Australian Critical Care

The ventilated patient undergoing hydrotherapy: a case study

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Abstract: The ascending peripheral neuropathy and paralysis that result from Guillain-Barre Syndrome's (GBS) demyelination of peripheral nerves is a challenge to health professionals; the patient requires support during the acute disease process and during the remyelination recovery period, often lasting months to years.

The staff of a major metropolitan teaching hospital's critical care unit (CCU) and physiotherapy departments developed a hydrotherapy treatment programme for a ventilated patient with GBS. Through careful planning and appropriate preparation, it was found that hydrotherapy could successfully and safely be incorporated into a patient's treatment regimen. The benefits included improved range of movement due to the supportive nature of water, anecdotal increased strength, size and movement of remyelinating muscles and a psychological improvement. Although this patient has not recovered from GBS to be independent, hydrotherapy was a valuable part of the treatment regimen and it could be suggested the increase muscle strength lead to improved respiratory function and enabled weaning from ventilation, reducing intensive care length of stay and cost.

Taylor S. The ventilated patient undergoing hydrotherapy: a case study. Australian Critical Care 2003; 16(3):111-115.

INTRODUCTION

Guillain-Barre Syndrome (GBS) is a post-infectious peripheral polyneuritis, characterised by a rapidly progressive ascending peripheral neuropathy due to demyelination and leading to paralysis [1-3]. It has been proposed that GBS is an autoimmune response [1, 4, 5]. Antibodies attack schwann cells causing demyelination. The uninsulated portion of the nerve then becomes inflamed, leading to interruption of nerve conduction, causing the classic signs of muscle weakness, tingling and numbness [6]. The disease is often worse at approximately 4 weeks as the demyelination is self-limiting, followed by remyelination with recovery occurring over a period of months [6]. Some patients get worse after initial improvement and enter a chronic phase with a very prolonged recovery [3, 6].

Respiratory failure leads to approximately 30% of GBS patients requiring mechanical ventilation in a critical care unit (CCU) [7, 8]. The challenge for the multi-disciplinary team caring for patients severely affected by GBS is to develop programmes that minimise complications from prolonged ventilation and reduced activity, while maximising functional return. Particular attention needs to be paid to correct positioning, an extensive exercise regimen, psychological support, adequate nutrition and appropriate analgesia [7].

At the suggestion of a physiotherapist and following consultation with the intensive care consultant and nursing staff on duty at a major Australian metropolitan teaching hospital, an initial hydrotherapy session with a fully ventilated patient with GBS was undertaken. The success of this first session resulted in hydrotherapy being incorporated three times per week into this patient's care routine.

Ethical issues

Before writing this article, permission was obtained from June (a pseudonym to protect the patient's identity) at a meeting with her family, in order that photographs detailing her hydrotherapy regimen and for information regarding her condition and treatment to be used as part of this case study for publication. Although June's comprehension of English had improved during her incapacitation, her son also acted as interpreter. June nodded consent. Written consent was also obtained from her son, on behalf of his mother, after viewing the photographs to be included. An interpreter was present at the first hydrotherapy session to ensure June understood and agreed to all aspects and instructions of the therapy. Permission was also obtained from all staff appearing in the photographs.

HISTORY

June was a 77 year old woman who emigrated from Asia to Australia 6 months prior to her admission, with a seven day history of upper respiratory tract infection (URTI) and multiple falls. She had been unable to get out of bed on the day of her admission but was alert and cooperative, within the limitations of her poor English language skills. On examination she had jaw weakness, poor neck control, bilateral flaccid paralysis of upper and lower limbs with absent reflexes and urinary retention. Nerve conduction studies were consistent with the diagnosis of GBS, showing slow impulse transmission [6].

June's paralysis was extensive, involving all limbs, abdominal, respiratory and facial muscles. Her breathing was shallow with accumulation of secretions requiring intubation. Early tracheostomy was performed within four days for patient comfort.

Initial treatment consisted of six therapeutic plasma exchanges (or plasmapheresis) over 8 days, with 2.4-2.9 litre exchanges with 4% albumex at each session. It is believed that by performing plasma exchange or by using intravenous gamma globulin, the acute demyelination phase of GBS is reduced[2,6,9]. Urinary acidification, with hippuric acid and vitamin C, was undertaken for recurrent light growths of *Pseudomonas aeruginosa* and *Staphylococcus aureus* in the urine. Enteral feeds were administered initially via a nasogastric tube and later via a percutaneous endoscopic gastrostomy (PEG) tube, to meet nutritional requirements.

