Regional anaesthesia (or regional anesthesia) is anesthesia affecting only a large part of the body, such as a limb or the lower half of the body. Regional anaesthetic techniques can be divided into central and peripheral techniques. The central techniques include so called neuraxial blocks (epidural anaesthesia, spinal anaesthesia). The peripheral techniques can be further divided into plexus blocks such as brachial plexus blocks, and single nerve blocks. Regional anaesthesia may be performed as a single shot or with a continuous catheter through which medication is given over a prolonged period of time, e.g. continuous peripheral nerve block. Regional anaesthesia can be provided by injecting local anaesthetics directly into the veins of an arm (provided the venous flow is impeded by a tourniquet.) This is called intravenous regional techniques (Bier block).

Regional anesthetic techniques (without general anesthesia) are effective for patients in whom oral instrumentation and/or endotracheal intubation is undesired. The patient with the difficult airway, with poor dentition, with uncertain NPO status, and/or existing morbidities (rheumatoid arthritis) is a classic example. Patient selection is key, as it is important to make sure that little or no sedation is tolerated.

Regional anaesthesia may provide anaesthesia (absence of feeling, including pain) to allow a surgical operation, or provide post-operative pain relief. Various brachial plexus blocks exist for shoulder and arm procedures. Methods similar to routine regional anaesthetic techniques are also often used for treating chronic pain.

In labour and childbirth, epidural or combined spinal epidurals provide effective pain relief. Regional anaesthesia is now more common than general anaesthesia for Caesarean section procedures.

Unlike general anesthesia, patients may remain awake during the procedure, resulting in reduced side effects and enabling the surgeon to converse with the patient during the procedure if required. However, many patients prefer to receive sedation either during the block, the procedure, or both.

However, it is necessary to realize that the use of regional anesthesia does not preclude the use of subsequent general anesthesia. For any case, the anesthesia practitioner must be equipped and prepared for general anesthesia.
Regional Anesthesia versus Local Anesthesia

<table>
<thead>
<tr>
<th>Regional Anesthesia</th>
<th>Local Anesthesia</th>
</tr>
</thead>
<tbody>
<tr>
<td>-large part of the body, such as a limb or</td>
<td>-small part of the body such as a tooth or</td>
</tr>
<tr>
<td>the lower half of the body</td>
<td>an area of skin</td>
</tr>
</tbody>
</table>

Types of Blocks:

Upper Extremity Blocks
- Cervical Paravertebral Approach
- Interscalene
- Supraclavicular
- Infraclavicular
- Axillary
- Mid-Humeral
- **Peripheral Branches (Rescue Blocks)-** peripheral nerve blocks (PNBs) of the distal upper extremity, specifically, those of the median, radial and ulnar nerves. These blocks are fairly simple to perform even by a beginner to produce anesthesia or analgesia for surgery of the forearm, wrist and hand. They may be done when blockade of the entire brachial plexus is not necessary or as a “rescue” block with an incomplete brachial plexus block. Traditionally, these blocks have been performed at the level of the elbow and wrist using surface landmarks with nerve stimulation or paresthesia techniques. More recently, ultrasound has been used to block the nerves at several different points between the elbow and wrist:

  - Peripheral Nerve Block-Median Nerve
  - Peripheral Nerve Block-Musculocutaneous Nerve
  - Peripheral Nerve Block-Radial Nerve
  - Peripheral Nerve Block-Ulnar Nerve

Lower Extremity Blocks
- Lumbar Plexus
- Femoral Nerve
- Fascia Iliaca
- Sciatic Nerve
- Ankle
- Lateral Femoral Cutaneous Nerve
- Obturator Nerve
- Saphenous Nerve
- Sciatic Nerve-Gluteal Region
- Sciatic Nerve-Popliteal Region
- Sciatic Nerve-Proximal Thigh Region
- Sciatic Nerve-Subgluteal Region

Truncal Blocks
- Intercostal Space
- Ilioinguinal/Iliohypogastric Nerve
- Psoas Compartment Block
- Thoracic Paravertebral
- Transversus Abdominis Plane (TAP)

Neuraxial Blocks- neuraxial anesthesia refers to placement of local anesthetic in close proximity to nerves in the central nervous system and includes spinal, epidural and caudal techniques.

