

Neurovascular Assessment



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Glossary

Acute limb ischaemia	A sudden decrease in limb perfusion that threatens the viability of the limb.
Abduction	Movement of the limb away from the midline of the body.
Adduction	Movement of the limb towards the midline of the body.
Anticoagulants	A substance or drug that reduces the tendency of blood to coagulate, thereby reducing the risk of thrombosis.
Blanching	A test of blood circulation in the fingers and toes. Pressure is applied to a fingernail or toenail until normal colour is lost, the pressure is then removed and circulation colour is allowed to return.
Compartment syndrome	A condition resulting from increased pressure in a muscle compartment. This compromises the blood flow and/or nerve supply to the muscle compartment leading to impaired circulation, tissue perfusion and motor function.
Dorsiflexion	Upward flexion of the part of the body, as the hand, foot or toes are pushed towards the body.
Dorsalis pedis	The pulse of the dorsalis pedis artery which is palpable between the first and second metatarsal bones on the top of the foot.
Dorsum	The posterior or upper surface of a body part.
Extension	An increase in the angle between the bones of a limb at the joint. For example, extension of the leg increases the angle between the femur and the tibia.
Extremity	A limb (arm or leg).
Flexion	A decrease in the angle between the bones of the limb at a joint. For example, bending the elbow decrease the angle between the humerus and the ulna.
Hyperaemia	An excess of blood in part of the body caused by an increased blood flow, such as the inflammatory response, local relaxation of arterioles, or obstruction of the outflow of blood from an area.
Interstitial oedema	A condition in which there is an abnormally large volume of fluid in the tissues between the body's cells (interstitial spaces).
Medial malleolus	Bony prominence on the medial (inner) side of the ankle.
Neurovascular assessment	The sensory and motor function evaluation of the neurological and vascular integrity of a limb.
Paraesthesia	Any subjective sensation, experienced as numbness, tingling, or a 'pins and needles' feeling.
Paralysis	The loss of muscle function, loss of sensation, or both, causing powerless limb movement/immobility.
Passive movement	The movement of parts the body by an outside force without voluntary action or resistance by the individual.
Plantar flexion	When the toes are pushed down away from the body.
Posterior tibialis	The pulse of the posterior tibial artery which is palpable behind the medial malleolous of the ankle.
Thumb opposition	Bringing the the thumb across (opposing) the hand to the fifth finger.

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Purpose of this guide

Surgical procedures, investigations or trauma can affect a person's circulation and nerve function to extremities. Neurovascular assessment is performed to detect early signs and symptoms of acute ischaemia or compartment syndrome and support appropriate clinical management.

The purpose of this document is to provide guidance to clinical staff on:

- who is at risk of neurovascular compromise or compartment syndrome
- accurate neurovascular status assessment requirements
- when to initiate prompt critical review and intervention for neurovascular compromise
- when to escalate subtle changes to a patient's neurovascular status
- documentation of neurovascular status.

Clinical team members should perform neurovascular assessment in accordance with the following guidelines.

Patients at risk of neurovascular compromise or compartment syndrome

The following injuries and/or procedures indicate that a patient is considered to be at risk of neurovascular compromise or compartment syndrome, and therefore a neurovascular assessment must be performed:

- limb fractures
- vascular injuries and procedures
- trauma/surgery to limbs/joints
- external fixators
- casts, splints and constrictive dressings to limbs
- traction
- burns
- crush injury
- gunshot injury
- procedures that may cause limb thrombosis or emboli, e.g. cardiac catheterization
- interstitial oedema of limbs/massive intravenous fluid infusion
- prolonged immobility caused by drugs or alcohol induced coma
- snake envenomation
- anticoagulation therapy, e.g. warfarin.

Additional information

Please also refer the following documents:

- Neurovascular Assessment Form Upper Limb (Left and Right)
- Neurovascular Assessment Form Lower Limb (Left and Right)
- Acute Compartment Syndrome – consumer factsheet.

