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Aneurysmal subarachnoid haemorrhage - Part 2: Post-operative nursing management diagnosis, complications and treatment: A composite case study

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## Aneurysmal subarachnoid haemorrhage – Part 2: Post-operative nursing management diagnosis, complications and treatment: A composite case study

## ABSTRACT

Patients who have been diagnosed with an Aneurysmal Subarachnoid Haemorrhage (ASAH) frequently require surgical intervention to prevent further complications. Due to the complex nature of ASAH it is imperative to be meticulous in monitoring the patient's neurological condition. This is even more relevant post operatively as complications such as cerebral vasospasm peak incidence is between days four to fourteen and as well as complications of surgical and medical intervention may become evident.

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## INTRODUCTION

Patients who have been diagnosed with an Aneurysmal Subarachnoid Haemorrhage (ASAH) frequently require surgical intervention to prevent further complications. Due to the complex nature of ASAH it is imperative to be meticulous in monitoring the patient's neurological condition. This is even more relevant post operatively as complications such as cerebral vasospasm peak incidence is between days four to fourteen and as well as complications of surgical and medical intervention may become evident.

Neurological assessment should be per-

#### Key Words

post-operative; nursing management; intraoperative; surgical interventions; Glasgow coma scale; hydrocephalus; external ventricular drains; cerebral oedema; seizures; triple H therapy; cerebral balloon angioplasty; intra-arterial Papaverine

formed prior to the use of the various treatment modalities. This assessment will provide a baseline to gauge any improvement or deterioration of the patient's condition. Any change in conscious state, orientation, motor function, pupillary function, location and onset of headache must be noted and reported to the physician responsible so that early intervention and diagnostic evaluation can be initiated. Close monitoring of the patient's cardiovascular, hepatic, endocrine, renal, and respiratory and other body systems must be included in line with parameters set by the managing physician. This not only detects any side effects from the various treatment modalities, but also determines any underlying conditions of the patient that may affect their full recovery.

As previously discussed in Part 1, Mrs. X is a 55-year-old lady who presented to a major metropolitan hospital with symptoms of headache, photophobia, nausea and vomiting. Her only relevant past history is of hypertension and she is a current smoker of 25 years. Her initial diagnosis of subarachnoid haemorrhage was made by Computed Tomography (CT) scan and later confirmed as an ASAH by Intra-Arterial Digital Subtraction Angiography (IADSA), to have been caused by an Anterior Communicating Artery Aneurysm (ACommAA). Surgical intervention was required to treat this condition.

#### SURGICAL TREATMENT

Surgical treatment of an aneurysmal subarachnoid haemorrhage usually depends on the location, severity and cause of the bleed. Common techniques used to stabilise blood vessels causing an ASAH include clipping and coiling.

As previously stated in Part 1 Mrs X was consented for a clipping of her ACommAA.

Clipping has been widely and successfully used for over 20 years to stabilise cerebral aneurysms. A craniotomy is performed that enables the neurosurgeon to access the effected blood vessel. Once located a surgical clip is placed at the neck of the cerebral aneurysm occluding it from the cerebral blood flow and decreasing the risk of further bleeding (Kaye, 1997).

An alternate method to clipping of cerebral aneurysms is endo-vascular coiling. This procedure performed with the aid of IADSA to locate the effected vessel and usually is performed by centres with expertise in this field. Minute coils are then introduced into the aneurysm to fill it completely. This causes the area to thrombise and excludes it from blood flow, preventing any further bleeding. As this technique was introduced in the early 1990s (Bell & Kongable, 1995) it is still not widely accepted by all Neurosurgeons. However it is more commonly used in aneurysms that are difficult to locate with a craniotomy, especially posterior cerebral circulatory vessels such as the Basilar or Vertebral arteries.

#### **INTRA-OPERATIVE**

A craniotomy and clipping of the ACommAA was performed. Unfortunately due to the complexity of the surgery and Mrs X's past history of hypertension her aneurysm burst during the operation, causing more blood to enter the subarachnoid space. To prevent further complications and to monitor her condition closely an External Ventricular Drain (EVD) with Intracranial Pressure (ICP) monitor technology was inserted to prevent acute hydrocephalus and to monitor her intracranial pressure. A Central Venous Catheter (CVC) was inserted to monitor Central Venous Pressure (CVP) and to initiate hypervolemic therapy. Mrs X's blood pressure was monitored via a left radial arterial line and an indwelling urethral catheter was inserted and enabled hourly assessment of urinary output.

