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Nursing Care and Management of Patients with Ommaya Reservoir: A Case Report

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Abstract: ***The Ommaya reservoir is a medical device designed for the administration of medications into the cerebrospinal fluid (CSF). It is surgically implanted under the scalp, providing direct access to the brain's ventricles. This case report presents the nursing care and management of a patient diagnosed with B-cell Acute Lymphocytic Leukemia requiring intrathecal chemotherapy. Nursing care focuses on the maintenance of the reservoir, patient education, and emotional support. This article highlights the significance of a multidisciplinary approach to ensure patient safety and recovery.***

Keywords: Ommaya reservoir, intrathecal chemotherapy, nursing care, CNS management, case study

Ommaya Reservoir:

The Ommaya reservoir is a device used to treat various neurological conditions including cancer.

Purpose:

The purpose of this article is to present a case study highlighting the nursing care, management, and challenges associated with Ommaya reservoir placement for intrathecal chemotherapy.

Ommaya reservoir allows direct administration of medication into the cerebrospinal fluid, which can be particularly beneficial in delivering chemotherapy or other medications directly to the brain or spinal cord.

This case study highlights the critical role of nurses in managing patients with Ommaya reservoirs, focusing on infection prevention, patient education, and emotional support.

History of Ommaya Reservoir:

Dr. Ayub K. Ommaya, a neurosurgeon and biomedical researcher invented Ommaya reservoir and so the device is named after him. He was born in Pakistan in 1930 and later moved to the United States. Dr. Ommaya made significant contributions to the development of medical devices. His work on the Ommaya reservoir, was initially used in the treatment of brain conditions and has had an impact on the field of neurosurgery, advancing the understanding of brain injuries and their management. His innovations and contributions to the medical community continued until his last breath in 2008.

Features of the Ommaya reservoir:

Ommaya reservoir consists of a small, dome-shaped reservoir that is surgically implanted under the scalp and connected to a catheter that is inserted into the brain's ventricles, allowing targeted drug delivery into the central nervous system. It is a refillable, sustained release device consisting of an Ommaya reservoir that has been modified by the addition of a semipermeable membrane between the reservoir and the delivery tube.

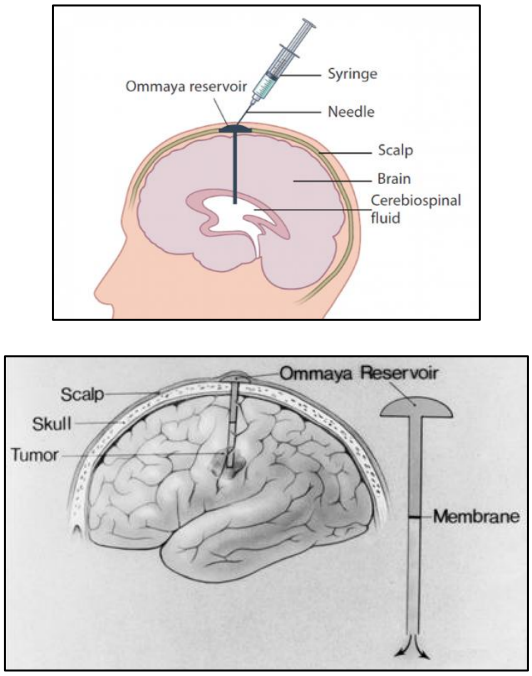

Fig.1: Ommaya reservoir

(https://www.cancer.ie/cancer-information-and-support/cancer-types/brain-tumours/how-are-brain-tumours-treated/surgery-for-brain-tumours/what-are-the-types-of-brain-surgery)

Materials used in Ommaya Reservoir:

The choice of materials for Ommaya reservoirs are made of biocompatible materials that are well-tolerated by the body, safe and minimize the risk of adverse reactions and complications.

Silicone: Silicone is a commonly used biocompatible material in medical devices which is flexible, durable, and compatible with bodily tissues, making it suitable for use.

Polyurethane: Polyurethane is another biocompatible material that is known for its resilience, strength, and ability to withstand various environmental conditions within the body.

Indications:
- Spinal anatomy abnormality
- Obesity making lumbar punctures technically challenging
- Patients with hydrocephalus, microcephaly or known abnormalities of CSF flow

Contraindications:
- Scalp infection
- Brain abscess
- Previously known allergy to silicone

Advantages:
- The blood-brain barrier is not a factor in drug delivery.
- Large concentrations of drug can be administered with little systemic toxicity.
  - Administration of fluids and intrathecal (IT) chemotherapeutic agents for intracranial neoplasms as well as haematological conditions with CNS involvement such as in acute Leukemia.

