

Andrea Mechery, Eliana Palumbo, Rahul Krishnan  
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## Table of Contents

<b>Client Background</b>	<b>3</b>
<b>Possible Risks</b>	<b>4</b>
Neck Injuries	4
Bedsore	5
<b>Competitor Analysis</b>	<b>6</b>
Symmetric Designs Savant Total Control Head Support	6
Whitmyer Heads Up	7
Whitmyer Plush Axys Single Pad Headrest System	8
<b>Bibliography</b>	<b>10</b>

## **Client Background**

This team was presented with the case of a young girl suffering from spastic convulsions. The client is unable to move her body and cannot speak, but, from observations made of her interactions with staff, she seems to be conscious of her surroundings and is alert. However, in times of high anxiety and stress, she will suddenly convulse, causing her body to stiffen and tense. Due to the amount of pressure exerted, she has broken several of her wheelchair accessories such as multiple headrests and a footrest. Furthermore, these convulsions also decrease her, already low, range of motion and her head can be forced around the side and bottom of the head rest. When free from the support of the device, the client's head has been found to be stuck in between the wheelchair backing and the headrest. If not found, she can lie in that position for hours, which is extremely uncomfortable and potentially dangerous.

The client's parents and staff have bought a few headrests, but all of the headrests have failed to perform the expected functions due to the amount of damage caused by the client's convulsions. From observing her current headrest (insert the make of the headrest), the device appears to be breaking at the joint, specifically where the back of the headrest is connected to the wheelchair. The screws on the right side joint are ripped from the backing of the metal rim, implying that more support is needed on the left side of the headrest. Because of this, the headrest now rotates to the left when pressure is applied, therefore allowing her head to fall out and her body to slump over the left side of the wheelchair.

Currently, the client's parents and staff at Seven Hills are using a blanket to fill the void between the headrest and the wheelchair. While it is temporarily effective, a more permanent solution is needed. This current method has 1 major flaw, though. This blanket only functions as

a filler in between the client's headrest and her wheelchair, however it does not provide her head with any protection from falling out of the headrest altogether.

## **Possible Risks**

### *Neck Injuries*

The client's spastic convulsions allow her neck to lie in hyperextended positions for long periods of time. Combined with her neck's position under the headrest, these positions can be dangerous and possibly lethal. This is because of the pressure that is placed on the client's neck, especially along the cervical spine.

The cervical spine is the first of 4 segments of the human spine and connects the cranium to the thoracic cavity. This section of the spine contains 8 vertebrae, with C1 and C2 being the most important. C1, called the atlas, is the most superior vertebrae of the spine and connects the skull to the rest of the spinal cord. This vertebra is responsible for 50% of the head's forward and backward range of motion that occurs on its joint. C2, called the axis, is the located under C1 and the uppermost cervical vertebra rotates about the odontoid process of C2. The joint between the axis and atlas is a pivot type of joint. When extreme pressure is caused upon either of the vertebra, the bone can fracture and potentially hit the spinal cord, which runs through the center of the ring-like bones. Damage to the spinal cord can cause injuries such as paralysis and loss of motor skills, but with C1 and C2, there is a higher potential for sudden death. Although these types of injuries are only found in 2% of all spinal cord injuries (Spinalcord 2018), they are still a present concern for this client.

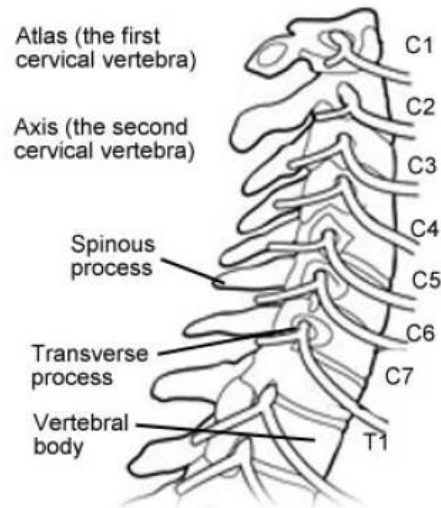


Figure 1. Diagram of Cervical Spine

## *Bedsore*

If pressure is reduced on one body part, pressure will increase elsewhere on the body. The goal any support is to obtain the best pressure redistribution possible, but, all the pressure may never be taken away. Pressure ulcers begin to develop when the capillaries supplying the skin and tissues are compressed enough to impede perfusion; this may ultimately lead to tissue necrosis. The normal blood pressure within capillaries ranges from 20 to 40 mmHg, where 32 mmHg is considered to be the average. Keeping external pressures at less than 32 mmHg should be sufficient for preventing the development of pressure ulcers. Capillary blood pressure may be less than 32 mmHg in ill patient, so, even lower applied pressures may be enough to induce ulceration. However, patients who are bedridden may experience ulceration at pressures lower than 32mmHg because. Pressure ulcers can develop in as little as 2 to 6 hours. (Hughes, 2008)