### Post-surgical nursing MANAGEMENT

Again frequent neurological observations (as per individualised protocol) are performed to closely monitor any changes in a patient's neurological status and to provide a baseline to gauge any improvement or deterioration of the patient's condition as well as to plan for appropriate treatment.

Environmental stimulus should be kept to decrease possible exacerbating factors, such which may lead to a rise in blood pressure.

Post operatively Mrs X's Glasgow Coma Score or GCS decreased to 12. She was now eye opening to speech, localising to pain and confused to time and place but orientated to person. Her condition was routinely monitored post operatively as pre neurosurgical protocol. Which includes neurological assessment in

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recovery by the ward nursing staff to ensure that they are confident to take the patient back to the ward. On return to ward from recovery another set of neurological observations must be attended. Neurological (GCS, ICP and EVD), cardiovascular (Bp, pulse, Central Venous Pressure or CVP), respiratory (respiration rate and oxygen saturation) and pain (severity and position) assessments are then attended, half-hourly for four hours, hourly for four hours, one to two-hourly overnight until review by the Neurosurgery medical staff in the next morning. Then four hourly until the acute phase of the patient's condition is over (which will be for the entire stay of Mrs. X due to the potential of cerebral vasospasm). If at any stage a patient's condition deteriorates then it must be reported immediately to the nurse-in-charge (Crowe et al., 2003). The frequency of the neurological observations will then increase as per the nurse-in-charge's instructions on consultation with the medical staff. Mrs. X also had her temperature taken every four hours. Her indwelling catheter was also emptied/measured every hour to assess her fluid status.

Postoperatively Mrs. X was recovered in bed at a thirty-degree angle and was issued with anti-embolic stockings. Her Nimodipine was continued (see Part 1) and she was also commenced on Dexamethasone 4mg/6hourly and subcutaneously Heparin 5000 units twice a day. Her blood pressure was to be maintained at a hypertensive level (between 140–180mmHg systolic) and her combined intravenous and oral fluid intact was to be keep above 3000mls a day thus keeping her hypervolemic. Her EVD was to be maintained 15cm above the tragus and Cerebro-Spinal Fluid or CSF amounts of less than 10mls or more than 25mls an hour are to be reported.

### **Hydrocephalus**

Mrs X's EVD was inserted to prevent acute hydrocephalus, which may be associated with blood in the subarachnoid space and thus circulating in the cerebro ventricular system. Hydrocephalus as explained previously in Part 1 of this article could occur through the blockage or obstruction in the reabsorption of CSF (communicating) or flow of CSF (non-communicating). Treatment for acute hydrocephalus usually involves the insertion of an EVD. An insertion of an EVD involves inserting a catheter into one of the lateral ventricles allowing CSF to flow into a closed burette system for measurement.

Mrs X's EVD was draining approximately 10 mls an hour of blood stained CSF, which eventually became straw coloured and clear after five days.

### Nursing management (hydrocephalus/external ventricular drain)

As always-frequent neurological assessment should allow for early detection of deterioration in a patient's neurological state which may indicate hydrocephalus and or meningitis.

Considerations for EVD's include hourly empty/measure (into a burette system) and observation of CSF as well as daily pathology tests, which can detect any alteration that may indicate complications. As the chorioid plexus of the brain produce approximately 10–21mls of clear straw coloured CSF an hour, approximately that amount of CSF is drained every hour but can depend on the patient's condition and the activities they are performing. Any blood can indicate trauma caused by the catheter or further bleed, abnormal amounts of protein or glucose or the presence of white blood cells can indicate meningitis.

After the patient has stabilised (usually a few days), and the CSF has been constantly normal (without the presence of blood or signs of infection). A trail of the cerebro-ventricular system's ability to function is assessed. Clamping the flow of CSF to the burette system is done for a few hours to see if the patient exhibits any signs of hydrocephalus or leaking from around the drain's exit site. If however this test fails, a more permanent solution such as a Ventricular Peritoneal or a Ventricular Atrial shunt is considered.

