Controversies in Regional Anesthesia

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1. INTRODUCTION

In some sense all of anesthesia is a controversy. Then in addition, of all the sub-fields in anesthesiology, perhaps the most scientific controversy is found in regional anesthesia.

It has been said that the strongest view-points in medicine are found on subjects where there is as little scientific evidence to prove the view-point, or as what there is to oppose the view-point.

We have a few controversies here to chat about. The views presented are certainly rooted in the author's personal perspectives. However, this author will try to present the broader consensus. Other views if different will also be revealed. Sometimes a claimed and formalized consensus is only the consensus of the committee few, and others still vociferously disagree.

We all treat patients and manage their care on a day to day basis. We desire to do the best we can. We should always take decisions that are in the best interests of each patient. This we do as we perceive and believe what the best care is. We also have to treat patients within the constraints of our working circumstances. The popular phrase is, we "try to cover ourselves" doing while our best.

2. DEFENSIVE MEDICINE.

Defensive medicine is medical care where healthcare providers act in a fashion that they perceive will least likely associate them with any allegation of having given bad medical care. It is game of perceptions. The thought is to include personal considerations into decision making about patient matters. Some will defend this approach and argue that they individually still place the patient's interest first. Most medical ethicists will counter-argue that any consideration of self, in the process of patient care decision making is unethical. The result is that with defensive medicine one of three actions are taken;

i. OVER–INVESTIGATE. They request excessive extra investigations, just in case pathology is found.
   - Classic medical training teaches to only do an investigation if one has a specific *question* in mind. Also, only do the investigation if the answer will change ones planned care. Investigations are expensive. Doing tests "just in case" is poor medicine. There is an element of economic triage in this thinking. No healthcare system can do all tests, on all patients, all of the time. It is not the best healthcare provider, who is the one doing the most tests.

ii. OMISSION OF CARE. They omit medical care that they think has a chance of being associated with negative patient consequence for which they will get blamed and sued or disciplined. Omitting care for fear of blame for something concerning by one patient in a thousand, deprives the other nine hundred and ninety nine of the benefit of the care that would have been given. All decision must be risk- benefit assessments for the patient only. The healthcare provider must never consider themselves in such decision making, lest it be defensive medicine which is bad.

iii. OVER-TREATMENT. Healthcare providers prescribe an excess of drugs often in multiple combinations for one problem, so that they can claim they acted "best" should a problem later arise. The medications are often perceived as preventative. Healthcare providers do not want to be accused of failing to prevent anything, so they prescribe everything possible for a problem that does not exist yet.

Defensive medicine is universally regarded as bad medicine. Healthcare providers are, by all the respected ethical standards from the times of Hippocrates to the Geneva Convention expected to place the patient before ourselves.

The foremost defensive medicine anesthesia providers practice in regional anesthesia is the omission of nerve blocks. This occurs when the anesthesia providers could do an intervention on the same limb as the surgeon. Surgeons are often scared that the anesthesia provider we cause a nerve injury that could also be caused by the surgery. The surgeon fears they will get blamed for "our" nerve block. The surgeon will then override the anesthesia provider's rights to autonomy and prohibit a nerve block. Ironically when a nerve injury does occur on a "shared the limb" the surgeons is most likely to blame the anesthetic.

POINT CONCLUSION; anesthesia providers, in general, need to perform more nerve blocks on their patients. This is in the best interest of patients.

3. **NO NERVE BLOCKS IN ANTI-COAGULATED PATIENTS**.

The catastrophe of paraplegia secondary to bleeding, after a neuraxial block is as serious as death after anesthesia and probably a bigger burden on the remaining family by far. I think the benefits of neuraxial anesthesia are so few, and there are such good alternatives, if not better that I see no reason to challenge current guidelines on the subject. In short, anti-coagulation means do not do a neuraxial block.

The issue with peripheral nerve blocks performed in the presence of varying grades of anti-coagulation therapy is harder to resolve. Opinions are diverse and world guidelines are as diverse in their recommendations. There is little science available to base recommendations on. Common logic is seldom applied. One needs to make a risk benefit assessment, as one does with every single therapy intervention given to all patients. Before deciding on whether to perform any peripheral nerve block on any patient ask the following questions;

- Is the prevailing anticoagulant therapy prophylactic or therapeutic in its effects? One can be bolder about administering a peripheral nerve block, if the therapy is only a prophylactic dose.
- Is the surgeon willing to operate under the same coagulation circumstances?
- How sizable a benefit does the patient stand to gain from a lighter general anesthetic combined with the nerve blocks, or from awake surgery under peripheral nerve block only? In other words, is the patient a young ASA1 athlete, or an aged obese cardiorespiratory cripple?