Frequency of assessments

The frequency of assessments at a minimum should be:

- Documented medical orders

OR

- Hourly for 8 hours then
- Second hourly for 24 hours then
- Fourth hourly up to 60 hours (therefore from 24 hours to 60 hours)
- Increased frequency to half hourly if deficit identified

OR

- Determined by condition of the patient at any given time and/or related procedural protocols

Patients who are discharged

Some patients are not admitted for the duration of the recommended frequency of assessment (for example, due to attendance to plaster clinics, day only procedures, emergency department visits). They are exempt from the frequency outlined above.

However, these patients must be provided written information/instructions about neurovascular compromise prior to discharge. This should include information about the signs and symptoms of acute compartment syndrome.

Neurovascular assessment procedures

Neurovascular assessment should be conducted and recorded within the electronic medical record (eMR) as defined by all sections of the Neurovascular Observation Form and as outlined below. See Documentation.

Neurovascular assessment is comparative. The unaffected limb should be evaluated to establish a baseline, prior to assessing the affected limb.^{1,2,3}

Prior to assessing the patient's neurovascular status, ensure that:

- nail polish, dirt, blood or any stained skin preparation is removed from the distal extremities²
- any jewellery is removed from the injured/affected limb, as it may cause constriction due to expected swelling
- there is full light (necessary to perform neurovascular assessment).^{1,2}

Deterioration or deviation in neurovascular status

The medical officer should be notified immediately of any deterioration or deviation in neurovascular status.

Pain

Any compromise to a patient's neurovascular status will result in pain due to sensory nerve damage and diminished blood flow.³ Neurovascular compromise may be indicated by:

- pain disproportionate to the injury
- deep, localised extreme pain unrelieved by analgesia
- increased pain upon passive stretch of the involved muscle.

The related form for this guideline has used the reference of the Numerical Rating Scale (NRS).⁴

Assessment

- Assess a patient's level of pain by asking the patient to rate the pain on a scale from 0 (no pain) to 10 (the worst pain imaginable).⁴
- Consider the PAINAD (Pain Assessment in Advanced Dementia) tool for patients with cognitive impairment.⁵
- Record whether there is any pain at rest (pain score).
- Record whether there is any pain at rest and on passive movement of the extremity (passive stretch), particularly for the affected muscle group. Pain may indicate the development of compartment syndrome.
- After administering analgesia, record whether this relieves the pain. If there is no relief of pain this may indicate the development of compartment syndrome.

Skin colour

When comparing the unaffected with the affected extremity, normal skin colour indicates adequate venous return. A coloured extremity could indicate hyperaemia or inflammation, inadequate arterial supply or inadequate venous return.

Assessment

- Compare the colour of the unaffected limb to the affected limb.
- Identify the colour of the affected limb (e.g. natural in colour, pale/white, flushed/red, dusky, cyanosed). The colour of the extremity could indicate:
 - **Red** – hyperaemia or inflammation
 - **Normal skin tone** – normal
 - **Pale** – inadequate arterial supply
 - **Mottled** – inadequate venous return.
- Record the colour of the affected limb.

Skin temperature (warmth)

The skin temperature of the extremity can be indicative of venous congestion or diminished arterial flow.³

Assessment

- Place the dorsum (back) of your hand or fingers on the extremity being examined.
- Compare the unaffected limb to the affected limb.
- Record the patient's skin temperature (e.g. hot, cool, warm, cold/clammy).
- The temperature of the extremity could indicate:
 - **Hot** – venous congestion
 - **Warm**
 - **Cool**
 - **Cold** – diminished arterial flow.³

Capillary refill

Measuring capillary refill helps to evaluate the arterial blood supply to the small peripheral vessels, as the capillary bed is the farthest portion of the vascular system from the heart.⁶

Assessment

- Compress the tip of the patient's finger/toe between your thumb and index finger until blanching occurs and release.
- Time how long it takes for the nail colour to return:
 - <2 seconds = brisk
 - >3–4 seconds = slow
 - >7 seconds = sluggish.²

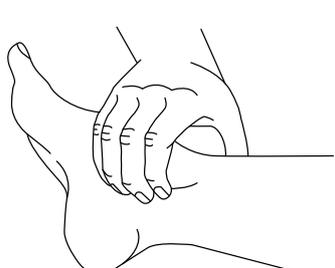
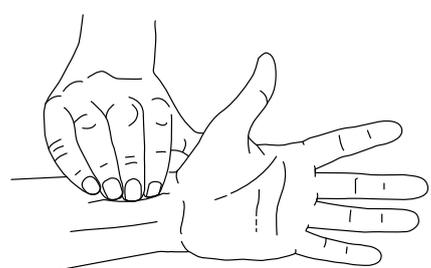
Pulses

Pulses are palpated to sense the movement or flow of blood through the peripheral vessels.