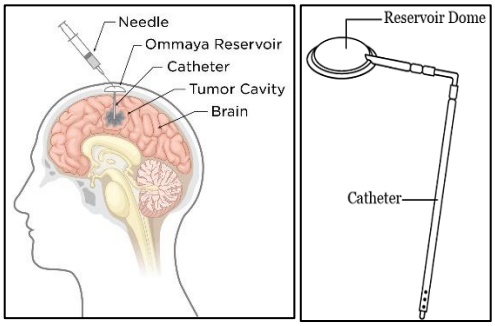

Fig.2. Intra-tumoral chemotherapy (https://images.app.goo.gl/VoVsSDvvT6Tdd7c36, https://www.mskcc.org/cancer-care/patient-education/faq-about-ommaya-reservoirs-and-ommaya-taps)

  - Administration of Intrathecal antibiotics for chronic relapsing meningitis, spinal muscular atrophy, progressive multiple sclerosis and multi-drug resistant central nervous system infections.
  - Administration of opioid analgesic for cancer pain
- Chronic drainage of CSF for infants with intraventricular haemorrhage
- Aspiration of residual subdural hematoma or effusion

Ommaya reservoir implantation:

Preparation of patients:

Pre-requisites:

  - White blood cell count ≥ 2000/mm3
  - Platelet count ≥1,00,000/ mm3
  - Serum creatinine ≤ 2.0 mg/dL
  - Karnofsky performance status ≥ 60%
  - Localized tumour (largest diameter <6 cm on contrast enhanced MRI) and confined to one cerebral hemisphere.
- **Patient Education:** Explain the procedure - the reason for its necessity, the settings of the procedure, pre-anaesthesia clearance, before, during, and post procedure care and monitoring.
- **Consent:** Ensure that the patient or their legal representative fully understands and signs the informed consent form.
- **Preoperative Instructions:** Provide specific instructions regarding fasting, medication management and any necessary preparatory measures, such as skin cleansing protocols. The scalp is prepared with antiseptic scrub and head shaving is preferred in cancer patients considering prevention of infection.
- **Emotional Support:** Address any concerns or fears the patient may have, providing reassurance and emotional support throughout the preparation process.
- **Vital Signs Assessment:** Conduct a comprehensive assessment of the patient's vital signs, including temperature, blood pressure, and heart rate, to establish a baseline before the procedure.
- **Intravenous Access:** Establish intravenous access for the administration of necessary medications and fluids during the procedure.
- **Documentation:** Ensure accurate and detailed documentation of the patient's medical history, current medications, and any relevant preoperative assessments.
- By diligently addressing the patient's physical and emotional needs, nurses can help **alleviate anxiety**, enhance patient cooperation, and contribute to a more successful Ommaya reservoir implantation procedure.
- **Fasting** before an Ommaya reservoir implantation procedure may vary depending on the specific instructions provided by the healthcare team. Patients are instructed to fast for a specific period to reduce the risk of complications during the surgical procedure.

Common fasting guidelines before a surgical procedure like Ommaya reservoir implantation may include:

  - Clear Liquids: Fasting from clear liquids for around 2-4 hours before the procedure.
  - Light Meals: Fasting from light meals, including solids, for approximately 6-8 hours before the procedure.

However, these guidelines can vary based on the patient's age, medical history, and the specific instructions provided by the healthcare provider.

- **Medication related instructions:** Clear and comprehensive medication management education is crucial to ensure the patient's understanding of their treatment plan, promote medication adherence, and minimize the risk of complications following the Ommaya reservoir implantation procedure.
  - **Antibiotics:** Explain the importance of taking prescribed antibiotics to prevent infection, and provide guidance on the proper dosage and duration of the antibiotic regimen.