If there cannot be stated one single comment-worthy benefit from performing the peripheral nerve block, then omit the block. If the surgeon is willing to operate under the same coagulation conditions one can be braver, and more strongly consider doing a peripheral nerve block. If one clear comment-worthy reason exists to benefit the patient by receiving a peripheral nerve block, then perform the nerve block in the presence of prophylactic anti-coagulant therapy. If two such reasons exist then perform the peripheral nerve block, even in the presence of therapeutic anti-coagulant therapy.

A permanent life changing disability following a bleeding associated with the combination of a peripheral nerve block and anticoagulant therapy is as small a risk as getting struck by lightning while walking in the rain. Do not fear the millionth patient. Feel the good done by a nerve block in the other nine hundred thousand patients.

If you lack the courage to act in the best interest of an individual patient, consider a career shift into administration, without patient involvement.

LAST COMMENT: Discuss the PROs and CONS very bluntly with the patient. Let the patient take the final decision. Also, be sincere about the choice you would like to make, but never push a reluctant patient into receiving a nerve block they fear. Lastly have the surgeon be informed of your decisions and your reasons for them before you proceed.

4. THE ADDUCTOR CANAL BLOCK.

This is currently one of the most widely performed blocks in the world for knee arthroplasty surgery. It is also probably the least effective peripheral block ever conceived. The block is injected deep to the sartorius muscle in mid antero-medial thigh. The sartorius muscle forms the roof of a fascial canal containing the femoral artery and vein, and the saphenous nerve.

The popularity of the nerve block is driven by surgeon's instruction to the anesthesia provider to inject the nerve block.

The surgeons like the adductor canal nerve block for three main reasons.

a) They believe it will be associated with less patient falls after knee surgery, than that seen after femoral nerve blocks. Femoral nerve blocks are the most single effective nerve block for knee surgery pain. No credible study has shown evidence that adductor canal blocks prevent post knee surgery patient falls. One study of near a half million patients, by Memtsoudis, could only (i) identify multiple co-morbid systemic disease, and (ii) male gender as associated factors with increased falls. Use of nerve blocks in that study, had zero correlation with risk for falls after surgery. Regardless many surgeons have insisted on abandoning the femoral nerve block in knee arthroplasty patients.