Assessment

- Palpate pulse points with the pads of your middle and index fingers, applying gentle pressure.
- Mark any palpable pulse points with a pen to facilitate ongoing assessment.
- Specify which pulses are palpable, i.e. dorsalis pedis and posterior tibialis for lower limbs and radial pulse for upper limbs (refer to the pictures below and as indicated on the form).
- Assess the pulse (grade it as strong, weak or absent).
- Record the pulse distal to injury and/or surgical site. Note if a Doppler was used to assess the pulse.
- If the patient has a plaster or bandage in situ, record 'unable to test'.

Palpating pulses

Dorsalis pedis	Posterior tibialis	Radial
Palpate on the dorsum of the foot between the first and second metatarsals.	Palpate posterior to the medial malleolus of the ankle.	Palpate on the lateral wrist over the distal radius.
		

Sensation

Changes in sensation, such as numbness or tingling in the extremity can indicate neurovascular compromise.

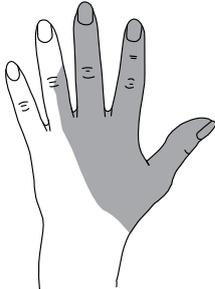
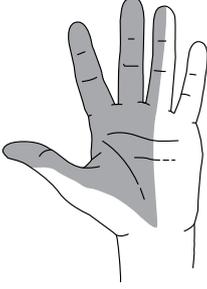
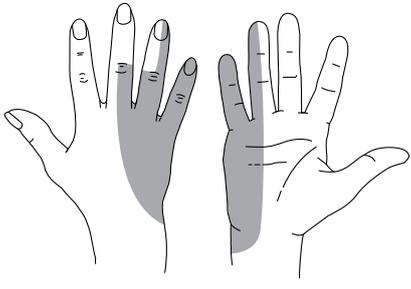
Assessment

Ask the patient to close his/her eyes prior to initiating assessment of sensory function.

- Test each nerve-related area using the tip of your index finger.
- When testing sensation, the location of numbness, tingling or prickling must be determined to indicate distribution of vascular compromise or nerve damage.
- Assess and record the nerve sensation as normal, pins and needles or absent.
- Avoid using sharp objects unless indicated.
- The diagrams below indicate the nerve distribution for upper and lower limb to assist you with conducting the assessment.

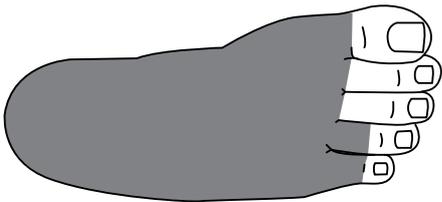
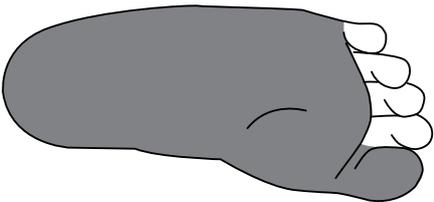
Upper limb sensation assessment

Test radial, median and ulna nerves by lightly touching the skin in the areas as shaded in grey in the diagrams below.

Radial nerve Web space between the thumb and index finger, including the dorsum of the hand	Median nerve Web space between the thumb and index finger, including the palmer surface of the hand	Ulnar nerve Between the little finger and distal ring finger on palmer and dorsal surface of the hand
		

Lower limb sensation assessment

Test common peroneal and tibial nerves by lightly touching the skin in the areas as shaded in grey in the diagrams below.