- **Epidural Space**- epidural anesthesia can be used as the sole anesthetic technique for cesarean section, lower abdominal and lower extremity surgery. Or, it can be used in combination with general anesthesia for thoracic and abdominal surgical procedures. An epidural may be given at a thoracic or lumbar site. It is also an effective analgesic technique providing continuous relief of labor and post-surgical pain through the infusion of local anesthetic and other additives. The term epidural is often short for epidural analgesia, a form of regional analgesia involving injection of drugs through a catheter placed into the epidural space. In an epidural, an indwelling catheter may be placed for additional injections later. The injection can cause both a loss of sensation (anaesthesia) and a loss of pain (analgesia), by blocking the transmission of signals through nerves in or near the spinal cord.
• The epidural space is the space inside the bony spinal canal but outside the membrane called the dura mater (sometimes called the "dura"). In contact with the inner surface of the dura is another membrane called the arachnoid mater ("arachnoid"). The arachnoid encompasses the cerebrospinal fluid that surrounds the spinal cord.

Epidural anesthesia and analgesia has been shown to improve pain relief, reduce opioid use, and facilitate earlier extubation in patients undergoing major abdominal and vascular surgery. In addition, epidural anesthesia has been recognized for its role in the dramatic reduction in mortality in the obstetric population over the past several decades.

• **Sole epidural anesthetic:**

  Orthopedics - Surgeries of lower limbs, including hip, knee, and pelvic areas

  Vascular surgery - Lower limbs, amputations

  Obstetrics - Cesarean delivery

  Gynecology - Surgeries of female pelvic organs

  Urology - Prostate and bladder surgeries

  General surgery - Lower abdominal surgeries, including appendectomy, bowel surgeries, hernia repair

• **Epidural anesthetic in combination with general anesthetic**

All of the indications noted above for sole epidural anesthetic may also be performed with CSE.

Pediatric surgery - Penile procedures,inguinal hernia repair, lower limb orthopedic procedures

Thoracic surgery - Thoracotomy, cardiac bypass, other cardiac surgeries

Epidural analgesia combined with general anesthesia reduces the incidence of postoperative pneumonia in patients with chronic obstructive pulmonary disease who are undergoing major abdominal surgery.
- **Spinal Anesthesia** - local anesthetic solution injected into the subarachnoid space blocks conduction of impulses along all nerves with which it comes in contact, although some nerves are more easily blocked than others. A spinal is usually one-shot only; though a continuous spinal can also be administered, especially in pain management (with morphine pumps). A spinal must be injected below the L2 vertebrae to avoid piercing and consequently damaging the spinal cord.

- There are three classes of nerve: motor, sensory and autonomic. The motor convey messages for muscles to contract and when they are blocked, muscle paralysis results. Sensory nerves transmit sensations such as touch and pain to the spinal cord and from there to the brain, whilst autonomic nerves control the caliber of blood vessels, heart rate, gut contraction and other functions not under conscious control.

- Generally, autonomic and pain fibers are blocked first and motor fibers last. This has several important consequences. For example, vasodilation and a drop in blood pressure may occur when the autonomic fibers are blocked and the patient may be aware of touch and yet feel no pain when surgery starts.
Spinal needles come in a variety of sizes (gauge and length) as well as bevel and tip designs.

![Common tip designs for spinal needles](http://www.anaesthesiak.com/images/lumbar-fig1.jpg)

**Cutting needles:**
- The Quincke is a cutting needle with end injection.

**Blunt-tipped needles:**
- The Whitacre has a rounded point with side injection.
- The Sprotte is also side injection with a longer opening.

*Note: Blunt tipped needles are believed to carry less of a risk of spinal headache. Smaller gauge needles also lower the risk.*

**Needle Sizes For Peripheral Nerve Blocks**

Choose the needle of appropriate size for each and every block technique!