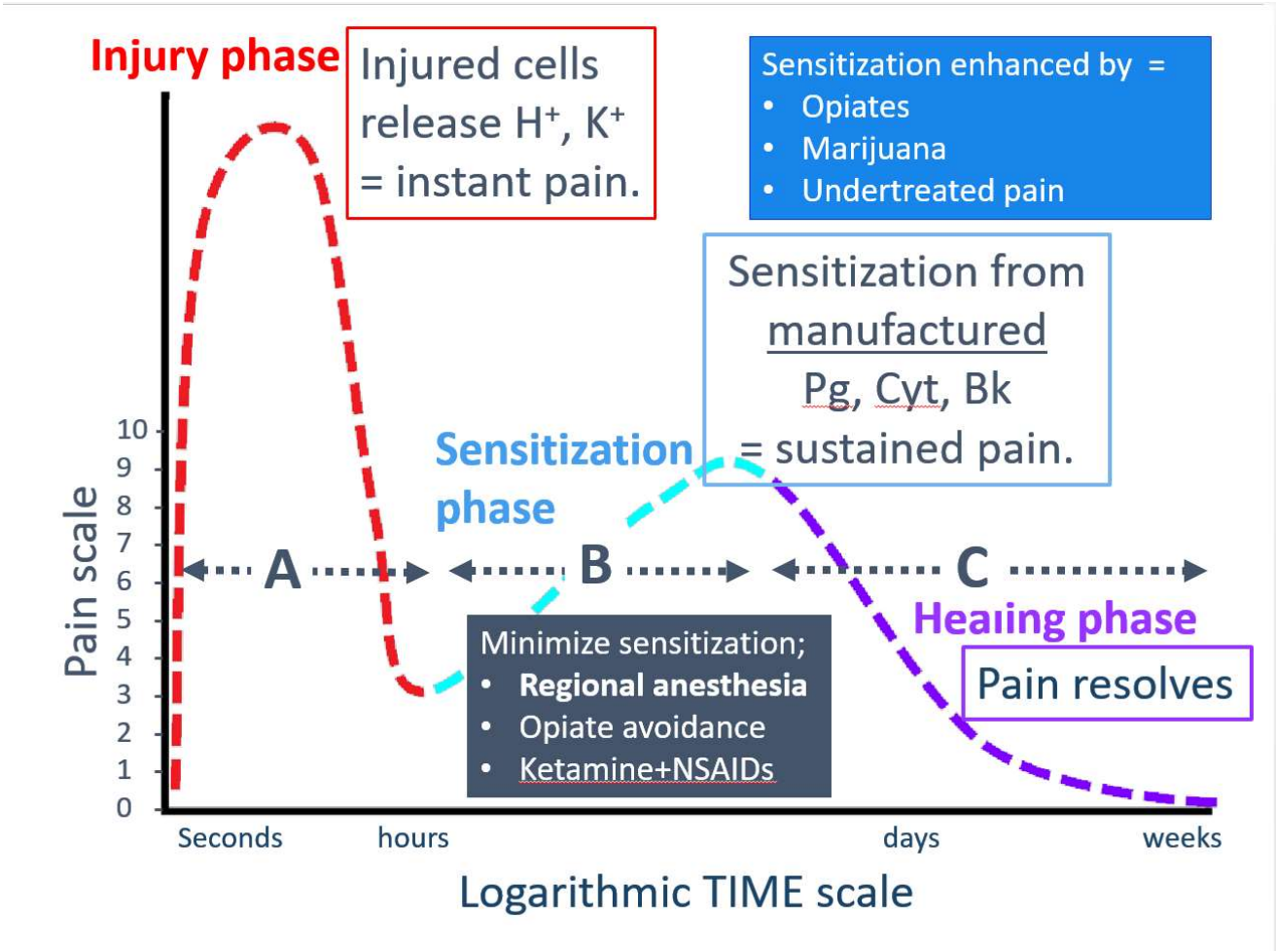
b) The regional anesthesia technique surgeons have used as a substitute for the femoral block that they have abandoned, is very deficient in providing post-surgery analgesia. This Local Infiltration Analgesia (LIA), also called Peri-Articular Infiltration (PIA). That duration of analgesia from an infiltration blocks only is 30% to 50% than the duration of analgesia from the same drugs (in smaller total doses) injected onto larger more proximal peripheral nerves, including the femoral nerve. LIA and LIA are also incomplete in half of patients. The patients wake up after a knee arthroplasty, with significant pain despite the surgeon administered an infiltration nerve block. This fact has induced surgeons to request a prophylactic adductor canal block to rescue their deficient LIA and PIA blocks.

- LIA and PIA have been well shown to be superior to zero therapy. That is, they are superior to placebos. That just proves some efficacy. That does not prove merit though, compared to alternative therapies.
- LIA and PIA are however clearly inferior in providing post-surgical analgesia compared to standard peripheral nerve blocks.
- Anesthesia colleagues who perform the adductor canal block a lot, in Denmark report that that they do ward-rounds twice per day to repeat the nerve blocks. In fifty percent of blocks the patient cannot perceive any degree of improved analgesia in the knee. Anesthesia colleagues who perform a lot of adductor canal block in Central Eastern USA, report that they surreptitiously inject the adductor canal block as far proximal as they dare without the surgeon thinking it is femoral nerve block. The idea is to try and have some drug spread to the femoral nerve to improve the analgesia.

c) Surgeons believe that omitting femoral nerve blocks will assist getting patients walking sooner. Forty years ago patients were not allowed to attempt walking after knee arthroplasty until the skin sutures were removed on the seventh day after surgery. Over the decades mobilization of patients was been done earlier and earlier. At a point, patients were achieving walking on the first or second day after surgery. They were also far more active in bed before walking. Physical therapy was passive before walking and then active with walking. It was clearly observed that there was no detriment to the surgical repair from this dramatically earlier mobilization. It was also strongly suggestive that patient outcomes such as leg thrombosis, and pulmonary complications improved with earlier mobilization. There is also a reduction in the extent of the usual loss of muscle strength following knee surgery. That is all well believed. The push now in the last half decade, is to have all patients walking on the day of surgery, and absolutely walking on the day after surgery. It is not clear if this will produce the magnitude of benefit that advancing walking form the eighth day to the second day did. Studies are inconclusive and arguable. Study parameters are developed for the studies as measures of long term outcomes. There is no good evidence that such extreme early mobilization can influence long term outcomes beneficially. This is believed to require abandonment of anesthesia applied femoral and sciatic nerve blocks. It is now clearer that the driving force behind this is not, in truth, focused on patient healthcare, but rather on health business care. The goal is earlier patient discharge from hospital. That shifts nursing costs away from the hospital and insurers. It shifts it onto patients who need to have family members take paid leave time to be home nursing aids. It also allows hospital beds to be utilized for more surgical patients. Surgery is very profitable for hospitals. The more surgery that is done for a given number of beds the better the profit margins.

