Pronation Therapy

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Final Report

Hamed Bazaz, Tom Eason, Nabeel Habib, and Shaobai Wang

Instructor: Professor Brent Gillespie, Ph.D.
Sponsor: Dr. Mary-Anne Purtill, M.D.

Department of Mechanical Engineering
University of Michigan
Ann Arbor, MI 48109-2125

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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.