Rice students work on weighty problem for doctors (w/ Video)

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A team of Rice University engineering seniors created a device to lift the weight from the abdomens of obese patients undergoing surgery. The R-Aides device uses suction cups hooked to vacuum to help patients under light sedation breathe. Credit: Jeff Fitlow/Rice University

The best doctors strive to relieve their patients' burdens. A physician in Houston asked Rice University students to help him do so in the most literal way.

A team of bioengineering seniors built a prototype device to literally lift the weight from obese patients who, while undergoing surgical procedures, might otherwise have trouble breathing.

The respiratory assist device built by Team R-Aides uses suction cups attached to a horizontal beam and tied in to a vacuum pump to gently lift

the abdomens of patients who are on their backs and under light sedation. Though the suspension device would not be suitable for patients under heavy sedation or who are undergoing abdominal surgery, it could be invaluable to surgeons performing operations that involved the upper or lower body.

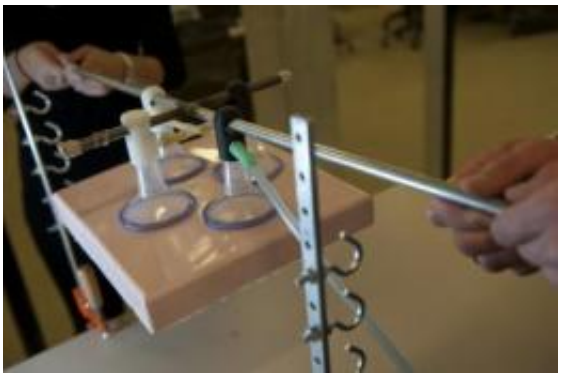
The students – Gabriel Ochoa, Marisa Prevost, Norman Truong, Daeun Yoon and Justin Yun – accepted the challenge last fall as their senior design capstone project, required of most graduates of Rice's George R. Brown School of Engineering.

Mehdi Razavi, director of electrophysiology clinical research at the Texas Heart Institute (THI), brought his idea to Rice last year. He had had success in the past working with students at the Oshman Engineering Design Kitchen (OEDK). "One of the highlights of working in the medical center is working with Rice and Maria (Oden) on senior design projects," said Razavi, co-adviser on the project with Oden, OEDK director and a professor in the practice of engineering education.

He found his inspiration on the job.

"Almost all of these ideas come during a procedure, when you have the 'What if?' moment," Razavi said. "I was in the midst of a surgical procedure on a very obese patient when he started snoring, which implies the airway may be a little bit occluded. We could see that his oxygen levels were going down, and he was trying to push against his abdominal contents to breathe.

"I thought if there was a way to support his belly, he would probably do much better and there would be less chance of having to declare an emergency and put a breathing tube in," he said.



The R-Aides device created by students at Rice University in collaboration with a Texas Heart Institute doctor is able to lift 40 pounds. Here, the suction cups grip a 12-pound piece of silicone the students used to simulate flesh. Credit: Jeff Fitlow/Rice University

Razavi envisioned a device that could not only help patients breathe by gently relieving pressure on the abdomen, but would also save hospitals money. "Hospitals aren't reimbursed by the insurance companies for medical complications," he said. "This could help avoid the cost of having to put a breathing tube in, which is not going to be reimbursed."

The doctor's pitch to the Rice students "sounded a little weird," Truong said. But a search of the literature by Razavi and the team turned up no evidence that such a device already existed.

"I would have heard about it," Razavi said.

"We asked around to see if doctors were interested," Prevost said. "It seems like it's an issue they just deal with. They get assistants to hold up the weight or pick it up themselves, but when we asked them if they'd be interested in a device, they said, 'Yeah, that would be good.'"

Razavi, a cardiologist, installs pacemakers through the chest and accesses

arteries to the heart through the groin. He said he would use a respiratory assist device "for everything I do. A lot of the time, the abdominal content pushes down and distorts the whole anatomy of the groin, so I could use this to hold it back. But I can see it being used in any number of ways, not only in hospitals and cardiac catheterization labs but also in outpatient clinics."

Once they decided noninvasive suction was the proper approach, the students needed suction cups that would gently caress the skin without bruising it while maintaining the vacuum. "The cups we used come from breast pumps," Yoon explained. "They have flexible rubber rims that conform to the contours of the skin, so they keep a good seal."

The cups, which would link to an operating room's vacuum system, are suspended from a horizontal beam that bears the weight. The students and Razavi served as test subjects for the prototype by lying on their backs with a weighted slab of silicone, which mimics human tissue, on their chests.

"It was a simple, nothing-can-go-wrong test," Ochoa said. "We had the subjects lie down on a table, and we put 40 pounds of weight on their stomachs to see how their vitals changed. We expected their CO2 levels to drop – we had a pulse oximeter on them – but we didn't find a statistically significant change. But we did find their heart rates increasing quite a bit to compensate."

"I got the full 40-pound treatment," said Razavi, who also had the cups attached to his real skin. "The suction was a concern; they left it on for, I think, a good hour." The doctor said he took "a good dose" of aspirin the day before to mimic the condition of patients likely to be on blood thinners and whose skin would be extra sensitive as a result. "At the end, my skin was a little red, but there was no bruising," he said, either after the test or the next morning.

A provisional patent has been filed for R-Aides' invention, which may be developed by Saranas, a medical device company founded by Razavi and recent Rice alumnus Alex Arevalos. The students said their prototype cost less than $200 to make. The most expensive components were the custom-printed plastic connectors fabricated on the OEDK's 3-D printer. Injection molding those parts would cut the cost even further, they said.

"The device will be very cheap, and the amount of training required to use it will be nominal," Razavi said. "And the approval process, the regulatory pathway, is likely to be quite straightforward. I've run this by a regulatory specialist, and we believe strongly that it's going to be an FDA Class 1, which is basically more paperwork than anything else."

Razavi is encouraging the team to show the device at the American Heart Association Scientific Sessions in Los Angeles in November. "If we get a spotlight there, it will spur a lot of studies," Yoon said.

In the meantime, the seniors will graduate this week with honors in hand from the third annual Rice Undergraduate Venture Challenge, in which they took the prize for best pitch May 3.

Provided by Rice University