SUMMARY; In the USA anesthesia providers stand very unequal to surgeons, even if they are physician anesthesiologists. Anesthesia providers are usually not invited to discuss designing knee arthroplasty patient care paths and analgesia protocols.

I predict a swing back to the femoral nerve block will occur. Knee arthroplasty is one of the most painful orthopedic surgeries. There is reluctant acknowledgement that the use of opiate analgesia must be reduced. Until then, inject the adductor canal block upon surgeon directives, and enjoy the extra money you earn.



In this diagram the perioperative pain curve is seen. The horizontal axis is time, starting in seconds and ending in weeks. The vertical scale represents the severity of pain that the patient can experiences at points in time. Note during the operative phase, that occurs under anesthesia, pain would be two to three times more severe than the end of the scale of 1 to 10. Phase "A" is when surgery is being performed and cells are being disrupted and destroyed. It typically lasts a few hours. Phase "B" spans the immediate postoperative period. Observe how the pain falls fast due to depletion of the released potassium and hydrogen ions from the injured tissues. Without a physiological system evolved to sustain the pain, all pain would cease shortly after completion of surgery. Phase "C" is the healing phase when inflammation at the level of the surgical injury diminishes and scarring matures and heals.

The "B" phase is characterized by infiltration of inflammatory cells into the injured tissue region and the generation of inflammatory mediators. The pain increases again, peaking at approximately between 8 to 24 hours after completion of the surgery. This inflammatory process has two purposes. First it facilitates healing via stimulation of neovascularization, attracting in inflammatory and immune cells, laying down of collagen and generation of other cells and release of multiple inflammatory molecules. Second the inflammatory process also sensitizes the peripheral nervous system to generated pain signals, and also sensitizes the central sensitization process within the spinal cord to amplify the intensity of the sustained pain signals coming from the surgical tissues. The purpose of pain in nature is to modify creature behavior towards that conducive to healing.

Surgery like a total knee replacement represent extreme injuries beyond what can be survived in nature. Consequently, full healing in nearly half of patients does not occur and significant pain signals continue to be produced for months as Persistent Post-Surgical Pain (PPP).

The inflammatory substances associated with pain sensitization include prostaglandins, cytokines and bradykinin. For some of those there are have pharmacological antagonistic agents, like Non-Steroidal Anti-Inflammatory Agents (NSAIDs) that are effective analgesics. Typically, they are all non-sedative and do not worsen the pain sustaining physiology. Excessive pharmacological suppression of the inflammatory process for analgesia purposes will unfortunately also impair the healing processes.

Some pain killers that do have sedative effects (1) produce some analgesia, but (2) predominantly reduce the "caring about pain feeling". They all have addictive potentials. They all enhance the pain amplification mechanism, thus inducing hyperalgesia. This results in (i) a need to use increasing doses and (ii) the extension of the time period that the patient experiences pain. In a bit more than half of TKA individuals the healing process dominates and the pain ultimately becomes zero. In the others pain can persist to a point time when it is considered to be pathological and a special problem.

Pain therapy after TKA surgery should therefore be designed (i) to limit opiate usage to the shortest time possible, and (ii) to use the lowest doses possible. This means one should use regional anesthesia, and established non-sedating analgesia drugs as much as possible, while reserving opiates for rescue analgesia in the initial few single days, and as sleep-time analgesia for a modestly longer period.

Regional anesthesia must be used to provide as complete as possible analgesia through the postoperative inflammatory peak, and then longer where possible even if only partial, in balance with the needs to mobilize and energize patients. Logistical and cost factors are not without consideration too.

Patients should be "over-promised" postoperative pain control. They must have realistic expectations. Stated goals could be; (i) "*We will treat the pain maximally for the first day and night*", (ii) "*On the following days onwards we expect to treat your pain down to a point where you will be able to deal with it, and tolerate it*", and (iii) " *we will make sure you sleep well in the first week*", and (iv) "*You being brave and getting moving and strong again will be your best investment in the long term best outcomes*". The bad thing to do is to over-promise giving the patient profound analgesia combined with over-prescribing opiates for excessively long periods.

5. WHO SHOULD PERFORM PERIPHERAL NERVE BLOCKS?

This is a discussion of *major nerve blocks*. There is of interest as many non-anesthesia-providers to start injecting major peripheral nerve blocks in unusual circumstances like in the emergency room or on the road-side. Many good institutions in non-America countries provide an anesthesia provider permanently in the larger emergency rooms to aid with such a service. Anesthesia providers are expected to advise and train these other persons. We also need to question whether even all of us anesthesia providers should be doing major peripheral nerve blocks.