Benefits of an EVD include the ability to allow intracranial pressure monitoring and CSF sampling. The risks however are infection (meningitis), over shunting and the patient is required to stay in bed whilst the EVD is insitu. Therefore it can only be for short-term use.

Mrs X's GCS increased over 5 days to be 15/15 and it was decided to remove the EVD/ICP. The EVD was clamped and the patient monitored for signs of raised ICP. After approximately 2 hours of half hourly neurological observation and observation of the exit site of the EVD, Mrs. X showed no ill effects and the drain and monitor were removed by a Registered Medical Officer.

### CEREBRAL OEDEMA

Mrs X's ICP monitor was inserted to assess for any changes in ICP, which may be associated with cerebral oedema. Dexamethasone was commenced to prevent this from happening.

A common side effect from any traumatic event involving brain tissue is cerebral oedema. In this case cerebral irritation caused by the blood in and around the brain causes cerebral oedema. Symptoms are very similar to a rise in ICP including nausea, vomiting, decreased conscious state, severe headache and alteration in neurological observations. Cerebral oedema can be diagnosed through a CT scan, which would show decreased gyri and sulci and grey like abnormalities at the peripheries (MacDonald, 1989).

# Nursing management (cerebral oedema)

Treatment for Cerebral Oedema includes the removal of the noxious stimuli causing the oedema (i.e. blood in the subarachnoid space) and the use of anti-inflammatory medications such as Dexamethasone (4 milligrams 6 hourly initially then titrated down) can be used to decrease the swelling. A complication of Dexamethasone is steroid induced diabetes so daily urinalysis should be preformed to detect glucose, if present in the urine or a daily random blood glucose test for elevated glucose levels.

Another treatment for cerebral oedema in acute cases is Mannitol (an osmotic diuretic) which can decrease swelling but urine output and CVP and blood pressure must be carefully monitored to insure that the fluid shift is not too sudden to compromise the patient hemodynamic status.

### SEIZURES

As stated in Part 1, isolated seizures can occur pre or post-operatively. If patients do develop seizures post ASAH, they are commenced on anti-convulsant therapy.

# Nursing management (cerebral vasospasm)

As discussed in Part 1, frequent neurological assessment is performed to detect and treat complications post ASAH. Usually observations are done no less than 4 hourly to assist in the early detection and treatment of this condition. As cerebral vasospasm can occur from day one to day twenty eight post bleed, peaking around day seven, treatment considerations post stabilisation of the cerebral aneurysm are mainly focused in prevention of the occurrence and or the severity of this potential condition. These treatments include the use of Nimodipine as discussed in Part 1 as well as use of methods employed in Triple H therapy, cerebral angioplasty and intra-arterial Papaverine.

# Nursing management (cerebral vasospasm)

#### Triple H therapy

The term triple-H therapy relates to the use of hypertension, hypervolaemia and haemodilution in the treatment of patients who have the potential to develop cerebral vasospasm (Rusy, 1996). Hypertension for the prevention of cere-

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bral vasospasm has been used since 1951 when Denny-Brown described its benefits. Wood et al., 1984 introduced the use of hypervolemic haemodilution almost three decades later in 1982. Awad et al., introduced the combination of all three methods in 1987. Triple-H therapy or hyperdynamic therapy has been the mainstay for the prevention of cerebral vasospasm for well over a decade now (Kopitnik & Samson, 1993). These three therapies may be used in conjunction with one another or alone with other treatment modalities, but all must be performed in a specialised monitored environment so that the patient can be closely monitored for possible complications (Wood et al., 1984).

Hypertensive therapy as the name suggests involves inducing a patient to become hypertensive. This assists with the perfusion of brain vessels. Monitoring and treatment of a patient's oxygenation allows the hypertensive therapy to force oxygen rich blood to flow to the brain cells, preventing possible ischaemia (that may lead to the release of vasogenic substances). Also this form of treatment prevents cerebral blood vessels from contracting due to the increase in blood pressure. Various inotropic agents such as dopamine and dobutamine or adrenergic agents such as Noradrenaline are prescribed to raise blood pressure (Wood et al., 1984). Once the blood pressure is at a therapeutic level (between 120-150 mmHg systolic for patients with unclipped aneurysms and 160–200 mmHg for patients with clipped aneurysms), it is maintained and monitored closely by nursing staff (Wood et al., 1984). These values are not absolute, rather they are based on a patient's baseline blood pressure as well as careful and thorough clinical examination.