- **Pain Management:** Discuss the use of analgesics, including the appropriate dosage, timing, and potential side effects. Educate the patient on when and how to report any concerns related to pain management.
- **Anti-seizure Medications** (if applicable): If the patient has a history of seizures or is at risk for seizure, explain the use of anti-seizure medications, including dosage, potential side effects, and the importance of adherence.
- **Steroids** (if applicable): Provide information on the use of steroids, if prescribed, including the dosage, timing, and potential side effects. Explain the importance of following the prescribed regimen to manage inflammation and reduce complications.
- **CSF Pressure Modifying Agents** (if applicable): If the patient requires cerebrospinal fluid pressure-modifying agents, explain the purpose of the medication and its role in managing intracranial pressure. Discuss the potential side effects and the importance of regular monitoring.
- **Other Medications:** Provide information on any other specific medications prescribed before or after the procedure, including their indications, dosages, administration instructions, and potential side effects.

The Ommaya reservoir implantation procedure:

The procedure is performed under general anaesthesia.

- **Anaesthesia:** The anaesthetist administers general anaesthesia.
- **Position:** The patient is positioned in supine position with the head fixed on a Mayfield clamp holder.
- **Incision:** A small incision is made in the scalp of the right frontal region to create a pathway for the reservoir placement.
- **Reservoir Placement:** An inverted U-shaped scalp incision is made over the entry point, 3cms lateral to the midline.

A small burr hole is made in the skull, and the Ommaya reservoir is then inserted into the brain's ventricular system, into the lateral ventricle.

- **Securing the Reservoir:** The reservoir is secured in place with sutures or staples and the incision in the scalp is closed.
- **Catheter placement confirmation:** In the postoperative period, a head CT scan is performed to evaluate the catheter placement and any evidence of haemorrhage.
- **Duration:** Ommaya reservoir can remain in place for months to years.

Nursing Care of patients on Ommaya Reservoir:

Postoperative Care: After the surgery, the patient is closely monitored for appropriate pain management, wound care and signs of complications.

Immediate postoperative care: Immediate postoperative care focuses on ensuring the patient's stability, managing pain and discomfort, preventing complications, and preparing the patient for a smooth transition to the next phase of recovery.

The immediate postoperative care for patients undergoing Ommaya reservoir implantation involves attentive monitoring and management of the patient's condition.

- **Vital Signs Monitoring:** Regularly monitor vital signs, including blood pressure, heart rate, respiratory rate, and temperature, to detect any early signs of complications or instability.
- **Neurological Assessment:** Perform frequent neurological assessments to evaluate the patient's level of consciousness, motor function, sensory responses, and any signs of neurological deficits.
- **Pain Management:** Administer analgesic as prescribed to alleviate postoperative discomfort.
- **Wound Care:** Monitor the surgical site for any signs of infection, bleeding, or other complications. Keep the incision site clean and dry to prevent infection.
- **Fluid and Electrolyte Management:** Maintain a proper fluid and electrolyte balance, ensuring the patient remains adequately hydrated and that electrolyte levels are within normal ranges.
- **Positioning:** Assist the patient in maintaining a comfortable and appropriate position to promote optimal recovery and prevent any complications related to positioning.
- **Nausea and Vomiting Management:** Address any postoperative nausea and vomiting by providing appropriate antiemetic medications as needed.
- **Patient and Family Education:** Provide the patient and their family with information about the procedure, expected recovery process, potential complications to watch for, and instructions for postoperative care at home.

Follow-up post procedure care:

- **Monitoring:** Regular monitoring of the patient's vital signs, neurological status, and signs of infection or complications in the follow-up care.
- **Wound Care:** Ensure proper wound care, including monitoring the incision site for any signs of infection such as redness, swelling, or drainage. The reservoir port should not be accessed until 5 days after Ommaya placement for reduction of infection.
- **Medication Management:** Monitor the patient's adherence to prescribed medications, including antibiotics, analgesics and any other specific medications and address any concerns or side effects.
- **Neurological Assessment:** Perform regular neurological assessments to detect any changes in the patient's neurological status or any potential complications related to the central nervous system enabling prompt intervention and appropriate management
  - **Level of Consciousness:** Evaluate the patient's level of consciousness using a standardized scale, such as the Glasgow Coma Scale, to assess their responsiveness and overall mental status.
  - **Cranial Nerve Assessment:** Assess the function of the cranial nerves, including evaluating visual acuity,

pupillary reactions, facial sensation, and motor function.
- **Motor Function:** Evaluate the patient's motor strength and coordination by assessing muscle tone, power, and coordination in all four extremities.
- **Sensory Assessment:** Test the patient's sensory perception, including assessing their ability to perceive touch, pain, and temperature in different areas of the body.
- **Reflexes:** Check the patient's deep tendon reflexes, such as the biceps, triceps, patellar, and Achilles reflexes, to evaluate the integrity of the spinal cord and peripheral nervous system.
- **Cerebellar Function:** Assess the patient's coordination, balance, and fine motor skills to evaluate the function of the cerebellum.
- **Gait Assessment:** Observe the patient's ability to walk and assess their gait pattern, balance, and coordination.
- **Cognitive Function:** Evaluate the patient's cognitive abilities, including memory, attention, and orientation, to assess any changes in cognitive function following the procedure.