A major nerve block has one or all of the following characteristics.

i. A potential needle consequence of the block could for example, be a life-threatening catastrophe such a cervical spinal block or pneumothorax.

ii. The intended dose of drug to be injected, if when injected INTRAVENOUS into experimental animals would cause cardiac arrest or grand mal convulsions in the experimental animals.
iii. The natural block effects could have an influence on patient ability to breath, or upon blood pressure changes from the sympathectomy.

Thus, the person performing the nerve block must have all of the following traits;

i. Be skilled and practiced in the ability to intubate a patient, ventilate a patient and provide all respiratory care. (Be ACLS competent)
ii. Be skilled and practiced in providing cardiovascular support. Be able to place IV lines and be familiar with drugs for treating hypotension and cardiac arrest.
iii. Be knowledgeable about all the applied anatomy of the particular nerve block, be trained in performing the nerve block, and be practiced in performing the nerve block.

The following persons could qualify for requirements numbers (i) and (ii) above. Anesthesia providers are the foremost qualifying group. Experienced ER (Emergency Room) physicians from large centers are the second best skilled group. ICU physicians who regularly have ventilated patients in their care would be the last qualifying group.

Another big problem arises from the fact the regional anesthesia skills are not part of routine anesthesia practice. It is insufficient to perform a nerve block less frequently than annually. All too often anesthesia providers, especially in smaller institutions can be required to perform a nerve block they have not seen, or done in years. Maybe it is a nerve block they have never done before. As much as an abdominal surgeon should not attempt to plate a bone fracture, as an inexperienced anesthesia provider should not perform an unfamiliar major nerve block alone.

ILLUSTRATIVE CASE 1. An orthopedic surgeon performed a caudal epidural block on a patient in a general ward without monitoring and without IV access. The patient developed convulsions and died.

ILLUSTRATIVE CASE 2. An inexperienced locum anesthesia provider tried to do an infraclavicular nerve block unassisted, having only never one done one previously. The patient acquired a pneumothorax and cardiac arrest occurred. A “code” team was able to save the patient and the final outcome was satisfactory. This locum anesthesia provider’s next job required she be skilled in upper limb blocks and she had wanted to “practice” on this one patient. She should have sought an experienced regional anesthesia practitioner to over-see her and teach her.

CASE 3. An orthopedic surgeon performed a Biers block on a patient for hand surgery. The block set up well but the tourniquet was an old fashioned manual mercury Baumanometer type that a nurse had to keep inflating. The nurse was called to perform additional duties and the cuff deflated. The patient developed cardiac arrest from local anesthetic toxicity and died before appropriately skilled persons were able to assist.

6. SHOULD ONE PERFORM NERVE BLOCKS ON A LIMB WITH REMOTE RISK OF DEVELOPING ISCHEMIA?

The classic signs of ischemia in a limb all stat with "P". They are (i) **P**allor, (ii) **P**ulseless, (iii) **P**aresis, (iv) **P**aresthesias, (v) **P**ain, and (vi) **P**erishingly cold. A nerve block during its most dense phase will conceal some of those signs. The diagnosis of limb ischemia can still be made if the diagnosis is suspected. An ischemic limb will always be cool, pale and blanched, and without pulses. This is especially if compared to the unaffected limb.

A block that provides anesthesia usually provides analgesia for twice as long as what it was good for surgical grade analgesia. That is the maximally dense phase is only about as long in duration as the surgery, but the medium dense phase is good enough to sustain post-surgical analgesia for nearly twice as long as the dense phase. Thus no patient seen in the ward has maximally dense nerve block anymore regardless of the drug used. When a nerve block is in its surgical grade of block, all of the thick and thin axons are blocked. Thick axons block slowest, need the highest concentration of local anesthetic, and reverse block the fastest. The thin axons block fastest and for longest. For example, a bupivacaine 0.5% grade surgical grade block could last 6 hours, and then the patient will began to feel skin touching and become able to wiggle the limb. They typically will remain free of severe somatic pain for an additional 6 hours. After that the thin axons that carry acute pain signals return to normal function. Touch sensation axons and motor axons are all of the thickest type and are hardest to block. Ischemic pain is transmitted via the thick touch axons. So, if ischemia is present in the limb it does tend to manifest earlier as pain typically at six hours after the bupivacaine was injected. Incisional (surgical pain) would only manifest about 12 hours after the block was injected.