Over 2 months elapsed before June regained some movement of her head and shoulders. An extensive regimen of therapy and exercises (Table 1) was developed to reduce the effects of muscle tightness and to maintain function. Various electronic devices (eye controlled computer programs and a ventilator speaking valve) were unsuccessfully trialled to improve her communication. Instead she was able to nod and shake her head to simple questions. Over time, her comprehension of English greatly improved, as shown by speech therapy picture/word recognition tests. Sertraline was commenced for depression and nightmares.

A multi-disciplinary team (Table 2) approach was required to maximise the treatment choices. Progress was, nevertheless, very slow. With little improvement in movement by 6 months, alternative treatments were considered and, following discussions with June and her family, she was taken to the hospital hydrotherapy pool.

HYDROTHERAPY

The term hydrotherapy is derived from the Greek words *hydor* (water) and *therapeia* (healing)[10]. Water provides buoyancy and other therapeutic benefits including relief of muscle pain and spasm; maintenance and increased range of movement of joints; strengthening of weak muscles and increased exercise tolerance; re-education of paralysed muscles; improved circulation; improved functional activity; and maintenance and improvement of balance, coordination and posture[11]. Water also allows for exercise in three dimensions, which cannot be as easily achieved on land – the bed mattress and chair back and arms restrict range of movement.

Table 1. Exercise and therapy regimen.

• Range of movements and limb exercises
• Calf stretches
• Hyperventilation and hyper-oxygenation with suction
• Resting arms splints
• Dynamic flexion arm splints
• OB (slings & pulleys) system for arms
• Tongue & oral muscle exercises
• Leg splints
• Tilt table
• Antiembolic stockings and sequential calf compressors
• Sitting out of bed in a chair
• Visits outside to the court yard
• Listening to music, watching favourite TV programmes or videos

A water temperature range of 33-35°C (thermoneutral) is recommended, allowing patients, especially the elderly, to exercise slowly without losing heat[11]. Water conducts heat more effectively than air. Water temperature less than 33°C increases risk of heat loss and can result in increased muscle pain and shivering. Conversely, water temperature over 35°C can lead to detrimental cardiovascular effects, including hypotension from vasodilation and tachycardia, and anecdotal evidence from physiotherapists suggests that the patient tires more easily.

Exercises are accomplished with the patient lying supported by flotation equipment, or in a sitting or standing position. The person's position and the exercise starting position of each limb are important, as they determine the muscle groups that are exercised. The position also determines whether buoyancy effects of water assist, support or resist limb movement[11]. Cooperation and flexibility between the physiotherapist, their assistant(s) and the patient is important to maximise the benefits to be gained through hydrotherapy.

Hydrotherapy sessions

From a nursing perspective there were some concerns with taking a ventilated patient to the hydrotherapy pool. These included: the risk of aspiration of chlorinated water; sufficient length and security of the ventilator tubing; adequate ventilation; access to emergency equipment; accidental decannulation of the tracheostomy tube; patient anxiety and communication; hypothermia; haemodynamic effects (hypotension or tachycardia); risk of infection from frequent disconnection of invasive devices (i.e. PEG and indwelling urinary catheter); prevention of body fluid contamination of the pool; and post session dehydration and safety in a wet environment (including using battery operated equipment to reduce the electrocution hazard, and staff not entering the pool wearing non-slip shoes).

To ensure the safety of other pool users, the pool was closed during the first few sessions, but once a routine was established, the pool

Table 2. Multi disciplinary teams involved.

• CCU doctors, nurses and physiotherapists
• Patient service attendants (PSA)
• Social workers and counselling services
• Transfusion – plasma exchange technician
• Occupational therapy
• Speech therapy
• Clinical nutrition and dietetics
• Interpreters
• Podiatry
• Dermatology
• Stomal therapy
• Neurology
• General surgery
• Hydrotherapy physiotherapists and assistant
• Laboratories – biochemistry, microbiology, haematology, transfusion

was opened to other ambulatory people. As June's therapy and equipment blocked access to the hydraulic lifter, and therefore the exit from the pool, only people able to use the stairs could use the pool during her sessions.

A detailed protocol was developed to support this therapy. A transport ventilator with a 3m circuit length, to reduce tracheostomy drag and increase patient range of movement, was used. The ventilator enabled both positive end expiratory pressure (PEEP) and pressure support (PS) to be maintained. June's normal ventilator parameters of tidal volume (VT) 550ml by 10 breaths, PEEP 5, PS 15 were used, but with oxygen increased to 100% (instead of her usual 30%) as we were using a single D size oxygen cylinder and suction system. It is possible with the ventilator to blend oxygen to 30% but this involved transporting both oxygen and air cylinders to the pool, which was considered unnecessary. As an added precaution, all joins in the circuit were secured with waterproof adhesive tape to reduce the risk of accidental disconnection.