- **Reservoir Function Check:**

Regularly assess the functionality of the Ommaya reservoir, including checking for proper fluid drainage and the absence of any blockages or malfunction.

- **Check Reservoir Position:** Verify that the Ommaya reservoir is in the correct position, usually through imaging techniques such as X-rays, CT scans, or MRI scans.
- **CSF Drainage Assessment:** Ensure that cerebrospinal fluid (CSF) is draining properly through the reservoir. Measure the volume of CSF drainage if necessary.
- **Flushing the Reservoir:** Periodically flush the reservoir with sterile saline to maintain patency and assess any potential blockages or obstructions.
- **Catheter Patency Check:** Confirm that the catheter connecting the reservoir to the ventricular system is functioning properly and is not kinked or obstructed.
- **Medication Administration Test:** Reservoir site should be accessed with a 22 to 25 gauge Huber needle, is pierced in an oblique fashion and CSF is aspirated. After the aspiration, a small amount of sterile fluid or medication is administered to ensure that it is infusing properly into the cerebrospinal fluid.
- **Observation of Reservoir Site:** Regularly monitor the Ommaya reservoir site for any signs of infection, such as redness, swelling, or discharge.
- **Regular Imaging:** Schedule regular imaging studies, such as CT scans or MRI scans, to assess the position and functionality of the Ommaya reservoir and to monitor for any potential complications.

Follow up visits:

The healthcare team will determine the appropriate schedule for follow-up visits based on the specific needs of the patient and condition of the patient. The frequency of follow-up visits after Ommaya reservoir implantation are;

- **Within the first week:** An initial follow-up visit is often scheduled within the first week after the procedure to monitor the patient's immediate postoperative recovery and ensure proper wound healing.
- **Regular follow-up visits:** Subsequent follow-up visits are usually scheduled at intervals of every 2 to 4 weeks initially, to closely monitor the patient's neurological status, assess reservoir functionality, and evaluate the response to the treatment. The sutures or staples in the scalp are removed approximately 10 to 14 days after the procedure. A small bump will remain at the treatment site, but normal activities can be resumed as soon as the incision is completed healed
- **Long-term follow-up:** Over time, the frequency of follow-up visits may be adjusted based on the patient's response to treatment, any ongoing complications, and the need for ongoing management of their condition.

Patient and Caregiver Education:

- Provide **ongoing education** to the patient and their caregivers on signs and symptoms of potential complications, the importance of adherence to the follow-up schedule and lifestyle modifications.

Life style changes:

After Ommaya reservoir implantation, patients may need to make certain lifestyle modifications to support their recovery and overall well-being.

- **Infection Prevention Measures:** Practicing good hygiene and avoiding exposure to individuals with contagious illnesses to reduce the risk of infections.
- **Dietary Considerations:** Following a well-balanced diet to support overall health and aid in the healing process, including consuming adequate fluids and nutrients.
- **Activity Restrictions:** Avoiding strenuous activities or heavy lifting as advised by the healthcare team to prevent strain or injury to the surgical site.
- **Medication Adherence:** Ensuring strict adherence to prescribed medications and following the medication schedule provided by the healthcare provider.
- **Regular Medical Monitoring:** Attending all scheduled follow-up appointments and diagnostic tests to monitor the functionality of the Ommaya reservoir and the patient's overall health.
- **Symptom Monitoring:** Being vigilant and promptly reporting any new or worsening symptoms to the healthcare team, such as changes in neurological status, signs of infection, or any unusual side effects from the treatment.
- **Emotional Support:** Seeking emotional support from friends, family, or support groups to cope with the challenges of the treatment process and maintain a positive outlook.

Complications:

Although Ommaya reservoir implantation is a safe and effective procedure, there are potential complications

which needs to be promptly reported to the healthcare team to ensure timely intervention and management.