In addition, motor function starts to return at six hours after the block injection. Thus, if motor paralysis persists unusually long in a limb after block was injected one must consider that limb ischemia is present.

If a limb is unexpectedly cold, pale and pulseless at any time after a nerve block was injected one must strongly consider the limb is ischemic.

ILLUSTRATIVE CASE 1: The anesthesia provider is called to visit a patient complaining of severe limb pain shortly after 5 hours of surgery and having received nerve blocks. The anesthesiologist was disappointed, assuming their nerve blocks had failed. On examination the surgical limb was clearly pale, pulseless and cold. That diagnosed ischemia. The surgeon was notified and arranged to immediately re-operate. The vascular graft had become clotted. Immediately after the second surgery that restored the blood flow the limb was pink, warm and pain free. The ischemic pain was gone and the residual low-grade nerve block still eliminated the somatic surgical pain. Had the patient not had a nerve block and the anticipation of being pain free the leg pain likely would have been treated with large amounts of opiates and the correct diagnosis likely have been delayed until too late. The nerve

block saved the leg. The ISCHEMIC pain broke through the nerve block, and the most diagnostic signs of ischemia pallor, absence of pulse, and coldness were present. KEY POINT: Inappropriate pain can be a strong pointer to the presence of limb ischemia. The clinical signs of pallor, absence of pulse, and limb coldness were unaffected by the nerve block. This case illustrated how ischemic pain can break through a still established nerve block.

ILLUSTRATIVE CASE 2: The anesthesia provider visited the patient the day after rectal-colonic surgery to check on the epidural block. The patient was pain free and one leg was still paralyzed after the epidural. The surgeon blamed the epidural. The anesthesia provider was adamant that the low concentration local anesthetic epidural could not cause motor paralysis. More so, the epidural block would highly unlikely cause block of one leg only. Twelve hours later the surgeon was convinced to investigate further. The patient was found to have bilateral compartment syndromes as lithotomy injuries. One lower leg and one foot was amputated. The surgeon tried to blame the epidural by alleging that it had concealed ischemic pain. The epidural with the visit of the anesthesia provider was finally credited with making the discovery of inappropriate persistent paralysis. The surgeon was finally blamed for not responding to the anesthesia providers very early concerns about the persistent paralysis in the legs. KEY POINT: Ischemia can be 100% pain free. Pain is an unreliable indicator of limb ischemia. Even a myocardial infarction is known to also sometimes be pain free. The inappropriate paralysis was the major pointer to the ischemia.

ILLUSTRATIVE CASE 3: The anesthesia provider was called to the recovery room to see a patient recovering from general anesthesia and rectal-colonic surgery. The patient had one pink, warm foot and one cold pale foot. Pulse was strong in the warm foot and weak in the cold foot. Neither leg had pain. The nurse was concerned the cold foot had ischemia. After examination it was decided the cold foot was appropriate for the cold patient, but the warm pink foot was inappropriately vasodilated secondary to a lithotomy induced sciatic nerve injury with resulting sympathectomy. The surgery induced sciatic nerve injury took 6 months to recover. No ischemia was ever involved.

SUMMARY. A surgeon who refuses that a patient be given a limb nerve block for fear of it concealing or masking potential ischemic pain, is incorrect. Ischemia may cause pain or not at all. Pain is thus a very unreliable sign of ischemia. The assessment of ischemia, if a real concern, must be based upon scheduled hourly examinations for limb warmth, color and presence of a pulse. Compartment syndrome is also easily monitored using intra-compartmental measuring devices. None of those is detrimentally influenced by the presence of a nerve block.

7. SHOULD ONE EVER PERFORM A NERVE BLOCK ON AN ANESTHETIZED PATIENT?

In 1998 Bromage and Benumof published a case report of a patient developing paraplegia after a spinal cord injury secondary to an attempted interscalene nerve block. The block needle had penetrated the spinal cord and drug was injected. Bubbles from the injection were visible within the spinal cord on axial scan. They argued that had the patient been awake the patient could have alerted the anesthesia provider that by way of experiencing pain upon needle penetration of the cord. Hypothetically, Bromage and Benumof argued, the cord injury and resultant paraplegia could thus have been prevented. They subsequently recommended that regional anesthesia never be performed on an asleep or heavily sedated patient.

The international regional anesthesia community has responded with vast evidence of regional anesthesia being safely performed on fully anesthetized children with good suggestion that nerve injuries are REDUCED by the fact that the child is restful and immobile. The experience base covered decades and hundreds of thousands of children.