Other preparation included disconnection of her PEG feed; the connector was secured with waterproof adhesive tape. The PEG tubing was additionally secured with tape to her abdomen to reduce the chance of accidental traction leading to tube dislodgment. The tracheostomy bib was removed and the velcro tie tightened to better secure the tube. The urinary catheter join was cleaned with antiseptic and, once the bag was disconnected, the catheter was spigoted and secured with waterproof adhesive tape. It was also secured to her leg to prevent accidental dislodgment. To prevent faecal contamination of the pool, an anal plug was lubricated and inserted into her rectum. She was then dressed in a patient gown and long pants.

Additional equipment accompanied her to the hydrotherapy pool. This included a hand ventilating assembly with double length oxygen tubing, double length suction tubing connected to the portable suction system, suction catheters, a spare tracheostomy tube, yanker sucker, gloves, tissues, an adult resuscitation trolley with transport defibrillator and transport monitor with electrocardiograph, oxygen saturation and non-invasive blood pressure cables for use in an emergency. Other items needed included fresh linen, face washer, towels, blanket, gown and toiletries.

Staff present at the first session included two physiotherapists and an experienced CCU registered nurse (RN) in the pool, two experienced CCU RNs to move and monitor the equipment and to have the emergency equipment ready to use if required, a CCU consultant, a Cantonese interpreter and another physiotherapist at the pool side.

Once at the hydrotherapy pool June was transferred to a hydraulic bed. A flotation pillow was placed behind her head and secured around her chest. After ensuring, via an interpreter, that she understood what was happening she was lowered into the pool (Figure 1). If she was uncomfortable or apprehensive at any time in the water she was to shake her head to alert staff, and this worked very successfully.

Once in the water June was floated off the hydraulic bed. A physiotherapist remained behind her to support her head and shoulders, keeping her tracheostomy tube well above the water. The other physiotherapist placed flotation pillows under each limb and her pelvis. The CCU RN secured the ventilator tubing over her shoulder and above the water, holding onto the tubing close to the patient to prevent dragging on the tracheostomy tube or disconnection (Figure 2).

A flotation pillow was removed from one limb at a time and a combination of neutral and buoyancy resistant exercises were performed. They were also either active or passive depending on June's muscular function in each limb (Table 3). The remaining pillows aided flotation and prevented rotation as her limbs were exercised (Figure 3).

The pool session lasted approximately 30 minutes. She was then lifted out of the water on the hydraulic bed. As the water was thermoneutral, at 34°C, a blanket was placed over her immediately

Figure 1. Lowering June into the hydrotherapy pool at the first session (photograph used with permission).

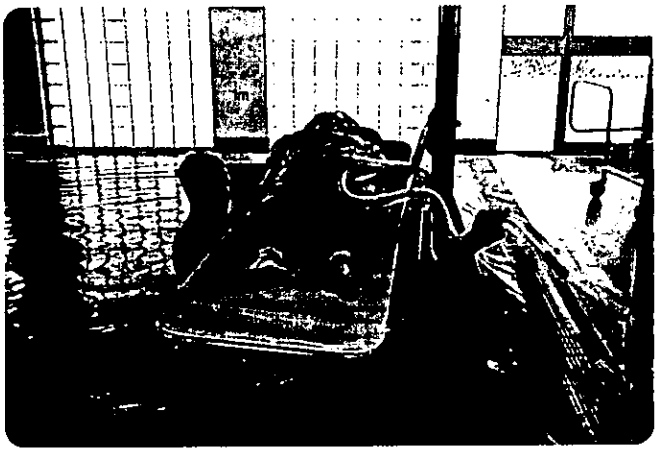

Figure 2. Flotation pillows used for head and limb support (photograph used with permission).

Table 3. First hydrotherapy sessions exercises.

• Hip extension against buoyancy
• Hip abduction and adduction, neutral buoyancy
• Arm abduction with external rotation, neutral buoyancy
• Arm adduction, neutral buoyancy
• Familiarisation with pool environment and floating sensation

to prevent hypothermia. She was then showered, to remove the chlorine, before transferring back to her bed and returning to her room in CCU.

Total preparation and session time was 2 hours. The session occurred during shift change over time, 1330-1430, allowing three CCU RNs to be in attendance at the hydrotherapy pool.

Beneficial effects

The following day, after this first session, it was noted that June was more actively involved in her exercise regimen in bed and had better active range of movement. This rapid change could not be the result of a single hydrotherapy session but was probably due to June realising she could move more than she thought she could plus an enormous psychological boost that saw her more responsive to her environment and treatment regimen.

A rotating roster was developed for a group of 10 experienced CCU RNs, who volunteered to coordinate each hydrotherapy session. Hydrotherapy sessions were usually three times per week. June made slow but steady progress and achieved some new movement each time. She could sit on a step in the pool with bilateral support and independently move her trunk from side to side and forward and backwards (Figure 4). She later progressed to standing with assistance and then to walking across the pool with two assistants supporting her weight and guiding her legs forward (Figure 5).