A needle that is too short will obviously not reach its targeted depth, whereas a needle of excessive length is much more difficult to control during advancement. In addition, excessively long needles tend to be inserted too far and, possibly resulting in serious complications. The recommendations in the table below are general recommendations only and they apply to nerve block techniques practiced at our institution and featured on NYSORA:
<table>
<thead>
<tr>
<th>Block Technique</th>
<th>Recommended Needle Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cervical plexus block</td>
<td>50 mm (2 in)</td>
</tr>
<tr>
<td>Interscalene brachial plexus block</td>
<td>25 mm (1 in) to 50 mm (2 in)</td>
</tr>
<tr>
<td>Infraclavicular brachial plexus block</td>
<td>100 mm (4 in)</td>
</tr>
<tr>
<td>Axillary brachial plexus block</td>
<td>25 (1 in) to 50 mm (2 in)</td>
</tr>
<tr>
<td>Thoracic paravertebral block</td>
<td>90 mm (3.5 in - 4 in)</td>
</tr>
<tr>
<td>Lumbar paravertebral</td>
<td>100 mm (4 in)</td>
</tr>
<tr>
<td>Lumbar plexus block</td>
<td>100 mm (4 in)</td>
</tr>
<tr>
<td>Sciatic block posterior approach</td>
<td>100 mm (4 in)</td>
</tr>
<tr>
<td>Sciatic block anterior approach</td>
<td>150 mm (6 in)</td>
</tr>
<tr>
<td>Femoral block</td>
<td>50 mm (2 in)</td>
</tr>
<tr>
<td>Popliteal block posterior approach</td>
<td>50 mm (2 in)</td>
</tr>
<tr>
<td>Popliteal block lateral approach</td>
<td>100 mm (4 in)</td>
</tr>
</tbody>
</table>

- **Combined Spinal–Epidural (CSE)**- Soresi first described the benefits of injecting anesthetics through a needle (not a catheter) both in the subarachnoid and epidural spaces in 1937. The first documented combined spinal epidural (CSE) procedure with placement of an epidural catheter was performed in 1979 by Curelaru, using the separate needle technique. Today CSE is commonly used for obstetric, gynecologic, orthopedic, urologic and general surgery anesthesia. For some procedures, the anesthetist may choose to combine the rapid onset and reliable, dense block of a spinal anaesthetic with the post-operative analgesic effects of an epidural. This is called combined spinal and epidural anaesthesia (CSE).

- The anesthetist may insert the spinal anaesthetic at one level, and the epidural at an adjacent level. Alternatively, after locating the epidural space with the Tuohy needle, a spinal needle may be inserted through the Tuohy needle into the subarachnoid space. The spinal dose is then given, the spinal needle withdrawn, and the epidural catheter inserted as normal. This method, known as the "needle-through-needle" technique, may be associated with a slightly higher risk of placing the catheter into the subarachnoid space.

- **Caudal Anesthesia**-
The epidural space may be entered through the sacrococcygea
l membrane (sacral hiatus), using a 22g catheter-over-needle or regular 21G needle. The caudal epidural space is the lowest portion of the epidural system. Injecting a volume of 1 cc/kg of local anesthetic here provides good analgesia of the perineum and groin areas. This is typically a single-injection technique and a catheter is not normally placed. This is known as a caudal epidural or "caudal".

- The caudal epidural is an effective and safe analgesic technique in children undergoing groin, pelvic or lower extremity surgery. It is usually combined with general anaesthesia since children cannot tolerate the injection awake. Positioning for adults-prone-preferred or lateral; children-lateral preferred.

- Drugs most commonly used drugs include Lidocaine 1% and Bupivacaine 0.25%. Bupivacaine has a longer duration of action than Lidocaine and is used more often.

- Drugs used for Caudal injection should come from single use ampoules and be preservative free.

**Other Notes**

- The onset of analgesia is approximately 15–30 minutes in an epidural, while it is approximately 5 minutes in a spinal.
- An epidural is safer if a higher level of block is required.

**Potential problems with Epidural Anesthesia**

1) **Side effects**

In addition to blocking the nerves which carry pain, local anaesthetic drugs in the epidural space will block other types of nerves as well, in a dose-dependent manner. Depending on the drug and dose used, the effects may last only a few minutes or up to several hours. Epidural typically involves using the opiates fentanyl or sufentanil, with bupivacaine. Fentanyl is a powerful opioid with a potency 80 times that of morphine and side effects common to the opiate class. Sufentanil is another opiate, 5 to 10Xs more potent than Fentanyl. Bupivacaine is markedly toxic, causing excitation: nervousness, tingling around the mouth, tinnitus, tremor, dizziness, blurred vision, or seizures, followed by depression: drowsiness, loss of consciousness, respiratory depression and apnea. Bupivacaine has caused several deaths by cardiac arrest when epidural anesthetic has been accidentally inserted into vein instead of epidural space in the spine.

Epidural correctly administered results in three main effects:
• Loss of other modalities of sensation (including touch, and proprioception)
• Loss of muscle power (hence, a risk of falling)
• Loss of function of the sympathetic nervous system, which controls blood pressure

Pain nerves are most sensitive to the effects of the epidural. This means that a good epidural can provide analgesia without affecting muscle power or other types of sensation. The larger the dose used, the more likely it is that the side-effects will be problematic.