Hypertension is normally considered a harmful state. One complication is an increased workload on the heart. As a result, the use of hypertensive therapy is contraindicated for patients with pre-existing heart disease. Also, cerebral angiography can sometimes miss small aneurysms or confuse them with normal anatomy, thus another subarachnoid haemorrhage may occur (due to rupture caused by the increased blood pressure on the cerebral vessels) further compromising the patient (Edlow & Caplan, 2000).

Hypervolemic or hyperperfusion therapy assists cerebral blood flow through fluid expansion of the intravascular compartment (within blood vessels). This is done to dilate the cerebral blood vessels so that they cannot contract (Stewart-Amidei, 1989). The infusion of crystalloids, such as lactated ringer's solution and plasma volume expanders such as Gelofusine is used to facilitate this process (Wood et al., 1984). Potential complications of this component of the therapy include pulmonary oedema, congestive heart failure, further cerebral haemorrhage, myocardial infarction and brain oedema caused by the increased intravascular volume (Miller et al., 1995). Patients with preexisting renal, cardiac or pulmonary dysfunctions must either be excluded or monitored very closely so as not to further exacerbate their underlying conditions.

As Mrs. X was closely monitored on day 12 post initial bleed she unexpectantly became unresponsive dropping her GCS to 10/15. She was immediately sent to radiology for an urgent CT scan, which showed no abnormalities. She then had a transcranial doppler, which showed severe cerebral vasospasm in both her anterior cerebral arteries. Her blood pressure had also dropped below acceptable limits and could not be maintained above set limits without high dose inotropic medication, which could only be administered in Intensive Care Unit (ICU).

Transcranial doppler is routinely preformed to diagnosis cerebral vasospasm. This procedure involves the use of non-invasive ultrasound, which measures the velocity of blood within the cerebral arteries (Young et al., 1996). If cerebral vasospasm is present an increased velocity is detected in the effected vessel. This is due to the vessel in spasm requires higher flow to move the blood. Other procedures used include Magnetic Resonance Angiography (MRA), Computed Tomography Angiography (CTA) & IADSA, which have been discussed previously in Part 1 of this article.

Her blood pressure was eventually stabilised in ICU with high dose inotropic therapies. Frequent transcranial doppler's however showed no improvement to her cerebral vasospasm despite intensive hypertensive and hypervolemic therapy combined with Nimodipine. It was decided that more aggressive treatment was required to prevent any further deterioration in Mrs. X's condition. Mrs. X was sent for further IADSA with cerebral balloon angioplasty and intra-arterial Papaverine.

# Nursing management (cerebral vasospasm)

#### Cerebral balloon angioplasty

Zubkov et al., first reported the use of cerebral balloon angioplasty for the treatment of cerebral vasospasm in 1984. Although this is not a commonly used technique, research into its use has shown it to be quite effective (Cook, 1990). Cerebral balloon angioplasty is a procedure performed under fluoroscopy. A balloon catheter is inserted via the femoral artery into the cerebral arteries. The area of cerebral vasospasm is identified and the balloon is then inflated to dilate these contracted arteries (Newell et al., 1989). Cerebral balloon angioplasty is not a preventive treatment and although it is highly successful, it is only used after other preventive treatments have been explored (Firlik et al., 1997). Various drug interactions, which can be associated with pharmaceutical treatment of cerebral vasospasm, are kept to a minimum, due to the treatment being mechanical in nature.

There are certain drawbacks to the use of cerebral balloon angioplasty. One such drawback is its inability to dilate small (usually) distal arteries, which may be involved in cerebral vasospasm due to the size of the vessel being smaller than the balloon catheter. Complications include anaphylaxis and decreasing renal function (from the contrast medium), thrombosis, embolism, dissection of the arteries at cerebral or insertion site origin, further haemorrhage from heparin and death (Grimes, 1991). Being a reactive rather than a preventative treatment, signs and symptoms of cerebral vasospasm must occur before treatment is initiated. This delayed response time can cause an increased morbidity and mortality rate. The need for specialised equipment and expertise makes this treatment limited to major metropolitan hospitals.