- **Infection:** The risk of infection at the site of the Ommaya reservoir insertion is a significant concern. Infections can lead to serious complications and may require antibiotic treatment or, in severe cases, removal of the reservoir.
- **Bleeding:** Excessive bleeding during or after the procedure may occur, leading to hematoma formation or other related complications.
- **CSF Leakage:** Cerebrospinal fluid (CSF) leakage can occur due to damage to the surrounding tissues during the procedure, leading to complications such as headache and an increased risk of infection.
- **Neurological Complications:** Damage to surrounding brain tissue or nerves during the implantation procedure may result in neurological deficits, including changes in sensory perception, motor function, or cognitive abilities.
- **Reservoir Malfunction:** Malfunction of the Ommaya reservoir, such as blockage or dislodgement, can affect the proper administration of medications or drainage of CSF, potentially leading to treatment inefficacy or complications related to increased intracranial pressure.
- **Allergic Reactions:** Some patients may develop allergic reactions to the materials used in the Ommaya reservoir, resulting in local or systemic symptoms that require prompt medical attention.
- **Toxic leukoencephalopathy:** This is due to damage to the white matter myelin of the brain caused by the intrathecal chemotherapeutic agents or cranial radiation. Patients develop neurological deficit.

Case study:

Mr. M an 18-year-old male, born to parents from nearby country. His father is a farmer and mother is a housewife, had non-consanguineous marriage and gave birth to him and his younger sister. Gives no history of abortions and childbirth were uneventful. He is at his 12th standard schooling now. He is a teetotaller with normal sleep and appetite. He had normal bowel and bladder pattern. No past history of surgery or chronic illness or viral infections. No family history of malignancies or haematological disorders.

He presented with the history of generalised weakness, easy fatiguability, headache and giddiness for 4 months. No history of bleeding sites. He was evaluated in a local hospital and was found to have significant anaemia (Hb 5g/dL), thrombocytopenia (20,000/mm^3) and elevated total counts (50,000/mm^3). He was diagnosed to have B cell Acute Lymphocytic Leukemia (B cell ALL) and referred to higher centre after started him on Tab. Mercaptopurine, Tab. Sulphamethoxazole & Trimethorprim and Cap. Fluconazole.

On arrival to the tertiary hospital in August 2023 for further evaluation and treatment, his vital signs were normal and SpO_2 was 98%. GCS 15/15, GRBS 113g/dL, had pallor and left cervical lymph node enlargement. CNS, CVS and Respiratory systems were normal on physical examination. Bone marrow analysis: peripheral blood smear showed 35% blast cells, immunophenotyping suggested him to have B cell ALL and cytogenetics showed low hyperdiploidy due to gain of chromosome X, 8 and 10. RT PCR was negative and Next Generation Sequencing (NGS) was normal. CSF cytospin study and CSF immunophenotyping revealed CNS involvement of the disease. He was administered preinduction and induction chemotherapy based on BFM paediatric intermediate Risk protocol. Post chemotherapy period, he developed steroid induced hyperglycaemia which was treated with insulin initially and later with Tab. Metformin. However, he had to be on regular intrathecal chemotherapy. considering the need for intrathecal chemotherapy and difficulty to access his subarachnoid space due to his obesity, Ommaya reservoir was placed in the middle of September 2023, after neurosurgeons' consult. He received two doses of intrathecal chemotherapy using Ommaya reservoir. His post Ommaya reservoir placement and post chemotherapy hospitalization were uneventful. His nursing care will be explained using Johnson's Behavioural System Model.

Application of Johnson's Behavioural System Model on Mr. M.:

Dorothy E. Johnson, a nurse wrote the Johnson's Behavioural System Model. She was a professor of nursing at the University of California in Los Angeles (Conner et. al. 1994). Johnson's theory focuses on behavioural rather than biology, maintaining behavioural balance during illness and adapt behaviours to social and biological needs. In this theory, Johnson proposed that patients were "stressed" by a stimulus of either an internal or external nature. These stressful stimuli create disturbances in the patient that leads to a state of disequilibrium. Johnson's Model states that it is at this point the nurse is needed in order to return the client to homeostasis (Conner et al., 1994). Johnson identified reducing stressful stimuli and supporting natural and adaptive processes are the two areas that nursing care should be focused. This model categorizes human behaviour into seven subsystems and aims to help patients maintain behavioural balance. The subsystems are Attachment, Dependency, Ingestive, Eliminative, Sexual, Aggressive Protective and Achievement. Each subsystem is interrelated with the others and the specific structural elements and functions that help maintain the behavioural system's integrity.