Secondly Bromage and Benumof were ignorant of the fact that the central nervous system produces no pain when handled surgically. Awake surgery is performed on both the brain and spinal cord without any patient pain being experienced. Only the overlying flesh, and bones covering the surgical access needs to be anesthetized with local anesthetic drugs. In addition, needles have been inserted into millions of nerves in fully awake patients, with only nominal non-painful vague sensations reported during the era of paresthesia guided nerve blocks. Using paresthesia needle guidance in is likely that nearly all nerve blocks are intraneural. There is further strong suggestive evidence from Urmey and others that using nerve electro-stimulation guided nerve blocks still place the needle inside the nerve in half of nerve blocks. The evidence from the ultrasound guided era of regional anesthesia has also reinforced the fact that intraneural injections occur frequently and harmlessly. Case reports confirm that ultrasound specific guidance avoiding intraneural injections has NOT prevented regional anesthesia associated nerve injury from occurring. There is in fact no confident way to eliminate intraneural injections consistently from all major peripheral nerve injections. As peripheral regional anesthesia is only rarely associated with nerve injury then there is clearly no advantage in exclusively performing peripheral nerve blocks on fully awake patients.

An occasional patient receiving a peripheral nerve block awake will report marked discomfort or pain from the block needle during a nerve block. That is not an exclusive sign of nerve penetration that will lead to nerve injury. That was a long past erroneous authorative statement. It is a sign of hyperalgesia. All such patients invariably have chronic severe tissue injury, and they have a history of having had allodynia within the preceding 12 months. They all strongly need the nerve block to help treat the hyperalgesia that the coming surgery will make even worse. Their nerves are physiologically altered, hence the pain experienced when the needle touches a nerve associated with their region of pathology. Were those patients to have had the same block under general anesthesia no discomfort would have been observed, but the nerve block benefit would be the same.

SUMMARY. If it is desirous for any practical reason the want to perform regional anesthesia on a patient under any level of sedation or under full general anesthesia, it is clinically appropriate and safe practice. This author performed 95% of all central and peripheral nerve block under general

anesthesia uneventfully for 14 years. This author then performed another 14 years of extensive peripheral nerve blocks under deep sedation with similar uneventfulness.

8. ARE ADDITIVES GOOD OR BAD IN REGIONAL ANESTHESIA?

There is diversity of views on this, with perhaps a majority leaning towards using additives. This author however leans strongly away from utilizing nerve block additives to local anesthetic drugs and will present argument to that cause.

Firstly, there is the risk of making a pharmaceuting error when preparing the drug concoction prior to injection. To understand this one has to know what constitutes a drug error.

Drugs errors can be a single event or permutation of events;

A. Related to drug type selection;
   (2) Right drug selected for the specific issue being treated, but wrong drug administered inadvertently.
   (3) Wrong drug selected for the indication, but correctly administered as chosen.
B. Related to drug administration;
   (1) A wrong drug is substituted for the one intended to be injected.
   (2) The wrong route of administration is selected. Injection routes can be subcutaneous, peripheral-intravenous, central-intravenous, intra-arterial, via neuraxial catheters (spinal or epidural), via perineural catheters, and intramuscular. An example is this error type would be injecting an antibiotic via the epidural catheter instead of the IV line.
C. Related to drug dose;
   (1) The total dose may be in error.
   (2) The drug concentration may be in error.
   (3) The rate of bolus administration may be in error.
   (4) The rate of infusion may be in error.
D. Documentation of error.
   (1) The recorded note may reflect a correct drug was injected for the specific indication, and thus conceal from later review that a wrong drug that was erroneously administered.
   (2) The recorded note may reflect an incorrect drug for the indication that is clearly an erroneous drug to administer, but a correct drug was actually administered.
E. Related to *awareness* of the error.
   (1) The healthcare provider may realize the error immediately upon administration of the drug. The suspicion may then be revealed to others or concealed from others.
   (2) The healthcare provider may suspect an error, but they may be unable to verify that after the fact. The suspicion may then be revealed to others or concealed from others.
   (3) The healthcare provider may suspect an error occurred, and they may be able verify it. For example, an examination of the used drug ampules may

show an inappropriate ampule in the waste jar. The suspicion may then be revealed to others or concealed from others.

(4) The healthcare provider may have no suspicion a drug administration error has occurred, and they have no way to ever investigate that after the fact. This likely occurs every year to every single anesthesia provider. The true incidence of this is impossible to measure.

Studies into documentation of records show anesthesia drug errors were made with a rate of in **1 per 133 times** a drug is administered. These are discovered errors long after the time the patient was cared for.