Peroneal nerve Dorsal surface of the foot	Tibial nerve Plantar surface of the foot
	

Movement

Motor function assesses:

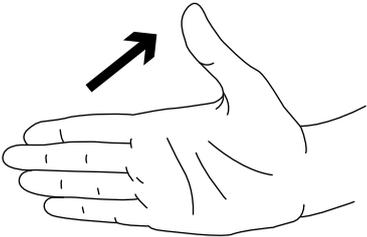
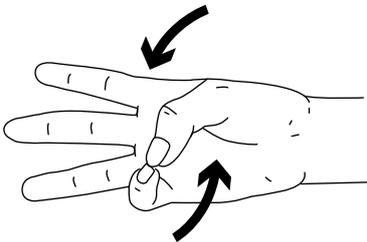
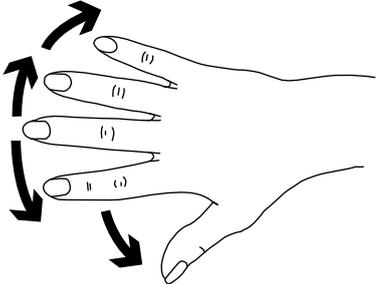
- normal movement of the muscles in the course of a nerve's innervation
- strength of movement against resistance
- the presence of pain associated with passive movement.

Assessment

- Test the active unassisted movement initially. If a patient's active movement is impaired or absent, passive movement must be tested. Investigate and document the reason for impaired or absent active movement, e.g. nerve block, limited by pain.
- Notify the medical officer of the appropriate specialty if there has been a decrease in motor function since the previous assessment.
- Assess and record movement as full, impaired or absent in comparison to the unaffected limb as active and/or passive.

Upper limb movement assessment

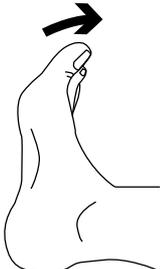
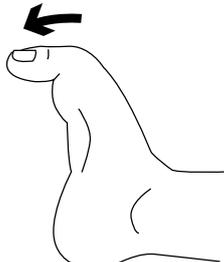
To assess for normal upper limb movement the following nerves are tested.

Radial nerve	Median nerve	Ulnar nerve
Test the radial nerve through thumb abduction.	Test the median nerve through thumb opposition/ ability to bring the thumb and little together so they are touching.	Test the ulnar nerve through finger abduction.
		

Lower limb movement assessment

To assess for normal lower limb movement the following nerves are to be tested.

If ankle dorsiflexion or plantar flexion is restricted by plaster then movement of the toes is tested. Record this in the comments section of the form in the free text field for 'other'.

Peroneal nerve	Tibial nerve
Test the peroneal nerve through dorsiflexion of the ankle and toes.	Test the tibial nerve through plantar flexion of the ankle and toes.
	

Swelling

Swelling occurs as a natural physiological response to injury.⁷

Assessment

- Compare swelling of unaffected limb to the affected limb.
- Assess and record swelling as nil, small, moderate or large.
- Limb circumference measurement can assist in monitoring swelling. When measuring, mark the level(s) on the limb to ensure accurate serial recording.

Blood loss/ooze

Assess blood loss on dressings, plasters and any surgical drains to the affected limb.

Assessment

- Mark the dressing/plaster and outline the area of blood/ooze and time (if appropriate).
- Record blood loss/ooze as 'nil', 'small', 'moderate' or 'large'.

Additional information

Any additional information that may be important with reporting an accurate the neurovascular assessment should be recorded. This may include:

- nil comments
- unconscious
- non-English speaking background
- confused (referring to the patient's cognitive state)
- increased elevation
- epidural spinal, regional block
- ice pack applied
- plaster of Paris (POP)/bandages split
- signs of compartment syndrome
- medical officer notified analgesia given.

Compartment syndrome

Acute compartment syndrome involves the compression of nerves and blood vessels within an enclosed space. The compression leads to impaired blood flow and muscles and nerve damage.

Compartment syndrome may occur in an extremity as a complication of certain types of fractures, injuries and/or procedures.⁸

If left untreated, irreversible damage to the muscle group and nerves can begin after only six hours. In 24–48 hours, the extremity is rendered useless, and in extreme cases the limb will require amputation.

