch 2000). A variety of pain assessment tools are available, each with their own advantages and disadvantages, the discussion of which is beyond the scope of this article. It is, however, important that the same pain assessment tool is used by all members of the nursing team treating the patient. This will improve the reliability of the results and decrease the subjectivity of the assessment. The numerical rating scale where the patient is asked to rate the severity of pain from one to ten is useful. The nurse should suspect that a problem such as compartment syndrome is developing if the pain experienced is disproportionate to the injury or increasing in severity despite the administration of analgesia. In addition to the score, attention should be paid to the location, radiation and characteristics of the pain (Dykes 1993). Non-verbal cues of pain such as guarding, grimacing and sweating are particularly important in patients who are unable to verbalise pain severity.

Paralysis (movement) Neurovascular deficit can cause muscles in the affected compartment to become paralysed as a result of nerve damage or necrosis. Therefore, the nurse should undertake an active or passive range of movement of both limbs, first the unaffected and then the affected side, noting any reduced range of movement, while taking into consideration

BOX 1

Step-by-step guide to neurovascular observations

Preparation

1. Explain the procedure to the patient and gain his or her consent.
2. Ensure the patient's privacy and dignity are maintained.
3. Ensure that your hands are clean and dry.

Procedure

1. Assess the patient's level of pain using an appropriate pain scale; consider the location, radiation and characteristics of the pain.
2. Palpate the peripheral pulse distal to the injury and/or restriction on the unaffected side, repeat on the affected side and note the presence of the pulse and any inconsistencies between sides in rate and quality of the pulse.
3. If the pulse is inaccessible or cannot be felt, perform a capillary refill test and note the speed of return in seconds on the chart.
4. An assessment of sensation should be made by first asking the patient if he or she feels any altered sensation on the affected limb – consider any nerve blocks or epidurals. Using touch, assess sensation in each of the areas of the foot or hand ensuring all nerve distribution areas are covered. Note any altered sensation on the chart.
5. Ask the patient to flex and extend each toe and/or finger and the ankle and/or wrist, where possible. If the patient is unable to move actively, perform a passive movement. Note any pain reported by the patient either on movement or at rest.
6. Observe the colour of the limb in comparison with the unaffected side noting any pale, cyanotic or mottled appearance.
7. Feel the warmth of the limb above and below the site of injury using the back of the hand and compare with the other side. Note any excess warmth, coldness or coolness of the limb.
8. Inspect the limb for swelling and compare with the unaffected side. Note whether swelling is moderate or marked, particularly noting any increase since the last set of observations was taken.

Post-procedure

1. Ensure that all documentation is complete including any actions taken. Where deficit is suspected, report to a member of the medical team.
2. Ensure that the patient is left comfortable.

the extent of the injury and/or surgery. Ischaemic muscles are sensitive to stretching and therefore extension of the joint(s) may result in extreme pain in the forearm or calf (Duckworth 1995, Middleton 2003, Solomon *et al* 2005). The patient may experience pain on movement as a result of the injury or surgery. If this pain remains once the fingers or toes are held in extension and the movement has stopped, the nurse should be alerted (Goldie 1998).