Extensive anecdotal reports strongly shows that many anesthesia drug errors are made, and immediately recognized after an inappropriate patient response to the drug. The practitioner either cognitively knows a wrong drug was inadvertently prepared, or wrong pre-prepared drug syringe inadvertently picked up. The practitioner may return to the waste ampule and then see an incorrect ampule had been used. In all such related events in the absence of an immediately attention-grabbing inappropriate patient response the **error would remain undiscovered**.

Informal confidential survey showed 100% of anesthesia providers admitted making a known drug administration error within a 12-month period. They were very largely without long term consequence. The errors were all largely rectifiable.

The consequences of drug administration errors.

A consequence can range from death to nothing. The timing of discovery of any negative outcome can range from immediate within seconds, to after six to twelve months.

A variety of sources suggest if a single wrong oral drug is taken orally once, the outcome is mostly inconsequential in the vast majority of cases, perhaps 99% of cases. Some of the 1% of consequential cases could be very serious.

A variety of sources suggest if a single wrong intravenous drug is administered once intravenous, the outcome is inconsequential in most cases, perhaps 66% of cases. Some of the 33% of consequential cases could be very serious.

A variety of sources suggest if a single wrong drug is administered direct onto a nerve, the outcome is catastrophic in very many cases. Specific studies have shown some drugs inadvertently injected direct onto a nerve have no consequence, and others are destructive. The clinical cases where consequences occur usually end in total nerve destruction. In many cases the destroyed nerve may recover many months later, but in other cases destruction is permanent. It seems if a consequence occurs following a direct injection of an incorrect drug onto a nerve that it is either very serious or not at all.

Why are regional anesthesia drug errors so much more serious and so more frequently consequential than drugs administered in error via other routes?

The answer is simple. All drugs, local anesthetics excepted, have to travel via the blood stream to reach their target receptors. The drugs get diluted at least 5000 times within the blood volume and get diluted by an additional amount by interstitial and intracellular fluids. The total dilution can be up to 70 000 times at most. Drugs injected perineural do not get that protecting benefit of massive dilution. Thus, instead of acting only on cell receptors the concentrated drug acts chemically directly on the physiologically very delicate axonal tissues many feet removed from their mother neuronal cells. Drugs needing dissolving in relatively high or relatively low Ph carrier solution seem to be the most tissue destructive. Therefore, some drugs are in these circumstances are severely neurotoxic. This neurotoxic effect would be scientifically unknown as very few drugs have ever been injected relatively undiluted direct onto nerves to assess potential for neurotoxicity.

ILLUSTRATIVE CASE 1. A drug for a nerve block was meant to be diluted to half strength by addition of 0.9% sodium chloride (normal saline). The local anesthetic was diluted accidentally with a near identical looking ampule of calcium chloride. The problem was only realized when the brachial plexus in its entirety failed to ever recover from the nerve block, and all the overlying skin died and sloughed. Extensive skin grafting was needed to repair the skin defect. The patient had flaccid arm that just hunt their side for the rest of their life. The person who prepared the drugs was a non-anesthesia provider assisting the anesthesia provider. That could be minor factor in the occurrence of the drug error.

ILLUSTRATIVE CASE 2. A patient was injected a brachial plexus block. It had been intended to add clonidine to the local anesthetic. The plexus remained paralyzed for many months after the nerve block but did finally recover. There was no evidence of a hematoma. There was recorded ultrasound video clip confirming the needle never penetrated any component of the brachial plexus. Typical nerve injuries associated with nerve blocks fit a pattern of only one component being injured. Complete injury to an entire plexus is unusual. This also suggests the nerve injury was chemical in nature from the fluid that was injected. That strongly suggests a wrong drug was injected. A private interview with the writer of the case report indicated that he was trainee at the time and had to prepare and mix the nerve block drugs in rush immediately prior to performing the nerve block under tutored guidance. That could be minor factor in the occurrence of the drug error. An ampule of clonidine at a glance, resembles many other drugs in an identical size, shape and color ampule. Some are oncology agents but one as metoclopramide antiemetic drug. Metoclopramide is possibly an available drug also be in an anesthesia drug cart. It is thus also available to be used erroneously. It is thus postulated that perineural injection of metoclopramide as local anesthetic additive chemically destroyed the axons but left the Schwan cell sheaths intact, hence the ability of the nerve to recover via regrowth of the axons.

CONCLUSION.

If an anesthesia provider performs a few thousand nerve blocks within a career and uses additives in every single case, there is one certainty. It is certain that drug mixing errors will occur. It is possible one patient at the least, will develop a life changing complication. There is no indication for, or benefit from, the use of local anesthetic additives that justifies this risk. “Use the drug as the factory made it and do not try to change it ever”.