• For example, a laboring woman may have a continuous epidural during labor that in 85% of cases provides good analgesia without impairing her ability to move around in bed. If she requires a Caesarean section, she is given a larger dose of epidural bupivacaine. After a few minutes, she can no longer move her legs, or feel her abdomen. If her blood pressure drops below 80/50 she is given an intravenous bolus of ephedrine or phenylephrine infusion to compensate. During the operation, she feels no pain.

Very large doses of epidural anaesthetic can cause paralysis of the intercostal muscles and diaphragm (which are responsible for breathing), and loss of sympathetic function to the heart itself, causing a profound drop in heart rate and blood pressure. This requires emergency treatment, and in severe cases may require airway support. This happens because the epidural is blocking the heart's sympathetic nerves, as well as the phrenic nerves, which supply the diaphragm.

It is considered safe practice for all patients with epidurals to be confined to bed to prevent the risk of falls.

The sensation of needing to urinate is diminished, which often requires the placement of a urinary catheter for the duration of the epidural.

Opioid drugs in the epidural space are relatively safe (as well as effective). However, very large doses may cause troublesome itch, and rarely, delayed respiratory depression.

2) Other potential problems and complications with epidural use
No pain relief = "block failure"
Accidental dural puncture
Catheter misplaced into a vein
High block
Catheter misplaced into the subarachnoid space
Neurological injury
Epidural abscess formation
Epidural hematoma formation
Paraplegia
Arachnoiditis
Death

Blocks for Chronic Pain

- Pudendal Nerve Block
- Stellate Ganglion Block
- **Epidural steroid injections** - an epidural steroid injection may be used to help reduce the pain and inflammation caused by herniated disc, degenerative disc disease, or spinal stenosis.

Pharmacology

Peripheral nerve blockade can be accomplished by applying local anesthetics and other agents from a variety of pharmacological classes to inhibit the conduction of electrical signals within nerve fibers of the peripheral nervous system. Peripheral nerve blockade is classically sub-categorized into minor and major nerve blocks. Minor nerve blocks are defined as procedures directed at isolating a single peripheral nerve, while major blocks are described as procedures involving a single nerve at a proximal location (i.e. femoral nerve block), two or more isolated nerves, or a nerve plexus.

A List of Common Local Anesthetics in Regional Anesthesia:

<table>
<thead>
<tr>
<th>Local Anesthetic</th>
<th>+/- Fentanyl 0.25mcg/kg or 0.25-0.5mg Duramorph</th>
<th>Concentration</th>
<th>T10 level Lower Abdomen</th>
<th>T4 level Upper Abdomen</th>
<th>Duration Plain</th>
<th>Duration With Epinephrine</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Procaine</strong></td>
<td>10%</td>
<td>125mg</td>
<td>200mg</td>
<td>45min</td>
<td>60min</td>
<td></td>
</tr>
<tr>
<td><strong>Bupivacaine</strong></td>
<td>0.75% in 8.25% dextrose</td>
<td>12-14mg</td>
<td>12-18mg</td>
<td>90-120min</td>
<td>100-150min</td>
<td></td>
</tr>
<tr>
<td><strong>Tetracaine</strong></td>
<td>1% in 10% glucose</td>
<td>10-12mg</td>
<td>10-16mg</td>
<td>90-120min</td>
<td>120-240min</td>
<td></td>
</tr>
<tr>
<td><strong>Lidocaine</strong></td>
<td>5% in 7.5% glucose</td>
<td>50-75mg</td>
<td>75-100mg</td>
<td>60-75min</td>
<td>60-90min</td>
<td></td>
</tr>
<tr>
<td><strong>Ropivacaine</strong></td>
<td>0.2-1%</td>
<td>12-16mg</td>
<td>16-18mg</td>
<td>90-120min</td>
<td>90-120</td>
<td></td>
</tr>
</tbody>
</table>
Regional Anesthesia Complication

Local Anesthetic Toxicity- Unlike a minor local anaesthetic infiltration to allow a wound to be sutured, or a skin lesion to be excised, regional anaesthesia may involve large doses of local anesthetic, or administration of the local anaesthetic very close to, or directly into the central nervous system. Therefore there is a risk of complications from local anaesthetic toxicity (such as seizures and cardiac arrest) and for a syndrome similar to spinal shock.

Sources:
