Nursing Capstones   Department of Nursing

6-21-2016

Anesthesia Management of a Cesarean Section Patient Following Failed Spinal Anesthesia

Katelynn Ryan

[How does access to this work benefit you? Let us know!](#)

Follow this and additional works at: https://commons.und.edu/nurs-capstones

Part of the Nursing Commons

Recommended Citation

Ryan, Katelynn, "Anesthesia Management of a Cesarean Section Patient Following Failed Spinal Anesthesia" (2016). *Nursing Capstones*. 205.
https://commons.und.edu/nurs-capstones/205

ANESTHESIA MANAGEMENT OF A CESAREAN SECTION PATIENT FOLLOWING
FAILED SPINAL ANESTHESIA

by

Katelynn T. Ryan

Bachelor of Science in Nursing, North Dakota State University, 2012

An Independent Study

Submitted to the Graduate Faculty

of the

University of North Dakota

for the degree of

Master of Science

Grand Forks, ND

December

2016

PERMISSION

Title   Anesthesia Management of a Cesarean Section Patient Following Failed Spinal Anesthesia

Department   Nursing

Degree   Master of Science

In presenting this independent study in partial fulfillment of the requirements for a graduate degree from the University of North Dakota, I agree that the College of Nursing and Professional Disciplines of this University shall make it freely available for inspection. I further agree that permission for extensive copying or electronic access for scholarly purposes may be granted by the professor who supervised my independent study work or, in her absence, by the chairperson of the department or the dean of the School of Graduate Studies. It is understood that any copying or publication or other use of this independent study or part thereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and to the University of North Dakota in any scholarly use which may be made of any material in my independent study.

Signature_____

Date_____

ABSTRACT

Title: Anesthesia Management of a Cesarean Section Patient Following Failed Spinal
                Anesthesia

Background: A 25 year-old female undergoing a cesarean section and tubal ligation with
                history of failed spinal anesthesia that was subsequently converted to general
                anesthesia. General anesthesia in parturients undergoing cesarean section has
                less favorable patient satisfaction scores and is associated with greater risks of
                postoperative complications, mortality, and harm to the fetus compared to spinal
                anesthesia.

Purpose: To evaluate trends and risk factors of failed spinal anesthesia in parturients
                undergoing cesarean section for use of prevention and decreased incidence of
                conversion to general anesthesia.

Process: CINAHL, Google Scholar, and PubMed databases were utilized through the
                University of North Dakota Harley E. French Library of the Health Sciences.
                Relevant sources were retrieved along with other articles and studies found within
                the reference lists of the sources drawn from the databases. Most articles found
                and used for the purpose of this review were published within the past seven
                years. Articles published at an earlier date were examined for applicability to
                today's practice and determined to be beneficial. Retrospective and prospective
                studies within the articles used were synthesized to summarize risk factors and
                trends associated with the incidence of failed spinal anesthesia.

Results: The risk and occurrence of failed spinal anesthesia has been found to be higher
                among specific parturient and fetal demographic groups and with various
                techniques, methods, and positioning during administration.

Implications: Successful spinal anesthesia for cesarean sections provides many advantages over
                epidural and general anesthesia. It is imperative for anesthesia professionals to be
                aware of the evidence based recommendations and risk factors to prevent and
                decrease the incidence of failed spinal anesthesia.

Keywords: Failed spinal anesthesia, failed spinal blockade, failed regional anesthesia,
                anesthesia management of cesarean section, anesthesia techniques for cesarean
                section

Anesthesia Management of a Cesarean Section Patient

Following Failed Spinal Anesthesia

"Birth by cesarean section accounts for over 30% of all deliveries and is performed over 1.5 times annually in the United States" (Nagelhout & Plaus, 2014, p. 1142). Administration of a single-shot spinal anesthesia is generally regarded as straightforward and simple. However, occasionally, total or partial failure of spinal anesthesia can require conversion of the anesthesia plan to general anesthesia. General anesthesia is associated with more intraoperative and postoperative risks to the parturient and fetus making care less safe and more costly and timely (Hoppe & Popham, 2007).

As spinal anesthesia has been considered the management of choice for the parturient undergoing cesarean section (C/S) due to the many advantages over general and epidural anesthesia, it is important to determine the risk factors for spinal anesthesia failure and identify problems that are potentially correctable to help develop strategies to overcome failure problems and risks. By analyzing incidences of block failure and failure trends and recognizing risk factors, prevention and improvement in failure rates can be made to improve patient care, safety, and outcomes.

Case Report

A 25 year old female, 168cm tall and 74kg, gravida 3, para 2, term 2, presented for a C/S and tubal ligation. The patient was 39 weeks pregnant, and her pregnancy had been uncomplicated. Her past medical history included gastroesophageal reflux disease and asthma. Her past two deliveries included a vaginal birth with a reported patchy epidural block and a planned C/S with a failed spinal anesthetic that was subsequently converted to general anesthesia. Upon review of the patient's past medical records, the failed spinal administration

during the previous C/S was documented for presence of free flow cerebrospinal fluid (CSF) and

negative for blood, paresthesia, or complication on the first attempt. For the current C/S, the

patient gave consent for both regional and general anesthesia with the understanding of the

possibility of having another failed or insufficient spinal blockade. A complete blood count

(CBC) and electrolyte panel revealed labs were all within normal limits.

The patient was transported to the operating room and then positioned sitting for

subarachnoid block (SAB) placement. Standard monitors were applied. Vital signs taken before,

during, and after the spinal blockade were unremarkable with blood pressures ranging from 90 to

120 mmHg systolic, heart rate 80 to 110 beats per minute, and oxygen saturations 98 to 100%.

Following identification of the L3-L4 interspace, the patient was prepped and draped in a sterile

fashion. The skin was then anesthetized with an injection of 3ml of 1% lidocaine. A mid-line

approach was performed with a 25 gauge Whitacre needle through an introducer needle. No

paresthesias were elicited during needle insertion. Following the return of clear and free flow

CSF, 1.4 ml of bupivacaine 0.75% with fentanyl 20 mcg and morphine 0.2 mg was slowly

administered and the needles were removed. The patient was then placed in the supine position.

The patient tolerated the procedure well.

Prior to incision, the surgeon performed a skin test and subsequently the patient reported

feeling "a sharp pain." Lidocaine was injected by the surgeon at the surgical incision site.

Approximately five minutes later, another skin test was performed and the patient denied any

discomfort. The patient tolerated incision and complained of only minor discomfort with pushing

and pulling sensations that were "tolerable, but increasing" according to the patient. After

delivery of the baby, the patient's pain became less tolerable with increasing complaints of pain

and facial grimacing was noted. For the last 45 minutes of the case, the spinal was supplemented

with a total fentanyl 325mcg, midazolam 2mg, and propofol infusion 50-75mcg/kg/min. In addition, a mixture of nitrous oxide 5L/min and oxygen 3L/min was administered through a face mask until incision was closed. The patient was closely monitored and spontaneous ventilation was maintained by the patient without intervention.

The patient was transferred to the PACU alert and oriented with oxygen 3L/min via nasal cannula. On arrival to the PACU, the patient denied pain and nausea. In addition, the patient stated her lower extremities felt "weak and heavy." A fentanyl PCA was started within 2 hours of arrival to the PACU for postoperative pain. Twenty-four hours later, the patient stated she had adequate pain control postoperatively with the fentanyl PCA and denied paraesthesias and weakness to lower extremities.

Discussion

The characteristics of a successful spinal are often summarized as the right place, right drug, and right dose. The right place is injection within the subarachnoid space in the CSF that is continuous with nerve structures (nerve roots, cauda equine, and medullary cone) to facilitate penetration and action at the level of the axonal membrane, where it blocks nerve conduction as long as there are no physiological, biochemical, or mechanical barriers to prevent the anticipated action of the drug. When adequate local anesthetic concentration and volume is able to reach the nerve structures, blockage or dampening of neural signaling, pain transmission, and sympathetic nervous system responses results. To provide effective anesthesia for cesarean section blockade of dermatome level T4 is required (Praxedes & Filho, 2010).

Meticulous care, judgement, and technique is a key component to avoiding failed spinal anesthesia. Features that are frequently considered typical for successful spinal anesthesia administration include correct identification of anatomical landmarks, feeling discernible clicks

of the spinal needle as it pierces the dura mater, absence of pain or paresthesia throughout the

procedure, free aspiration of CSF before, during and at the end of injection of the local anesthetic

agent, and onset of motor and sensory block within 5 minutes. Factors or barriers that alter any

of these features can reduce or abolish the anticipated block effect (Hoppe & Popham, 2007).

General aspects of block failure have been attributed to clinical technique, inexperience,

and a less than meticulous approach by the provider (Fettes, Jansson, & Wildsmith, 2009).

Anatomical and pathophysiologic causes of failure are often summarized as a lack of contact

between the anesthetic and nerve structures, administration of a low volume or concentration of

the anesthetic, inactive or ineffective local anesthetic solution, or inadequate patient positioning

after the spinal injection (Praxedes & Filho, 2010). The local anesthetic, itself, has also been

scrutinized as being the factor to blame for the occurrence of failed spinals (Munhall, Sukhani, &

Winnie, 1988).

Anesthetic Management of Choice

Following administration of spinal anesthesia, rapid and predictable anesthesia is often

achieved providing relief from the surgical pain associated with C/S without causing depression

of the parturient or fetus. General anesthesia, on the other hand, has been found to provide less

effective postoperative pain control, more residual sedation, and is associated with increased

maternal mortality from failed intubation and aspiration of gastric contents (Hoppe & Popham,

2007). Research has shown the risk of maternal death is 16.7 times greater with general

anesthesia compared to regional anesthesia (Nagelhout & Plaus, 2014). The parturient with

successful spinal anesthesia also has ability to be awake for and aware of the delivery.

Postoperative parturient surveys reveal higher patient satisfaction scores with regional anesthesia

compared to general anesthesia (Dharmalingam & Zainuddin, 2013). Spinal anesthesia also has

advantages when compared to epidural anesthesia. A small dose of local anesthetic is needed to

provide a dense, reliable block with spinal anesthesia, therefore, risk of local anesthetic toxicity

is decreased as compared to a larger dose needed with epidural anesthesia (Nagelhout & Plaus,

2014).

Definition of Failure

When literature discusses or uses the terms "failed spinal anesthesia," "failed spinal

blockade," or "spinal block failure," they can simply imply that the spinal anesthetic was

attempted, but that no block resulted. However, another common definition of these terms occurs

when some form of sensory and/or motor block results, but is inadequate for the proposed

surgery and requires need for further anesthesia whether general, regional, or supplemental. A

recent review of the literature produced varying definitions of failed spinal anesthesia. The

narrowest, and perhaps most specific, definition of a failed spinal blockade was developed by

Praxedes and Filho (2010):

> Failure is seen after the anesthetics has been deposited in the subarachnoid space,
>
> confirmed by adequate CSF backflow, whenever general anesthesia is necessary to
>
> continue the surgical procedure without causing pain to the patient, regardless whether
>
> the failure is complete, incomplete, or the level is not enough, excluding situations that
>
> require mild sedation with opioids or benzodiazepines to offer comfort for a responsive
>
> patient (p.94).

Other literature (Rukewe, Adebayo, & Fatiregun, 2015; Pan, Bogard & Owen, 2004; Kim et al.,

2015) defines spinal failure on a broader spectrum of results that not only include the

requirement of converting to general anesthesia, but when the use of supplemental analgesia was

needed as well. Rukewe et al. (2015) defines spinal anesthesia failure as the inability to achieve a

"pain-free operative condition" regardless of if there was CSF backflow during administration or not (p. 1301). If the patient required general or supplemental analgesia, such as ketamine or fentanyl, the block was considered failed spinal anesthesia. Pan et al. (2004), similar to Rukewe et al. (2015), considers failure as a block resulting in inadequate analgesia or no block at all.

Incidence of Failed Spinal Anesthesia

The incidence of failed spinals has been found to vary greatly between sources and it is likely due to differences in the definition of failure. Several publications, including both prospective and retrospective studies, reported a wide range of failure rates in comparison to one another.

A literature review conducted by Hoppe and Popham (2007) explored the failure rates of spinals in parturients. Their review of prospective studies reported failure rates of 3.1% in 1,891 patients and 4% in 200 patients. Retrospective studies used in their literature review found the incidence of failed spinals occurring 2.7% in 2,314 patients and 17% in 100 patients. Fettes et al. (2009) found that most experienced practitioners would consider the incidence of failure to be less than 1% versus a failure rate as high as 17% was quoted from an American teaching hospital. Although failure rates varied from source to source, it appears the overall goal of each study was to find risks and common features among the parturients who were a part of the failed percentage to assist in decreasing the incidence of spinal anesthesia failure.

Positioning

Positioning of the patient during placement and administration of the spinal anesthetic should not be underestimated in importance for successful blockade. Poor patient positioning can limit the separation of laminae and spinous processes, making it more difficult to identify landmarks for needle insertion. Improper positioning can make placement technically more

difficult for even an experienced provider. Optimum positioning can be achieved by placing the patient on a firm surface and having the patient maximally flex their entire spine, including the neck, along with also flexing their hips and knees. It is imperative to avoid rotation or lateral curvature of the spine. Having the patient in the sitting or lateral position are often the easiest positions for placement. It is also beneficial to have the assistance of an additional staff member to aid in maintaining the patient in the correct position (Fettes et al., 2009).

Kinsella (2008) followed and examined 3,224 cesarean section patients over a five year period to compare factors that could be associated with failure of spinal anesthesia, such as body mass index, history of previous cesarean sections, administration techniques, and drug variations. The study found that the sitting position was associated with a higher failure rate (5.1% of those with failed spinals) compared to patients who received their spinal anesthetic in the lateral position (2.9%). Similarly, in a study of 778 C/S parturients, Imbelloni, Obral, and Carneiro (1995) found a higher incidence of failure with administration in the sitting position as compared to the lateral position.

Even though studies have revealed a higher incidence of failed spinals using the sitting position compared to the lateral position, the case study patient was placed in the sitting position due to the comfort level and preference of the anesthesia provider. The patient had been in the sitting position with assistance from a nurse to maximally flex her spine without any lateral rotation or slumping to one side. The patient had no problems assuming and maintaining this optimum position and appeared relaxed throughout the spinal anesthesia administration.

Optimum positioning is difficult to achieve without a calm, relaxed patient. Improper patient positioning and patient movements due to pain or anxiety can greatly increases the likelihood of a failed spinal block. Recommendations for improving patient cooperation and

ability to assume and maintain optimum positioning include a thorough, unhurried explanation of the procedure and positioning and providing gentle, unrushed patient care before and during the placement of the block. In addition, effective local anesthetic infiltration of the skin and subcutaneous tissue of the puncture site without obscuring the positioning landmarks will also assist in decreasing the incidence of the patient moving out of positioning in response to pain. Even small, discrete patient movements can displace the needle from its desired target (Fettes et al., 2009).

Needle Insertion and Injection

The only immediately obvious cause of failure is what is known as a 'dry tap' in which the provider is unable to obtain CSF. Some anesthesia professionals believe that the needle's lumen is being blocked at the outset; however, this is often unlikely with the current design of spinal needles. Even though 'dry taps' are rarely a result of an equipment abnormality, it is prudent to check the needle and stylet for correctness of fit before use. It is also recommended to avoid advancing the needle without the stylet in place as tissue or blood clot can easily obstruct the needle and prevent return of CSF once in the subarachnoid space (Fettes et al., 2009).

Needle insertion level. Preferable needle insertion for parturients undergoing cesarean section is often between the third and fourth lumbar inter-space; however, a specific patient examination may reveal more desirable space. Consideration should be taken if attempting below the fourth lumbar or the lumbo-sacral interspace as the local anesthetic may become 'trapped' below the natural lumbar curve of the spine causing a block that is restricted to the sacral segments, especially if the patient is in the sitting position (Hoppe & Popham, 2007).

Rukewe et al. (2015) followed 3,568 cesarean deliveries in a prospective, observational study and determined the injection at the L4/5 interspace, rather than the L3/4 interspace, was 2.4

times more likely to result in failed spinal. On the other hand, in a prospective study by

Imbelloni et al. (1995) of 778 spinal anesthetics that were not limited to cesarean section

patients, there was no association of failure with level of puncture site. The case study patient

was given the spinal anesthetic between her third and fourth lumbar space.

Meticulous technique should be used with every spinal insertion by anesthesia

professionals. Insertion of the needle at right angles to the back in both planes should start mid-

line, mid-way between the spinous processes or via paramedian approach and advanced slowly

adjusting the angle of the needle only if resistance is met. A thorough knowledge of spinal

anatomy with the ability to relate changes in resistance to the anatomy will greatly assist the

professional in correct placement within the subarachnoid space (Fettes et al., 2009).

A common cause of the loss of the local anesthetic being injected is a loose Luer

connection between the needle and the syringe. As the local anesthetic is being injected through

a loose connection, leakage of the solution may occur. Even a few drops lost through the loose

connection can result in a diminished or failed block as the total volumes used in spinal

anesthesia are already small. Therefore, losing of any of the local anesthetic during injection can

cause a significant decreased in the mass of the drug reaching the CSF limiting the effectiveness

of the block. Assuring a firm connection between the hub of the needle and the syringe

containing the injectate is imperative to ensure the patient is receiving the entire intended amount

of local anesthetic (Fettes et al., 2009).

Accidental movement of the needle outside the subarachnoid space during connection to

the local anesthetic containing syringe or during injection of the solution can lead to

administration into the wrong site and result in a failed block. Meticulous manipulation must be

used to avoid movement of the patient and the professional's hand once inside the subarachnoid

space to avoid removing the needle from the desired target location. Using one hand as an anchor against the back holding the needle in place while attaching the syringe and injecting the medication is strongly encouraged (Praxedes & Filho, 2010).

Accidental subdural injection has also been suggested as a potential causative factor of failed spinal blockade. The subdural space is a narrow potential space located between the dura and arachnoid matter. Injection into this space rather than past the arachnoid layer can result in an inadequate block for parturients undergoing C/S. Injection of local anesthetics into the subdural space often spares sympathetic and motor function due to the distance from anterior nerve roots within the spinal column. Therefore, subdural injection will most likely, if not always, lead to an insufficient block for a parturient to tolerate C/S. Identification of subdural blocks is often based on clinical findings including the presence of a delayed, gradual onset sensory blockade.

A literature review by Agarwal, Mohta, Tyagi, and Sethi (2010) sought to determine the rate of occurrence and predisposing risk factors for accidental subdural injections. The exact incidence of subdural injection during SABs was not found. However, the review found within three studies using contrast myelography, the incidence of subdural injection was 1 to 13% when injection into the subarachnoid space was being attempted. Additionally, they found the risk of subdural injection was higher among epidural attempts than SAB attempts and predisposing risk factors overall for both epidural and SABs included the use of long beveled needles, difficult block placements, recent back surgeries, and a recent lumbar puncture.

Needle Length. The length of the bevel in cutting needles and size of the lateral holes of pencil-tip needles, as mentioned with inadvertent subdural injections, may also play a part in administration within the wrong space. For example, longer bevels and larger lateral holes have

been associated with failed blocks as they are more likely to be only partially introduced into the

subarachnoid space. With partial placement, free flow of CSF is observed, but during the

injection, part of the solution can be administered outside the subarachnoid space resulting in a

less dense, reliable block. To prevent this partial introduction into the subarachnoid space, it is

recommended to introduce the needle a little deeper after the backflow of CSF is observed and to

observe the free flow of CSF before and intermittently during the injection (Praxedes & Filho,

2010).

Needle gauge. The gauge of the needle may also play a role in incidence of block failure.

A study by Imbelloni et al. (1995) of only experienced professionals administering spinal blocks,

explored whether the caliber of the needle was included in the observation of block failure. The

study revealed 25 gauge needles were associated with a significantly lower incidence of block

failure when compared to 27 gauge and 29 gauge needles.

Needle type. Another factor that may impact the incidence of spinal block failure is the

type of needle. Rukewe et al. (2015) conducted a prospective, observational study of 3,568 C/S

deliveries to evaluate factors that increased the risk of failed spinal anesthesia and found the type

of needle used, such as a Quincke or Sprotte, did not establish any association with incidence of

failure rate. Additionally, they found an increase in failure rate with multiple lumbar puncture

attempts when compared with just one attempt.

Clear Fluid is not CSF

Final confirmation of entrance into the subarachnoid space is the appearance and free

flow of clear fluid at the needle hub. Although rare, the clear fluid may not be CSF. If the spinal

is being attempted after trying to 'load up' an epidural for a cesarean section, the provider may

be getting flow of the local anesthetic from the epidural. Adding to the difficulty of deciphering

the difference of the fluid being local anesthetic or CSF, a positive test for glucose in the fluid would not confirm that it is CSF as extracellular fluid constituents rapidly diffuse into fluids injected into the epidural space (Praxedes & Filho, 2010).

The fluid may also be from needle insertion into a congenital cyst. A variety of extradural cysts may exist including arachnoid, synovial, ganglion, Tarlov's, and dermoid cysts, and cystic neuromas. Some types of cysts can exist in up to 9% of the population. Tarlov cysts, for example, have an estimated incidence of 4.5-9% of the population and these percentages are actually found to be increasing due to the more frequent use of magnetic resonance imaging (MRI). Tavlov cysts are dilations of the meninges that enclose the posterior spinal nerve root sheaths and can be present asymptomatically since birth or resulting from trauma or surgery. The cysts can obstruct continuity of the intrathecal space, therefore, even though they contain CSF, injection of local anesthetic into a cyst will not result in an adequate block if the local anesthetic cannot reach the cauda equina. While technology has improved the detection of these cysts, there is still limited evidence of specificity and sensitivity of cyst detection with MRI (Hoppe & Popham, 2007).

Recommendations after a failed spinal with CSF return have been made in the literature to inject at a different level to avoid reentrance into the cyst or performing an epidural with use of a 'top off' for cesarean section for the local anesthetic to absorb past the dura to the target nerves rather than risk administration into a cyst (Hoppe & Popham, 2007).

Subcutaneous cysts often derived from hair follicles have also been known to give a false click upon entrance of the needle into the cyst and may contain lipaceous material that can mimic CSF. Fortunately, these cysts tend to be small and contain little fluid so CSF often stops quickly and free aspiration of the fluid is not possible revealing to the professional that the needle is not

located in the intrathecal space (Hoppe & Popham, 2007). These occurrences demonstrate that even though the appearance of CSF is essential for spinal anesthesia, the presence of the fluid does not guarantee success as it may not be CSF or within the continuation of the spinal cord and further investigation may be needed beyond the presence of freely flowing fluid down the spinal needle (Fettes et al, 2009).

Level of Provider Experience

The study mentioned earlier in this paper by Rukewe et al. (2015) found the level of experience of the anesthesia provider to be an independent risk factor for failed spinal anesthesia. By dividing the anesthesia providers into two groups based on years of residency, the residency group with the least amount of years was found to be 1.4 times more likely to administer a failed spinal compared to the groups with more years of experience. Conversely, Sng, Lim, and Sia (2009) used a prospective cohort of 800 parturients undergoing elective cesarean section at a large maternity hospital to determine the incidence and characteristics of failed spinal anesthesia and found no difference in incidence among anesthesia specialists and those in residency with less years of experience.

Local Anesthetic Failure

Reasoning behind a failed spinal may be attributed to the solution itself if the solution reaches its target nerves, but is inactive or ineffective. An additional common occurrence is the accidental use of the wrong solution used as the injectate. Separate local anesthetic solutions are often included in the same sterile preparation area and the possibility of confusing them can lead to an ineffective block. Applying labels that are often included in the sterile pack is strongly encouraged along with minimizing the number of ampoules on the block tray and using different

sizes of syringes for each component of the procedure to avoid making the use of an unintended

medication for the spinal blockade (Praxedes & Filho, 2010).

Mixing with opioids. Mixing the local anesthetic with other opioids and medications

may increase or decrease the risk of ineffectiveness. Even when local anesthetics are mixed with

medications that are physically compatible, effects of combining the solutions is not 100%

predictable in terms of effectiveness of the local anesthetic. If the addition of a medication to the

local anesthetic solution lowers the pH of the local anesthetic, the concentration of the non-

ionized fraction, also known as the fraction that diffuses into nerve tissue, will decrease and,

therefore, result in a less concentrated block (Rukewe et al., 2015).

Intrathecal opioids added to the local anesthetic were not found to increase the risk of

failed spinals in the study done by Rukewe et al. (2015). Similarly, Kinsella (2008) found the use

of opioid addition to the local anesthetic to decrease the incidence of block failure. A limitation

of the Rukewe et al. (2015) and Kinsella (2008) studies was that they reported limited data and

reliability on predicting effects of opioid addition as only a minority of their participants were

given the spinal opioid.

Imbelloni et al. (1995) found no significant differences in failure rates among local

anesthetics used from different laboratories and manufacturers and glucose containing solutions

compared to plain solutions. However, they did find a significantly lower incidence of failure

with isobaric local anesthetic solutions.

Prolonged age and storage. Inactive local anesthetic solutions due to prolonged age and

storage is another consideration of local anesthetic failure with spinal blockade. Ester-type local

anesthetics are known to need more careful handling and storage compared to amides as they are

chemically labile in that hydrolysis can occur with heat sterilization and prolonged storage

making them clinically ineffective. It is recommended the use of esters should be limited to no more than two years from date of manufacture (Praxedes & Filho, 2010). Amides, on the other hand, won't lose potency with heat sterilization in solution and storage for several years even though it is often recommended to use within three years from manufacturing date. Reports attributing failure of spinal blocks to inactive drug have been reported with amides even though it is considered a stable drug (Fettes et al., 2009).

A review of the incidences of failed spinal blocks between local anesthetics within the same class do not reveal significant differences. For example, a prospective study by Tarkkila (1991), observed the results of 1,891 spinal blocks performed for various procedures not limited to C/S patients at a university hospital and found no significant differences between the amide agents bupivacaine and lidocaine.

Most anesthesia providers have heard of or attributed a failed spinal to a 'bad batch' of local anesthetic when a clustering of failed spinal injections occurs at their facility even though the local anesthetics are not expired nor were stored improperly. However, in most checks with quality assurance tests done by the manufacturer, it was demonstrated that the drugs fulfilled the production standards. Other evidence that limits attributing the failed spinal to a 'bad batch' or production problems are the large amount of cases in which patients have repeatedly failed spinals with more than one of their cesarean sections presenting months and years apart as the case study patient had. Therefore, different batches of local anesthetics failed at different times. Investigating other causes of failure must be done before assuming failed blocks are due to manufacturing and production problems (Hoppe & Popham, 2007).

Resistance. Local anesthetic resistance may be considered if the patient has a history of repeated failure of dental or other local anesthetic drugs. The problem may be due to a genetic

mutation of a sodium-channel that causes the local anesthetic to be ineffective. Such mutations

are poorly understood and described, however, and clinical reports that attribute failure to

resistance of the local anesthetic have mostly been incomplete in recognizing other factors that

may have caused the failure (Praxedes & Filho, 2010).

Insulin-dependent diabetic patients. Insulin-dependent diabetic patients have been

considered to be among those with increased risk of local anesthetic resistance. Studies have

found diabetic patients to be a noticeable fraction of patients with a history of failed neuraxial

anesthesia. However, highly speculative and not well researched, theories among this population

attribute the resistance to glycosylation of the nerve roots involved in the development of

diabetic neuropathy. Arguments have also been made that the higher incidence within this

population may also be due to increased difficulty of placement of neuraxial blocks among

diabetic patients as they are more likely to be obese (Hoppe & Popham, 2007).

Obesity. In a study by Kim et al. (2015), 209 patients undergoing elective total knee

replacement arthroplasty were divided into a non-obese group (BMI <30kg/m2, n=141) and an

obese group (BMI >30kg/m2, n=68) to compare spinal anesthesia failure rate between obese and

non-obese patients. Similar doses of bupivacaine were administered to both groups. The

incidence of failure was significantly lower in the obese group (18.9% failed) than the non-obese

(30.5% failed). Conversely, Nielsen et al. (2005) analyzed the incidence of failure of 9,038

blocks over a four year time span at an ambulatory surgical center and found the overall

incidence of failure directly increased with BMI. Notably, blocks in this study included neuraxial

blocks (SABs and epidurals) and peripheral nerve blocks on both men and women.

Ellinas, Eastwood, Patel, Maitra-D'Cruze, and Ebert (2009) examined 427 parturients for

effect of obesity on neuraxial technique difficulty. They found the number of needle passes and

time spent for placement were significantly greater among the obesity due to the difficulty

palpating the patient's bony landmarks and the patients' ability to flex her back, but did not find

a significant difference in failure rates among the obese and non-obese groups.

Anatomical Abnormalities

The spread of local anesthetics even when correctly placed in the intrathecal space has

been described by Hoppe and Popham as unpredictable and unreliable (2007). Anatomical

abnormalities can further limit and hinder the desirable spread of local anesthetic for an effective

blockade. Abnormalities in the curvature of the spine, such as kyphosis, lordosis, and scoliosis

may not only make placement of the block more difficult, but limit its spread as well. Ligaments

that support the spinal cord within the intrathecal space and trabeculae within the subarachnoid

space can also act as barriers to the local anesthetic reaching its target if they form complete or

near complete separation. A unilateral block may occur if the ligaments are longitudinal or an

insufficient cephalad spread can occur if the ligaments are transverse. Patients with Marfan's

syndrome or other connective tissue disorders may have a pathologic enlargement of the dura,

known as dural ectasia, which is also known to limit spread of spinal blockade (Fettes et al.,

2009).

Spinal stenosis, pathologic lesions or lesions from past surgeries within the vertebral

canal, and intrathecal chemotherapy may also limit the spread and effectiveness of the block. A

retrospective study by Hebl, Horlocker, Kopp, and Schroeder (2010) of 545 patients with either

spinal stenosis or lumbar disk disease with or without a history of spine surgery who underwent

spinal anesthesia for surgical anesthesia, labor analgesia or postoperative analgesia were

evaluated for block efficacy. The study found no significant difference in block efficacy between

patients with a history of spinal surgery to those without. When analyzing the results of these

545 patients in combination with those undergoing other types of neuraxial anesthesia such as epidurals and continuous spinals (911 patients total), 97% of all patients in the study reported a satisfactory block, 10% reported a patchy or segmental block, and 1.7% experienced complete block failure.

CSF volume. Although there is no simple technique to evaluate a patient's CSF volume, anesthesia professionals are aware of the possibility of block failure or insufficiency occurring when volumes are higher than average. Higher CSF volumes will result in a smaller anesthetic level when fixed doses of local anesthetics are used (Praxedes & Filho, 2010).

Gestational Age

A retrospective study completed by Adesope, Eihorn, Olufolabi, Cooter, and Habib (2016) investigated the influence of gestational age and fetal weight on the risk of spinal anesthesia failure for parturients. 5,015 patients (3,387 term and 1,628 preterm) were included and the incidence of failure was found to be higher in preterm (6.1%) versus term (5.4%) parturients. Using the multivariable model, the study also found low birth weight was significantly associated with failure.

Another retrospective study by Butwick, El-Sayed, Blumenfeld, Osmundson, and Weiniger (2015) found that within 11,539 women used in their cohort undergoing preterm C/S between 24 and 36 weeks, the odds of needing to convert to general anesthesia increased by 13% for every one week decrease in gestational age at delivery. A limitation of this study was that they didn't explore the proportion of those who subsequently received general anesthesia due to failed spinal anesthesia. The case study patient was at full term as she also had been with her previous two pregnancies at the time of their births.

Independent Risk Factors

A prospective study of 800 parturients undergoing elective cesarean section under spinal anesthesia was conducted by Sng et al. (2009) to determine the influence of the various independent risk factors for block failure. All parturients were given a single-shot spinal anesthetic with the same local anesthetic (2ml of 0.5% bupivacaine) using a 27-gauge Whitacre spinal needle via a 20-gauge introducer. Results found a higher incidence of requiring supplemental intravenous fentanyl and/or nitrous oxide among patients of greater height, patients having post-operative sterilization, and patients who underwent surgical complications such as excessive bleeding. The duration of surgery between those with and without postpartum sterilization or surgical complications was not significantly different, and the study found no association with duration of surgery and incidence of spinal anesthesia failure. Based on these results, the study suggests the failure is most likely due to the additional surgical manipulation with postpartum sterilization and surgical complications and not due to the block receding over time. At the time when tubal ligation began for the case study patient, her ability to tolerate pain rapidly decreased requiring supplemental analgesia and sedation.

<div align="center">

Evidence Based Recommendations

</div>

Based on these studies and the literature, certain factors associated with technique, positioning, and demographics of the parturient and fetus should warrant greater attention and prevention to avoid spinal anesthetic failure. Technical and administration factors include the use of the L4/5 interspace, multiple lumbar puncture attempts, and the level of experience of the anesthesia provider (Rukewe et al., 2015), the use of smaller gauge needles (such as 27 and 29-gauge), positioning in the sitting position (Imbelloni et al., 1995; Kinsella, 2008), and no addition of intrathecal opioid to the anesthetic (Kinsella, 2008). Possible parturient and fetal

characteristics that can increase the risk of spinal failure include preterm and low birth weight

(Adesope et al., 2016), parturients with postpartum sterilization or intraoperative surgical

complications, and parturients of greater height (Sng et al., 2009).

        Future research should focus on the superiority of hyperbaric versus plain local anesthetic

solutions along with the effects of additional intrathecal adjuncts to the local anesthetic such as

opioids. In addition, research could also focus on identifying a more consistent definition of

failed spinal anesthesia to more accurately identify risk factors associated with failure. Studies on

spinal anesthesia failure can be difficult to compare as each may have a slightly different

definition of failure.

Conclusion

        Spinal anesthesia is considered the anesthetic of choice for cesarean section parturients.

While it does have an excellent safety profile, it remains essential for anesthesia professionals to

promptly recognize risk factors and manage associated problems related to spinal anesthesia

failure. Awareness of these risk factors provide the anesthesia professional a better opportunity

to develop and implement strategies to minimize these failure risks and problems. Greater

prevention efforts by anesthesia professional to avoid spinal anesthesia failure will most likely

lead to an improvement in failure rates. A decrease in failure rates can greatly improve the

safety, care, and outcomes for the parturient and fetus.

References

Adesope, O. A., Eihorn, L. M., Olufolabi, A. J., Cooter, M., Habib, A. S. (2016). The impact of

gestational age and fetal weight on the risk of failure of spinal anesthesia for cesarean

delivery. *International Journal of Obstetric Anesthesia*. Retrieved from

http://www.sciencedirect.com/science/journal/aip/0959289X.

Agarwal, D., Mohta, M., Tyagi, A., Sethi, A. K. (2010). Subdural block and the anaesthetist.

Anaesthesia and Intensive Care, 38(1), 6-20.

Butwick, A. J., El-Sayed, Y. Y., Blumenfeld, Y. J., Osmundson, S. S., Weiniger, C. F. (2015).

Mode of anaesthesia for preterm caesarean delivery: Secondary analysis from the

maternal-fetal medicine units network caesarean registry. *British Journal of Anesthesia,*

115(2), 267-274.

Dharmalingam, T. K., & Zainuddin, N. A. A. (2013). Survey on maternal satisfaction in

receiving spinal anaesthesia for caesarean section. *The Malaysian Journal of Medical*

Sciences, 20(3), 51-54.

Ellinas, E. H., Eastwood, D. C., Patel, S. N., Maitra-D'Crus, A. M., Ebert, T. J. (2009). The

effect of obesity on neuraxial technique difficulty in pregnant patients: A prospective,

observational study. *Anesthesia and Analgesia, 109*(4), 1225-1231.

Fettes, P. D. W., Jansson, J. R., Wildsmith, J. A. W. (2009). Failed spinal anaesthesia:

Mechanisms, management, and prevention. *British Journal of Anaesthesia, 102*(6), 739-

748.

Hebl, J. R., Horlocker, T., Kopp, S., Schroeder, D. R. (2010). Neuraxial blockade in patients

with preexisting spinal stenosis, lumbar disk disease, or prior spine surgery: Efficacy and

neurologic complications. *Neuroscience in Anesthesiology and Perioperative Medicine:*

Research Reports, 111(6), 1511-1519.

Hoppe, J., & Popham, P. (2007). Complete failure of spinal anaesthesia in obstetrics.

International Journal of Obstetrical Anesthesia, 16, 250-255.

Imbelloni, L. E., Obral, M. G., Carneiro, A. N. (1995). Incidence and causes of failures

In spinal anesthesia in a private hospital: A prospective study. *Brazilian Journal of*

Anesthesiology, 45(3), 159-164.

Kim, J., Kim, W., Lim, H. W., Kim, J. A., Shin, B. S., Sim, W. S., Hahm, T. S., Kim, C. S., Lee,

S. M. (2015). Obesity is independently associated with spinal anesthesia outcomes: A

prospective study. *PLos ONE, 10*(4), 124-126.

Kinsella, S. M. (2008). A prospective audit of regional anesthesia failure in 5080 caesarean

sections. *Anaesthesia, 63*(8), 822-832.

Munhall, R. J., Sukhani, R., Winnie, A. (1988). Incidence and etiology of failed spinal

anesthetics in a university hospital: A prospective study. *Anesthesia Analgesia, 67*, 843-

848.

Nagelhout, J. J., & Plaus, K. L. (2014). *Nurse anesthesia* (5th ed.). St. Louis, MO: Elsevier

Incorporated.

Nielsen, K. C., Guller, U., Steele, S. M., Klein, S. M., Greengrass, R. A., Pietrobon, R. (2005).

Influence on obesity on surgical regional anesthesia in the ambulatory setting: An

analysis of 9,038 blocks. *Anesthesiology, 102,* 181-187.

Pan, P. H., Bogard, T. D., Owen, M. D. (2004). Incidence and characteristics of failure in

obstetric neuraxial analgesia and anesthesia: A retrospective analysis of 19,259

deliveries. *International Journal of Obstetric Anesthesia, 13,* 227-233.

Praxedes, H., & Filho, A. L. (2010). Failure of subarachnoid blocks. *Revista Brasileira de*

Anestesiologia, 60(1), 94-97.

Rukewe, A., Adebayo, O. K., Fatiregun, A. A. (2015). Failed obstetrical spinal anesthesia in a

Nigerian teaching hospital: Incidence and risk factors. *Anesthesia Analgesia, 121*, 1301-

1305.

Sng, B. L., Lim, Y., Sia, A. T. H. (2009). An observational prospective cohort study of incidence

and characteristics of failed spinal anaesthesia for caesarean section. *International*

Journal of Obstetric Anesthesia, 18, 237-241.

Tarkkila, P. J. (1991). Incidence and causes of failed spinal anesthetics in a university hospital: A

prospective study. *Regional Anesthesia, 16*, 48-51.

Anesthesia Management of a Cesarean Section Patient Following Failed Spinal Anesthesia

Katie Ryan, SRNA

UND NURSE ANESTHESIA
UNIVERSITY OF NORTH DAKOTA

Introduction

- "Birth by cesarean section (C/S) accounts for over 30% of all deliveries and is performed over 1.5 times annually in the United States." (Nagelhout & Plaus, 2014, p. 1142)
- Anesthetic of choice for parturients undergoing C/S
- Importance of determining the risk factors for spinal anesthesia failure and identify problems that are potentially correctable
  - Prevention & improvement in failure rates can be made to improve patient care, safety, and outcomes
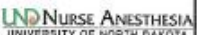
UND NURSE ANESTHESIA
UNIVERSITY OF NORTH DAKOTA

Case Information

- Surgical Procedure: Cesarean Section (C/S) with Tubal Ligation
- Age: 25 year
- Weight: 74kg
- ASA: 1

UND NURSE ANESTHESIA
UNIVERSITY OF NORTH DAKOTA

Pre-Operative Evaluation

- Past Medical History: GERD & Asthma
- Surgical History: C/S (failed spinal)
- Pre-op VS: BP-116/78, HR-66, RR-16, T- 36, SpO2-99%
- Pertinent labs/ EKG/chest X-ray, etc.: Platelets 242,000
- Airway evaluation: Mallampati I

UND NURSE ANESTHESIA
UNIVERSITY OF NORTH DAKOTA

Anesthetic Course

- Drugs: 1.4 ml of bupivacaine 0.75%, fentanyl 20 mcg, morphine 0.2 mg
- Technique:
  - L3-L4 interspace
  - Skin anesthetized with 3ml of 1% lidocaine
  - Mid-line approach with 25G Whitacre needle through introducer needle
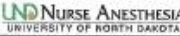 - Return of clear and free flow CSF

UND NURSE ANESTHESIA
UNIVERSITY OF NORTH DAKOTA

Intraoperative Issues

- Surgeon performed skin test → patient reported "a sharp pain"
- Lidocaine injected by surgeon at the surgical incision site
- 5 minutes later another skin test performed & patient denied any discomfort
- Tolerated incision & complained of only minor discomfort with pushing & pulling sensations that were "tolerable, but increasing"

UND NURSE ANESTHESIA
UNIVERSITY OF NORTH DAKOTA

Intraoperative Issues

- After delivery: Increasing complaints of pain and facial grimacing
- For last 45 minutes of the case, SAB supplemented with:
  - Fentanyl 325mcg, midazolam 2mg, & propofol infusion 50-75mcg/kg/min
  - Mixture of N20 5L/min & O2 3L/min via face mask
- Spontaneous ventilation maintained by patient without intervention

UND NURSE ANESTHESIA
UNIVERSITY OF NORTH DAKOTA

PACU

- Alert and oriented with O2 3L/min via nasal cannula
- Denied pain and nausea
- Stated lower extremities felt "weak and heavy"
- Fentanyl PCA started within 2 hours of arrival to the PACU for postoperative pain
- 24 hours later, the patient stated she had adequate pain control postoperatively with fentanyl PCA & denied paraesthesias/weakness to lower extremities

UND NURSE ANESTHESIA
UNIVERSITY OF NORTH DAKOTA

Discussion

- Characteristics of a successful spinal: **right place, right drug, & right dose**
  - Right place: Injection within the subarachnoid space in the CSF that is continuous with nerve structures (nerve roots, cauda equine, & medullary cone)
  - Facilitate penetration & action at the level of the axonal membrane
  - Blockade of dermatome level T4 is required for C/S (Praxedes & Filho, 2010)

UND NURSE ANESTHESIA
UNIVERSITY OF NORTH DAKOTA

Discussion

Anesthetic of Choice
- General anesthesia
  - Less effective postoperative pain control
  - More residual sedation
  - Risk of maternal death is 16.7 times greater (Nagelhout & Plaus, 2014)
- Epidural Anesthesia:
  - Decreased risk of LAST (Nagelhout & Plaus, 2014)

Failed Spinal Anesthesia
- Definition
- Incidence
- Causes

UND NURSE ANESTHESIA
UNIVERSITY OF NORTH DAKOTA

Discussion

Positioning
- Kinsella (2008)
  - Observed 3,224 C/S patients over 5 year period to compare factors that could be associated with failure of spinal anesthesia, such as BMI, history of previous cesarean sections, administration techniques, and drug variations
  - Found the **sitting position** was associated with a higher failure rate (5.1% of those with failed spinals) compared to patients who received their spinal anesthetic in the lateral position (2.9%)
- Imbelloni, Obral, and Carneiro (1995)
  - 778 C/S parturients- found a higher incidence of failure with administration in **sitting position** as compared to the lateral position

UND NURSE ANESTHESIA
UNIVERSITY OF NORTH DAKOTA

Discussion

Needle insertion & injection
- Consideration if attempting below 4th lumbar interspace → LA may become 'trapped' below natural lumbar curve of the spine → block restricted to the sacral segments (especially if the patient is in the sitting position) (Filoppe & Poplhare, 2007)
- Rukewe et al. (2015)
  - 3,568 cesarean deliveries: injection at the **L4/5 interspace**, rather than the L3/4 interspace, was 2.4 times more likely to result in failed spinal
- Imbelloni et al. (1995)
  - 778 spinal anesthetics: **no association** of failure with level of puncture site
- Luer connection

UND NURSE ANESTHESIA
UNIVERSITY OF NORTH DAKOTA

Discussion

Subdural injection

- Injection into subdural space (rather than past the arachnoid layer) can result in inadequate block for C/S
  - Often spares sympathetic & motor function due to distance from anterior nerve roots within the spinal column
- Identification of subdural blocks is often based on clinical findings (presence of delayed, gradual onset sensory blockade)
- Agarwal, Mohta, Tyagi, and Sethi (2010)
  - Literature review: Found incidence of subdural injection 1 to 13% when injection into subarachnoid space was being attempted
  - Additionally found the risk was higher among epidural attempts vs SAB attempts & risk fx included use of long beveled needles, difficult block placements, recent back surgeries, & a recent lumbar puncture

LND NURSE ANESTHESIA
UNIVERSITY OF NORTH DAKOTA

Discussion

Needle Details
Needle Length:
- Longer bevels & larger lateral holes associated with failed blocks as they are more likely to be only partially introduced into the subarachnoid space
  - To prevent → introduce the needle a little deeper after the backflow of CSF is observed & observe the free flow of CSF before & intermittently during the injection (Praxedes & Filho, 2010).

Needle gauge:
- Imbelloni et al. (1995) -Revealed 25 gauge needles associated with a significantly lower incidence of block failure when compared to 27 gauge and 29 gauge needles

Needle type:
- Rukewe et al. (2015)- Did not establish any association of type of needle (such as a Quincke vs Sprotte) with incidence of failure rate
  - Additionally, found an increase in failure rate with multiple lumbar puncture attempts when compared with just one attempt

LND NURSE ANESTHESIA
UNIVERSITY OF NORTH DAKOTA

Discussion

Clear Fluid is Not CSF
- Flow of the L.A. from the epidural after 'loading up'
- Needle insertion into a congenital cyst (Arachnoid, synovial, ganglion, Tarlov's & dermoid cysts, & cystic neuromas)
  - Some types of cysts can exist in up to 9% of the population
  - Tarlov cysts: Estimated incidence 4.5-9% of the population & these % found to be increasing due to more frequent use of MRIs
    - Can obstruct continuity of the intrathecal space → even though contain CSF, injection of local anesthetic into a cyst will not result in an adequate block if the local anesthetic cannot reach the cauda equine
- Recommendations after failed spinal with CSF return:
  - Inject at a different level to avoid reentrance into the cyst
  - Perform epidural with use of a 'top off' for C/S for L.A. to absorb past the dura to the target nerves rather than risk administration into a cyst (Hoppe & Popham, 2007)

LND NURSE ANESTHESIA
UNIVERSITY OF NORTH DAKOTA

Discussion

Level of Experience
- Rukewe et al. (2015)
  - Level of experience of the anesthesia provider an independent risk factor for failed spinal anesthesia
  - Residency group with the least amount of years was found to be 1.4 times more likely to administer a failed spinal compared to the groups with more years of experience
- Sng, Lim, and Sia (2009)
  - Found no difference in incidence among anesthesia specialists and those in residency with less years of experience

LND NURSE ANESTHESIA
UNIVERSITY OF NORTH DAKOTA

Discussion

L.A. Resistance
- Genetic mutation of a sodium-channel that causes the local anesthetic to be ineffective
- Insulin-dependent diabetic patients considered to be among those with increased risk of local anesthetic resistance
  - Resistance to glycosylation of the nerve roots involved in the development of diabetic neuropathy vs increased difficulty of placement of neuraxial blocks as more likely to be obese (Hoppe & Popham, 2007)

L.A. Failure
- Accidental use of the wrong solution
- Rukewe et al., 2015- Intrathecal opioids added to the local anesthetic were not found to increase the risk of failed spinals
- Kinsella (2008)- found the use of opioid addition to the local anesthetic to decrease the incidence of block failure
- Prolonged Age & Storage

LND NURSE ANESTHESIA
UNIVERSITY OF NORTH DAKOTA

Discussion

Anatomical Abnormalities
- Ligaments and trabeculae within the subarachnoid space can act as barriers L.A reaching target nerves
- Marfan's syndrome/other connective tissue disorders: pathologic enlargement of the dura (dural ectasia) common-can limit L.A. spread (Fettes et al., 2009)

