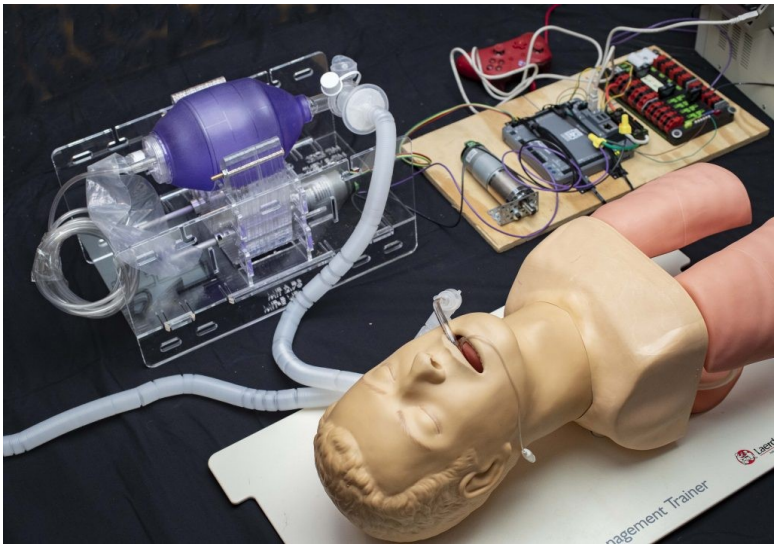
MIT Emergency Ventilator (E-Vent) Project



Early prototype MIT E-Vent being tested. Image courtesy JC.
Note: We have moved to a solid, metal framed version, posting soon.

Background & Need

We are one of several teams who recognized the challenges faced by **Italian physicians**, and are working to find a solution to the anticipated global lack of ventilators. In the US alone, the COVID-19 **pandemic** may cause ventilator shortages on the order of 300,000-700,000 units (**CDC Pandemic Response Plans**). These could present on a national scale **within weeks**, and are **already being felt** in certain areas. An increase in conventional ventilator production is very likely to **fall short** and with significant associated **cost** (paywall warning).

Almost every bed in a hospital has a manual resuscitator (Ambu-Bag) nearby, available in the event of a rapid response or code where healthcare workers maintain oxygenation by squeezing the bag. Automating this appears to be the simplest strategy that satisfies the need for low-cost mechanical ventilation, with the ability to be rapidly manufactured in large quantities. However, doing this safely is not trivial.

Use of a bag-valve mask (BVM) in emergency situations is not a new **concept**. A portable ventilator utilizing an ambu-bag was introduced in 2010 by a student team in the MIT class 2.75 **Medical Device Design** (original paper **here** and news story **here**), but did not move past the prototype stage. Around the same time, a team from Stanford developed a lower-cost ventilator for emergency stockpiles and the developing world. It looks similar to a modern ICU ventilator (**Onebreath**), but "production for US hospitals would start [in] about 11 months", making it "a second wave solution" (**MIT Tech Review Article**). Last year, the **AMBU® Bag** concept was re-visited by two student teams, one from Rice university (**here** & **here**), and another Boston-based team who won MIT Sloan's Healthcare prize (**MIT News: Umbilizer**). Other teams currently working on this challenge can be found linked on our "Additional Resources" page.

Key Research Question

We have launched an emergency research project with a team of MIT Engineers and American clinicians to address the question:

Is it possible to safely ventilate a COVID-19 patient by automatically actuating a manual resuscitator?

Our process in approaching this question is to first identify the minimum requirements for a low-cost ventilator, based on the collective wisdom of many clinicians, design against these requirements, conduct immediate testing, report the results, iterate and facilitate discussion.

Manual ventilation with an Ambu-bag is a short-term solution in a critical care environment, without any apparent clinical evidence regarding the safety of long-term use (days-weeks). There are multiple scenarios in which respiratory support could be needed: patients can be awake or asleep, sedated or sedated and paralyzed, breathing spontaneously, weaning off of a vent, etc. Furthermore, changing clinical presentations with ARDS require shifting minute ventilation (tidal volume x respiratory rate) to "lung-protective" strategies, which place patient's at risk for things like auto-PEEP. Some of these situations are simpler than others, with the simplest being ventilating a sedated, paralyzed patient, and at a minimum a safe emergency ventilator could be used in such a situation to free-up a conventional ventilator.

Any solution should be utilized only in a healthcare setting with direct monitoring by a clinical professional. While it cannot replace an FDA-approved ICU ventilator, in terms of functionality, flexibility, and clinical efficacy, the MIT E-Vent is anticipated to have utility in helping free up existing supply or in life-or-death situations when there is no other option.