Pronation Therapy

ME 450 Winter 2006
Final Report

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April -18-2006

EXECUTIVE SUMMARY

Acute respiratory distress syndrome is a severe lung dysfunction that requires treatment involving a technique known as pronation therapy. Medical studies and practice have shown this therapy to be beneficial in patient recovery. Unfortunately, the procedure introduces risks for both the patient and nursing staff. Various devices currently available in the market are largely cumbersome, expensive, and inadequate. As a result, the University of Michigan Hospital uses a manual proning process. This requires demanding tasks from a well trained nursing staff. Also, in smaller hospitals, many patients are denied pronation due to the lack of financial resources and staffing experience. The objective of this project is to design and prototype a device that will facilitate the proning process. This can be achieved by making the process safer for the patient, or by making the process easier for the nursing staff without compromising patient safety. Our work on this project is complete, but further design modifications and testing are necessary to market the product. This report details information on: background research, problem definition, benchmark methods, customer requirements, generated concepts, the concept selection process, engineering specifications, prototype descriptions, engineering analysis, a final design description, a manufacturing plan, testing results, and future recommendations.

We initially identified current devices/procedures used for pronation therapy. The manual method used at the University of Michigan Hospital is the safest procedure available. We visited the Surgical Intensive Care Unit at the University of Michigan Hospital to fully understand the customer needs and derive customer requirements. We weighted these requirements and developed engineering specifications; these specifications were in turn used to develop potential solutions. Upon review, we selected the Air Mattress as the best concept.

The Air Mattress inflates and deflates to rotate the patient from prone to supine position. The design of the air mattress includes a set of three triangular prism air chambers on each side of the hospital mattress which act as wedges to inflate and lift the patient. The mattress is adaptable to any standard hospital bed, reusable, and easy to install. A control box is used to manually inflate and deflate each chamber. The air lines will tap directly into the hospital's vacuum and air supply system.

We have calculated the maximum inflation pressure before rupture, minimum inflation pressure to lift patient, and inflation time through engineering analysis. Our design supports the patient's weight and thereby requires fewer staff members than with other techniques; hence, the staff can focus their attention on securing vital tubes and lines. The major distinction between the final design and the prototype design is an electronic interface control box instead of a manual one. The prototype manufacturing process involved using either a heat tool or an adhesive to form air tight seals. Prototype testing results have validated our design concept.

In conclusion, the mattress is an easily applicable and cost effective pronation tool that provides increased patient safety, inflation control, patient skin protection, patient chest accessibility, and reduces the demands on the nursing staff. The product is not yet ready for the market and further design and clinical trials must be completed. A prototype was delivered successfully on April 13th, 2006 at the University of Michigan Design Expo.