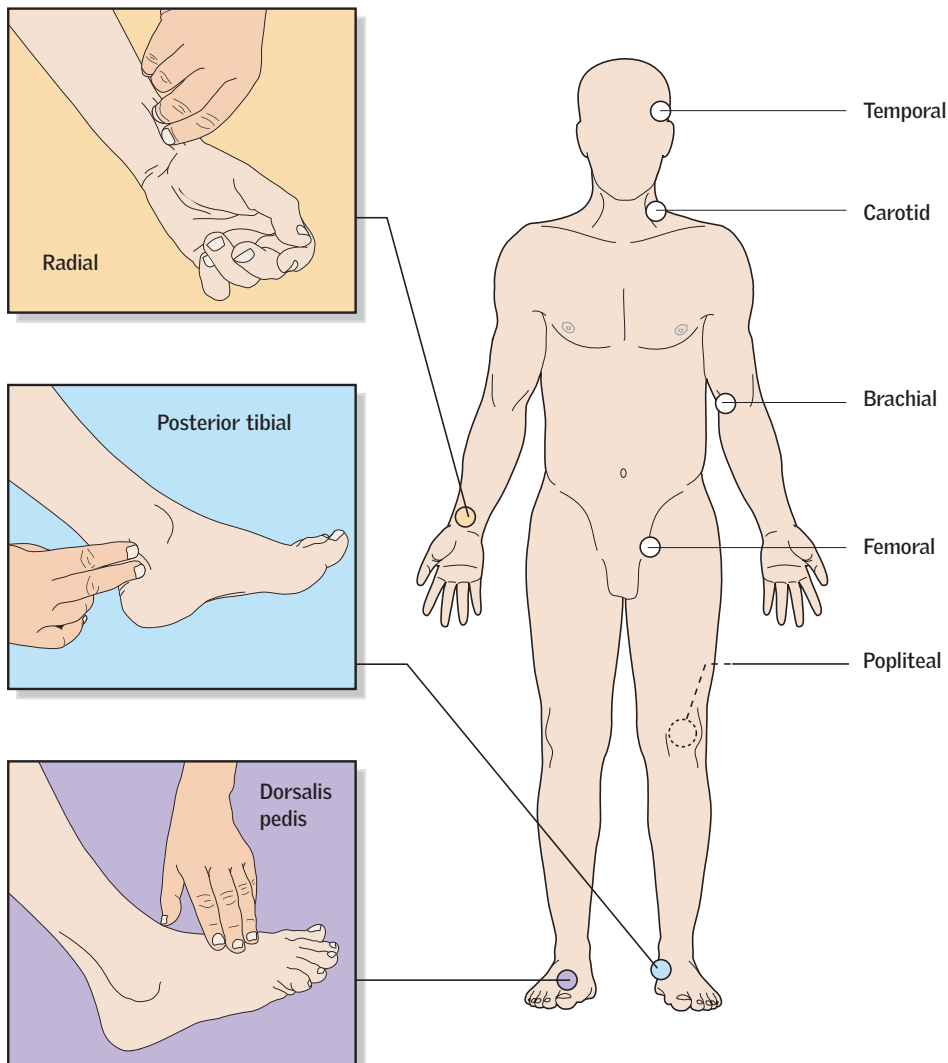
Paraesthesia (sensation) Paraesthesia of an area supplied by a specific nerve is a reliable finding in the patient who is awake and able to co-operate (Crowther 1999). The nurse should lightly touch the skin both proximally and distally to the affected site. The patient should

be asked to report any changes in sensation to the affected limb, which may result from pressure on the relevant nerve(s) (Mourad 1995). Reported changes may include decreased sensation, hypersensation, tingling, 'pins and needles', numbness or loss of sensation (Lucas and Davis 2005). Findings should be compared bilaterally.

Because a number of different nerves serve the limb all areas of the limb should be assessed, including between web spaces (Nicol *et al* 2002). Documentation should note where the patient reports altered sensation and what this alteration is so that medical staff can identify which nerve is affected (Goldie 1998). If the patient has had a nerve block, spinal anaesthesia

FIGURE 1

Location of peripheral pulses



or an epidural, findings must be considered in relation to the normal effects of such procedures.

Pulses and/or capillary refill An absence of pulse may indicate a lack of arterial flow (Mourad 1995). Pulses should be assessed distal to the injury and/or cast to assess whether blood flow is reaching past the area of injury/surgery and perfusing the remaining limb effectively. On the lower limb the dorsalis pedis pulse is usually assessed and on the upper limb the radial pulse (Figure 1). If possible, pulses should be assessed as soon as the patient is admitted so that a baseline can be established. This is particularly important with lower limb injuries because the dorsalis pedis pulse is congenitally absent in up to 12% of the population (Barnhurst and Barner 1968, Dykes 1993). If the dorsalis pedis pulse is not felt then the posterior tibial pulse should be palpated (Morison *et al* 1997).

Any differences in rate and quality of palpating pulses with the other limb should be noted (Dykes 1993). The absence of a pulse is rarely noted as an early symptom of compartment syndrome (Edwards 2004) and often pulses are still present because swelling may not necessarily affect the major vessels (Goldie 1998, Crowther 1999, Middleton 2003). A clinical diagnosis should not be based on the absence or presence of a pulse (Duckworth 1995, Solomon *et al* 2005).

Assessment of peripheral pulses remains subjective and should therefore be considered in combination with other findings such as pain, pallor, swelling, paralysis, temperature and altered sensation (Morison *et al* 1997). Documentation must note which pulses have been assessed so that consistency can be maintained between nursing staff. Nurses may find it helpful to mark the pulse area once found on the patient's limb.

Documentation must be clear as to whether a pulse is accessible but not palpable or whether the pulse cannot be accessed because of casts or bandages (Nicol *et al* 2002). Capillary refill should be used to measure arterial perfusion in patients who present with an inaccessible pulse as a result of restriction from a plaster cast or bandage. Normal capillary refill of two seconds indicates good perfusion. However, as with the presence or absence of pedal pulses, a delayed capillary refill can also be a late sign. Gradual slowing may be seen as the pressure increases. Capillary refill that slows to more than four seconds must be reported (Mourad 1995).