### INTRA-ARTERIAL PAPAVERINE

As cerebral balloon angioplasty cannot dilate small blood vessels, intra-arterial infusions of Papaverine have been effectively used to produce this effect. Papaverine is an opium alkaloid, which relaxes smooth muscle (Clyde et al., 1996). It is injected into an affected artery by cerebral angiography. Once injected, it exerts a vasodilatory effect on these small arteries (Clouston et al., 1995). This form of angiographic intervention has been shown to have less risk of thrombosis, embolism, vessel rupture or intra-cranial haemorrhage than cerebral balloon angioplasty (Clouston et al., 1995).

Complications such as unexplained monocular blindness and seizures and a paradoxical affect on cerebral vessels causing vasoconstriction instead of vasodilatation have been reported (Clyde et al., 1996). Although there is a decreased incidence of complications associated with cerebral balloon angioplasty, this procedure still runs the risk of any angiographic technique. Other complications include dye-induced anaphylaxis and decreasing renal function, thrombosis, embolism, dissection of the arteries of cerebral origin at the catheter insertion site, further haemorrhage from heparin and death (Grimes, 1991).

Intra-arterial infusion of Papaverine is another measure that has only recently been developed (Clyde et al., 1996). Further studies,

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including those into the long-term side effects, should be performed to evaluate the use of intra-arterial infusions of Papaverine.

After the IADSA with cerebral angioplasty and intra-arterial Papaverine Mrs. X spent four more days in ICU until her condition stabilised. Her GCS was 14/15 and blood pressure was kept within acceptable limits without the use of high dose inotropic medication. She was transferred to the Neurosurgery HDU and to the general Neurosurgery ward shortly after.

### NURSING MANAGEMENT GENERAL ISSUES OF CARE

Although the following issues of care may seem evident they are still pertinent in the care for any postoperative neurosurgical patient.

## Respiratory

Issues such airway maintenance and the monitoring of oxygenation levels are vital to maintain adequate oxygenation. This is especially important after a neurological insult like ASAH. As the adequate oxygenation of the patient's brain cells maybe already compromised by the ASAH. Limits on oxygen saturation are usually set well above dangerous levels (below 90%) at 95% to allow early detection and intervention and to ensure that the patient is receiving oxygen rich blood to the brain.

## Musco-skeletal

Adequate rest is also important after surgery, but extended bed rest is not encouraged. As patient's with restricted mobility is can develop deep vein thrombosis. To prevent this use anticoagulants such as sub-cutaneous heparin and the use of anti-embolic stockings are routine for all post neurosurgical patients.

After ASAH it is not uncommon for patients to have deficits such as hemiplegia, paralysis, ataxia etc. Assessment of a patient's posture, gait and limb function for any neurological, muscular or skeletal abnormalities can identity rehabilitation needs early as well as preventing related complications.

### Pain

Pain is associated with any surgical procedure. It's monitoring through position, pain score and sensation. Treatment through analgesia and the effectiveness of said treatment can dramatically effect not only a patient's recovery and perception of hospital stay. It can also decrease further complications associated with pain such as an increase in blood pressure.

Usually Paracetamol and Codeine are used to treat headache associated with ASAH. As Morphine and Pethidine have a sedating effect that can mask a patient's deteriorating conscious state.

### Psychosocial

Psychosocial issues for the patient should always be considered during any hospital stay. It cannot be underestimated the effect that the support for the patient their family and significant others assists with the recovery of a compromised patient. Psychosocial support through the use of social work referral etc will hopefully relieve any contributing or exacerbating factors that may further distress the patient and their significant others exerted on the patient in a particularly difficult time.

### Discharge

Mrs. X was discharged 20 days after her initial bleed with no significant morbidity and was seen in Neurosurgical outpatients 6 weeks later and was recuperating well and without any obvious neurological deficit.

## CONCLUSION

An aneurysmal subarachnoid haemorrhage is a very traumatic experience. As the exact aetiology of ASAH and complications such as cerebral vasospasm are unknown, it is difficult to prevent and treat these conditions. ASAH is a condition that requires high-risk treatment that can result in complications that are difficult to prevent or predict. As such, careful consideration of the patient's past and present medical condition is vital when weighing up all options for a patient's care and management. High levels of post-operative monitoring are essential to ensure timely response to any complications thereby preventing further harm to the patient.

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