LND NURSE ANESTHESIA
UNIVERSITY OF NORTH DAKOTA

Discussion

Independent Risk Factors
- Sng et al. (2009)
  - 857 parturients
  - Found higher incidence of requiring supplemental intravenous fentanyl and/or nitrous oxide among patients of **greater height**, patients having **post-operative sterilization, and patients who underwent surgical complications such as excessive bleeding**
- Adesope, Eihorn, Olufolabi, Cooter, and Habib (2016)
  - 5,015 patients
  - Found incidence of failure higher in preterm (6.1%) versus term (5.4%) parturients
  - Also found low birth weight significantly associated with failure
- Butwick, El-Sayed, Blumenfeld, Osmundson, and Weiniger (2015)
  - 11,539 women undergoing preterm C/S between 24 and 36 weeks
  - Found odds of needing to convert to general anesthesia increased by 13% for every one week decrease in gestational age at delivery

UND NURSE ANESTHESIA
UNIVERSITY OF NORTH DAKOTA

Recommendations

Keep in mind about the risk factors associated with failed spinal anesthesia:

1) Technical and Administration Factors:
   - Use of L4/5 interspace, multiple lumbar puncture attempts, and level of experience of the anesthesia provider.
   - Use of smaller gauge needles (such as 27 and 29-gauge), positioning in sitting position.
   - No addition of intrathecal opioid to the anesthetic.

2) Possible Parturient and Fetal Characteristics:
   - Preterm & low birth weight
   - Parturients with postpartum sterilization or intraoperative surgical complications, and parturients of greater height.

Future Research

UND NURSE ANESTHESIA
UNIVERSITY OF NORTH DAKOTA

Conclusion

- Essential for anesthesia professionals to promptly recognize risk factors & manage associated problems related to spinal anesthesia failure
- Awareness of these risk factors provide the anesthesia professional a better opportunity to develop & implement strategies to minimize these failure risks and problems
- Greater prevention efforts to avoid spinal anesthesia failure will most likely lead to an improvement in failure rates
- Decrease in failure rates can greatly improve the safety, care, and outcomes for the parturient and fetus

UND NURSE ANESTHESIA
UNIVERSITY OF NORTH DAKOTA

References

Adesope, O. A., Eihorn, L. M., Olufolabi, A. J., Cooter, M., Habib, A. S. (2016). The impact of gestational age and fetal weight on the risk of failure of spinal anesthesia for cesarean delivery. *International Journal of Obstetric Anesthesia*. Retrieved from http://www.sciencedirect.com/science/journal/0959289X.

Agarwal, D., Mohta, M., Tyagi, A., Sethi, A. K. (2010). Subdural block and the anaesthetist. *Anaesthesia and Intensive Care*, 38(1), 6-20.

Butwick, A. J., El-Sayed, Y. Y., Blumenfeld, Y. J., Osmundson, S. S., Weiniger, C. F. (2015). Mode of anaesthesia for preterm caesarean delivery: Secondary analysis from the maternal-fetal medicine units network caesarean registry. *British Journal of Anesthesia*, 115(2), 267-274.

Dharmalingam, T. K., & Zainuddin, N. A. A. (2013). Survey on maternal satisfaction in receiving spinal anaesthesia for caesarean section. *The Malaysian Journal of Medical Sciences*, 20(3), 51-54.

Ellinas, E. H., Eastwood, D. C., Patel, S. N., Maitra-D'Crus, A. M., Ebert, T. J. (2009). The effect of obesity on neuraxial technique difficulty in pregnant patients: A prospective, observational study. *Anesthesia and Analgesia*, 109(4), 1225-1231.

UND NURSE ANESTHESIA
UNIVERSITY OF NORTH DAKOTA

References

Fettes, P. D. W., Jansson, J. R., Wildsmith, J. A. W. (2009). Failed spinal anaesthesia: Mechanisms, management, and prevention. *British Journal of Anaesthesia*, 102(6), 739-748.

Hebl, J. R., Horlocker, T., Kopp, S., Schroeder, D. R. (2010). Neuraxial blockade in patients with preexisting spinal stenosis, lumbar disk disease, or prior spine surgery: Efficacy and neurologic complications. *Neuroscience in Anesthesiology and Perioperative Medicine: Research Reports*, 111(6), 1511-1519.

Hoppe, J., & Popham, P. (2007). Complete failure of spinal anaesthesia in obstetrics. *International Journal of Obstetrical Anesthesia*, 16, 250-255.

Imbelloni, L. E., Obral, M. G., Carneiro, A. N. (1995). Incidence and causes of failures in spinal anesthesia in a private hospital: A prospective study. *Brazilian Journal of Anesthesiology*, 45(3), 159-164.

Kim, J., Kim, W., Lim, H. W., Kim, J. A., Shin, B. S., Sim, W. S., Hahm, T. S., Kim, C. S., Lee, S. M. (2015). Obesity is independently associated with spinal anesthesia outcomes: A prospective study. *PLos ONE*, 10(4), 124-126.

Kinsella, S. M. (2008). A prospective audit of regional anesthesia failure in 5080 caesarean sections. *Anaesthesia*, 63(8), 822-832.

Munhall, R. J., Sukhani, R., Winnie, A. (1988). Incidence and etiology of failed spinal anesthetics in a university hospital: A prospective study. *Anesthesia Analgesia*, 67, 843-848.

UND NURSE ANESTHESIA
UNIVERSITY OF NORTH DAKOTA

References

Nagelhout, J. J., & Plaus, K. L. (2014). *Nurse anesthesia* (5th ed.). St. Louis, MO: Elsevier Incorporated.

Nielsen, K. C., Guller, U., Steele, S. M., Klein, S. M., Greengrass, R. A., Pietrobon, R. (2005). Influence on obesity on surgical regional anesthesia in the ambulatory setting: An analysis of 9,038 blocks. *Anesthesiology*, 102, 181-187.

Pan, P. H., Bogard, T. D., Owen, M. D. (2004). Incidence and characteristics of failure in obstetric neuraxial analgesia and anesthesia: A retrospective analysis of 19,259 deliveries. *International Journal of Obstetric Anesthesia*, 13, 227-233.

Praxedes, H., & Filho, A. L. (2010). Failure of subarachnoid blocks. *Revista Brasileira de Anestesiologia*, 60(1), 94-97.

Rukewe, A., Adebayo, O. K., Fatiregun, A. A. (2015). Failed obstetrical spinal anesthesia in a Nigerian teaching hospital: Incidence and risk factors. *Anesthesia Analgesia*, 121, 1301-1305.

Sng, B. L., Lim, Y., Sia, A. T. H. (2009). An observational prospective cohort study of incidence and characteristics of failed spinal anaesthesia for caesarean section. *International Journal of Obstetric Anesthesia*, 18, 237-241.

Tarkkila, P. J. (1991). Incidence and causes of failed spinal anesthetics in a university hospital: A prospective study. *Regional Anesthesia*, 16, 48-51.

UND NURSE ANESTHESIA
UNIVERSITY OF NORTH DAKOTA