Pallor and temperature A neurovascularly

impaired limb will be pale or dusky in appearance (Mourad 1995, Middleton 2003). The limb also tends to have a glossy exterior as a result of swelling (McRae 1999). Temperature of the limb proximally and distally to the injury should be assessed using the back of the hand (Dykes 1993, Judge 2004). Any alterations in temperature and colour should be noted. A cold and pale limb below the level of injury and/or restriction may indicate arterial insufficiency. A warm limb with a bluish tinge could indicate venous stasis (Dykes 1993, Crowther 1999, Lucas and Davis 2005). It is important that nursing staff always check findings against the unaffected limb.

Swelling Swelling of the affected limb is not necessarily a feature of neurovascular impairment (Duckworth 1995). It is important to remember that the limb, having undergone trauma, is likely to be swollen as part of its natural physiology (Mourad 1995). The presence of casts or bandages may also cause the limb to swell, resulting in altered sensation. Thus, by releasing the constriction through loosening bandages or splitting casts, swelling and subsequent altered sensation and pain may diminish (Hughes and Porter 1997). Before surgery or following injury, consideration should also be given to any tight-fitting jewellery (Lucas and Davis 2005). Although swelling is not necessarily characteristic of neurovascular deficit, any notable increase should still be documented and reported.

Nursing actions and documentation

Documentation of neurovascular observations is important to identify symptom patterns. A neurovascular chart should be used to assess every patient and results should be documented along with any action taken by the nurse. Figure 2 illustrates an example of a chart that can be used to document findings. As with any nursing procedure, neurovascular observations should be documented when they are conducted. If a problem arises and documentation has not taken place, it will be assumed that the observations were not acted on.

If a neurovascular deficit is suspected the nurse should report it to a member of the medical team as a matter of urgency so that it can be reviewed. The instigation of ice and elevation in the post-operative period is helpful to reduce swelling. However, elevation should be reduced to below heart level and ice removed if a deficit is suspected so as not to impede circulation further (Love 1998, Bongiovanni *et al* 2005). Any constricting bandages should be loosened and casts bi-valved to decrease constriction of the limb (Lucas and Davis 2005).

FIGURE 2

Neurovascular chart

Name:		Ward:		Hospital no:			
Consultant:				Procedure/injury:			
Area for observation:				Frequency of observations:			
Date							
Time							
Pain score (1-10)							
Colour	Normal						
	Pale*						
	Cyanotic*						
	Mottled*						
Warmth	Hot*						
	Warm						
	Cold*						
	Cool*						
Pulses	Name of pulse:						
	Strong						
	Weak*						
	Absent*						
Capillary refill greater than two seconds (yes/no)							
Movement							
Dorsi Flexion	No movement*						
	Movement no pain						
	Movement with pain*						
Plantar Flexion	No movement*						
	Movement no pain						
	Movement with pain*						
Toe Extension	No movement*						
	Movement no pain						
	Movement with pain*						
Toe flexion	No movement*						
	Movement no pain						
	Movement with pain*						
Sensation							
Web space First and second toe	No sensation*						
	Tingling/numbness*						
	Full sensation						
Web space Third and fourth toe	No sensation*						
	Tingling/numbness*						
	Full sensation						
Sole of foot/toes	No sensation*						
	Tingling/numbness*						
	Full sensation						
Arch of foot (medial)	No sensation*						
	Tingling/numbness*						
	Full sensation						

Initials

Always compare with the unaffected limb. If both limbs are affected use a separate chart for each limb.
 *These may be signs of abnormalities, take appropriate action, document and inform a member of the medical team.
 Document all actions taken in the space below.

Conclusion

Compartment syndrome can be devastating for patients because of the symptoms experienced and loss in functional ability, whether temporary or permanent. Length of stay in hospital will be increased and any decrease in functional ability may affect patients' ability to continue in their employment (Dandy and

Edwards 2004). Early detection of any neurovascular deficit is vital to avoid long-term disability (Middleton 2003). Nursing staff should be aware that it is not only patients who have sustained high impact trauma who are at risk of developing a neurovascular deficit, but also those who have undergone routine elective surgery, have a cast *in situ* or bandaging. The 'five Ps' approach to neurovascular observations should enable nursing staff to carry out efficient assessments, noting any deterioration and taking appropriate action where necessary **NS**

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