The Braden Scale is designed for adults and consists of 6 subscales: sensory perception, moisture, activity, mobility, nutrition, and friction and shear. It is based on the linking of the

clinical situations to the intensity and duration of pressure. The scores on the Braden Scale range from a 6 (high risk) to 23 (low risk); 18 is the cutoff score for the onset of pressure ulcer risk. (Hughes, 2008)

## **Competitor Analysis**

### *Symmetric Designs Savant Total Control Head Support*

The Savant headrest claims to provide support at three levels of the head to control lateral flexion and rotation. It is said to be lightweight and easily shaped by hand. The support is constructed with a steel core that allows selective shaping without tools and has pads that are filled with soft gel for comfort. The high lateral pads give effective lateral flexion control, while the mid-lateral pads are shaped for comfort behind the ears, and the suboccipital pads provide extra support below the mandible. The headrest is made of soft and durable nylon/Lycra knit fabric. The instrument is easy to put on and easy remove, while also being easy to clean because it can be washed with soap and water, then let to dry. This design retails for \$440, which is one of the most expensive designs for this product on the market.

The team's new devices will improve upon the of the cost, appearance, and structure of the design. The Savant headrest retails for \$440, which is around \$300 more expensive than any of the designs will be. The appearance will also differ, with the new device not having the multiple branches that are featured on the Savant headrest. The structure of this device is poor because since the wings are able to be repositioned by hand, when a force pushes on them like a person's head, they have no support and move. The new designs will not curve when forces are applied to them, they will resist the pressure while still being soft to the touch.



Figure 2. Front view of the Savant Total Head Support.

### *Whitmyer Heads Up*

The Whitmyer Heads Up support provides anterior, posterior, and lateral support of the head and neck. It features swing-out, adjustable arms that easily accommodate client transfers and varying client presentations. Anterior stabilization arms provide stabilization of the shoulders for optimal head control. The lower lateral adjustments of the arms accommodate varying body shapes. Sub-occipital and proximal lateral cervical support is provided with an independently adjustable occipital pad. The device comes with a reversible cover that has a Lycra side which is durable and is a water-resistant material with 4-way stretch. The other side is made of Dartex reverse which is hypoallergenic and waterproof with 2-way stretch. This device retails for \$355 and is on the more expensive side.

The team's new devices will improve primarily upon the cost and structure of the design. The Whitmyer Heads Up headrest sells for \$355, which is over than \$300 more expensive than any of the team's designs. Furthermore, the team's new design will differ greatly in its structure.

The headrest does not provide enough support on the sides, so it would not be suitable for the client because the headrest cannot keep the client's head in place. The new designs will have support on the sides of the headrest that will ensure the client's head does not fall.



Figure 3. Side view of the Whitmyer Heads Up headrest.

### *Whitmyer Plush Axys Single Pad Headrest System*

The Speciality Plush single pad is a wheelchair headrest that gives posterior and lateral support to the head and neck. These include the Adjust-a-Plush which gives lateral support, the dual mount plush for extra durability, and 12" narrow pads for low profile support. The Adjust-a-Plush support system is designed for those who exhibit poor head control and require lateral support on at least one side to maintain an upright head posture. It controls lateral cervical flexion and features two tapered locking joints to provide maximum lateral support. The 14" and 19" dual mount plush head support features two mounting points for durability and was designed for clients experiencing high tone or high extension. This wheelchair support claims to withstand



great amounts of force over time. The headrests have two cover options, Lycra and Dartex reversed, similar to the Whitmyer Heads Up device. The axys mounting hardware claims to be durable, compact, and a one-size option with basic anterior-posterior adjustability. The single pad headrest system retails for \$205.

The team's new devices will improve upon this design by providing more support around the head. A better joint will be designed so it will attach to the wheelchair with stronger supports. With the Whitmyer design, the client has the potential to slip under the headrest, so the new design will fill the gap between the headrest and the wheelchair.



Figure 4. Front view of the Whitmyer Plush Single Pad System.

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