Compartment syndrome is a medical emergency

Treat signs and symptoms of acute compartment syndrome as a medical emergency – notify the orthopaedic/specialty registrar or senior medical officer immediately or follow the escalation clause of your facility.

Signs and symptoms

Any sign and symptom of acute compartment syndrome should be assessed and recorded, including variation since previous assessment.

- **Pain** – Passive stretch of digits and/or limb can cause extreme pain, out of proportion to the injury and unrelieved by analgesia. The pain is due to tissue hypoxia rather than trauma/surgery.
- **Pallor (colour change)** – Skin becomes pale and cool or cyanosed (discoloured and slightly blue) due to venous congestion.
- **Paralysis** – Decreased or loss of movement due to nerve compression. Nerve compromise means that nerves cannot innervate muscles. Muscles can survive 4–12 hours in a hypoxic state.
- **Paraesthesia (changes in sensation)** – Nerve hypoxia causes changes in sensation, such as a tingling or prickling feeling. Nerves can survive 2–4 hours in a hypoxic state.
- **Pulselessness** – The absence of a pulse indicates serious compromise to the limb (late sign).
- **Firm, tense, shiny skin** – The skin over the muscle compartment can change.

Nursing management

- Notify the orthopaedic/specialty registrar or senior medical officer immediately.
- Elevate the affected limb to heart level only. Do not elevate above the heart level as this will decrease the perfusion to the limb overall.^{2,9}
- Reassess neurovascular status with another registered nurse or medical officer to confirm suspicion or variation.
- Apply ice if appropriate and if patient will tolerate it.
- Loosen any restrictive bandages or dressings. Increase the frequency of neurovascular assessment – at minimum, perform half hourly until review.
- Place the patient nil by mouth until review (in case surgical intervention is required).
- Make the patient as comfortable as possible – provide reassurance and information.
- Ensure analgesia is administered.
- After consultation with the orthopaedic/specialty registrar or senior medical officer, split/cut tight bandages/casts (plasters must be bivalve and underneath padding should be split to the skin).
- Document in the patient's healthcare record. Include details about variations of neurovascular status and effects of analgesia.

Documentation

Neurovascular assessment must be documented on a Neurovascular Observation Form in the electronic medical record (eMR).

Complete neurovascular assessment (sensory and motor) of the extremity should be conducted and recorded as defined by all sections of the Neurovascular Observation Chart.

Use a separate form for each limb assessed and ensure the correct form is used for the affected limb (that is, left/right upper limb or left/right lower limb) indicated on the Neurovascular Observation Form.

Patients undergoing elective procedures should have a pre-operative assessment recorded as a baseline.

Patients requiring neurovascular assessment should have documentation in the integrated notes every eight hours or when any deviation (even subtle) occurs.

References

1. Altizer, L. (2002). *Orthopaedic essentials: Neurovascular assessment*. Orthopaedic Nursing. 21(4):48-50.
2. Judge, NL (2007). *Neurovascular assessment*. Nursing Standard; 21 (45) 39-44 (literature review).
3. Schreiber ML. (2016). *Neurovascular Assessment: An Essential Nursing Focus*. MedSurg Nursing. 25 (1): 55-57.
4. Hawker GA, Mlan S, Kendzerska T and French M. (2011). *Measures of Adult Pain*. Arthritis Care and Research. 63, S11: 240-252.
5. Warden V, Hurley AC and Volicer L. (2003). *Development and Psychometric Evaluation of the Pain Assessment in Advanced Dementia (PAINAD) Scale*. The Journal of Post-Acute and Long-Term Care Medicine. 4 (10): 9-15.
6. Wiseman, T. & Curtis, K. (2011). *Gunshot wounds to the leg causing neurovascular compromise- A case study*. Australasian Emergency Nursing Journal.14:264-269
7. Johnston-Walker, E., & Hardcastle, J. (2011). *Neurovascular assessment in the critically ill patient*. Journal in Critical Care, 16(4), 170-177 from Medline (literature review)
8. Benche, K. (2010). *Avoid the pressure of compartment syndrome*. OR Nurse. 4 (1):42-47.
9. Altizer, L. (2004). *Orthopaedic Essentials: Compartment Syndrome*. Orthopaedic Nursing. 23(6):391.