Imbalance or disequilibrium in behavioural system of Mr. M

Functional Requirements:
Protection, Nurturance, Stimulation – stringent hand hygiene, following strict aseptic technique while handling the catheter connected to reservoir, regular assessment and care of the site, Maintaining its patency by flushing the catheter monthly when not in use, addressing stress, being connected to family and friends.

Structural component:
- Set goal – the goal was to prevent infection and other complications and to achieve adaptability.
- Choice – Ommaya reservoir was chosen over the conventional route for the treatment of CNS involvement.
- Action/behaviour - Indication, advantages & disadvantages and the necessity of Ommaya reservoir were thoroughly assessed and educated before insertion. Counselled him and family.

Biological system:
- Decision on Ommaya reservoir placement.
- Administration of intravenous and intrathecal chemotherapy.
- Management of steroid induced hyperglycaemia.

Behavioural system:
- ***Attachment or Affiliative Subsystem:*** He was in distress, often crying, not maintaining eye contact and was not cooperative to nursing care due to separation from his family. Mother and father had to go to home town to earn and to take care of his sister. Facilitated the social bond by encouraging video calls to his friends and family members.
- ***Dependency Subsystem:*** The presence of his father was withdrawn and was replaced with his uncle. His dependence on a person was withdrawn by engaging him in recreational activities.
- ***Aggressive Protective Subsystem:*** He was not cooperative which was managed by developing good rapport with him, assisting him to walk, enquiring about his wellbeing and providing positive strokes often. He was assisted with taking bath daily. His environment was maintained clean and tidy. His post induction febrile neutropenia was managed well with Inj. GCSF 500mcg SC od, Inj. Meropenem 1g IV Q8h, Inj. Amikacin 500mg OD and Tab. Tamiflu. Blood culture showed no growth of microorganism. Asymptomatic acute hepatitis was managed with Tab. UDCA 150mg BD. As part of BFM chemotherapy protocol he received Tab. Prednisolone 40mg to 20mg OD for two weeks and developed hyperglycemia which was treated with Inj. Actrapid 4U before every meal and later Tab.Metformin 1g PO BD.
- ***Ingestive Subsystem:*** He and his family were educated about the importance of low microbial diet and safe water intake. He had nausea which was managed with Tab. Pantoprazole 40mg OD and Tab. Emeset 8mg prn, his intake was adequate.
- ***Eliminative system:*** He did not develop diarrhoea and vomiting. His constipation was managed with Syr. Cremaffin 20mL TID. His bladder pattern was normal and urine output was adequate throughout the treatment.
- ***Achievement Subsystem:*** At the time of discharge, he was afebrile and hemodynamically stable. His electrolytes and LFT were normal. Hb was 11.9g%, Platelets 4,39,000/mm^3, WBC 6,000/mm^3. He had received a total of 6 intrathecal chemotherapy (Inj. Methotrexate 12.5mg, Inj. Cytarabine 40mg and Inj. Hydrocortisone 50mg) of which 2 were administered through Ommaya reservoir. Post induction bone marrow analysis revealed MRD positive (0.101%), Cellular marrow with no morphological evidence of residual disease. CSF analysis showed negative for blast cells. He was discharged with Tab. Folic acid 2.5mg OD, Tab. Septran DS 1 BD 2/7, Tab. Metformin SR 1g BD, Tab. Levetiracetam 750mg BD, Tab. UDCA 150mg BD and Syr. Vitamin D 60,000 Units 1/7 X 6 weeks. His hospitalization period was uneventful.

Balance or equilibrium in behavioural system of Mr. M was achieved

Desired patient outcome: He completed his course of chemotherapy, got discharged and left home. He did not develop infection, bleeding or neurological deficits throughout his treatment. His Ommaya reservoir was functional at the time of discharge. He was educated on the care and maintenance od Ommaya reservoir.

Conclusion

Mr. M had been through a critical time of his life since the time of diagnosis. The placement of the Ommaya reservoir provided an effective alternative for administering intrathecal chemotherapy, reducing patient discomfort and complications. Through meticulous nursing care, including infection prevention, emotional support, and education, the patient achieved recovery with no adverse events. This case study highlighted the importance of a structured nursing approach in managing complex medical interventions.

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