June's view

Through a group of yes/no questions and her family interpreting, it was determined that June had not had the opportunity to participate in swimming prior to emigrating. Her initial nervousness was mostly alleviated through the presence of familiar CCU staff and an interpreter at the first hydrotherapy session. She indicated she enjoyed the freedom of movement that swimming gave her and realised she was progressing more with each session. She was happy to continue hydrotherapy sessions and was disappointed if a session was cancelled due to unforeseen circumstances. June's family visited the hydrotherapy pool several times, they witnessed June's enjoyment and progress in exercise regimen and muscle function.

12-18 MONTHS ON

The hydrotherapy sessions were streamlined as staff became more familiar with the protocol. June's progress was very slow. She was weaned to a high flow tracheostomy mask circuit 13 months after her admission and a Venturi self-ventilating circuit (Figure 5) replaced the transport ventilator for hydrotherapy sessions. She was transferred to a general medical ward 15 months after admission. The RNs on the ward took over her hydrotherapy sessions following a period of support and education. June was later transferred to a long-term rehabilitation hospital but with minimal progress with her rehabilitation; she has since been transferred to a nursing home facility.

June still had severe weakness of all her limbs and had limited range of movement at the time of discharge from the acute care hospital. During her hydrotherapy sessions she had a freedom of movement she did not have out of the water. Her muscle bulk had increased for those muscle groups that had regained partial use. This could be contributed to hydrotherapy where her exercises were active in contrast to her passive/assisted exercises out of the pool.

Figure 3. Active hydrotherapy exercises, several weeks later (photograph used with permission).

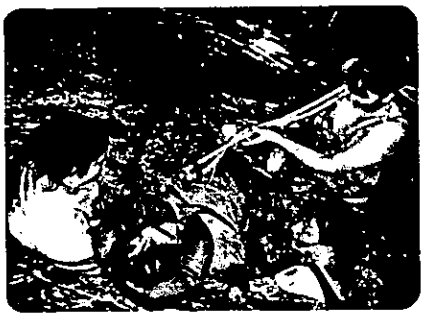

Figure 4. Sitting on a step at a later hydrotherapy session (photograph used with permission).

Figure 5. Walking across the pool, breathing via a Venturi circuit (photograph used with permission).

DISCUSSION

Following the initial session, staff requirements were adjusted to meet the session needs – a physiotherapist, hydrotherapy assistant and CCU RN in the pool, one CCU RN at the poolside and a CCU registrar present for the 30 minute pool session. It is difficult to specify the total cost of the hydrotherapy regimen which occurred two to three times per week for 7 months.

June's GBS, in retrospect, was very severe and she did not make a full recovery. With the anecdotal increase in muscle size and strength, where there had been little improvement in the months prior to hydrotherapy commencing, conclusions could be drawn

that hydrotherapy assisted with strengthening of respiratory muscles leading to successful weaning of mechanical ventilation. With a category 3 ICU cost per patient day of $1,988[12] at the time, earlier weaning from ventilation thus reducing CCU length of stay even by only 1-2 weeks could be seen as cost effective compared to long-term ventilator dependence.

The use of hydrotherapy is limited with ventilated intensive care patients because of factors such as availability of suitably trained staff, a hydrotherapy pool and sufficient time during shifts to prepare and attend the sessions. The anecdotal evidence of improved muscle mass, muscle strength, range of movement, the potential cost benefits of shortening length of intensive care stay, plus the psychological benefits suggest that hydrotherapy as part of the treatment regimen for particular ventilated patients is worth further research.

CONCLUSION

Previously published references to hydrotherapy for ventilated GBS patients have not been found, although this therapy is not uncommon for the unventilated GBS patient. It was found that, with appropriate preparation and staff numbers, hydrotherapy could be safely included as part of a patient's exercise regimen. For this patient, hydrotherapy was effective in increasing muscle strength through active exercises, improving range of movement in a weight supporting environment and improving her morale. Ventilation via tracheostomy need not delay access to the rehabilitation benefits of hydrotherapy in severe GBS.

ACKNOWLEDGEMENTS

I wish to thank all the Flinders Medical Centre CCU nursing, medical staff and allied health staff and the physiotherapy department staff involved in coordinating the hydrotherapy sessions. I also wish to thank the following people for their constructive comments Dr Andrew Holt (Intensive Care Consultant), Stephanie Cooper (Physiotherapist), Professor Sandra Dunn, Michelle Stuart (Clinical Nurse), Sally Dew (RN) and Tracy Smith (RN).

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