Medical Vacuum (Suction)

Jason Fader and Richard Davis

Introduction:

Medical Vacuum, more commonly called "Suction," is an integral part to any hospital, used in the operating room, recovery room, endoscopy suite, and on the ward. Sometimes it is used for negative pressure wound therapy as well. Centralized suction is usually built into hospitals in high-resource settings, including piping within the walls and outlets in patient care areas. We discuss the components of centralized suction at the end of this chapter.

In a low-resource setting, mobile units such as the Schuco S230A pictured below are very valuable. One drawback to a machine like this is that they are very loud: if it is in regular use in one place, build a wooden box to contain it.

An electrical suction with cannister and tubing. This machine is very loud and will disrupt patients' sleep or clinicians' conversation if placed in a ward. Note also that the provided suction cannister is made of plastic and intended for single use. If washed and reused, it will inevitably develop cracks, making suction less effective.

For Low-Continuous suction, it is better to get a fish tank aerator pump and reverse the motor so that it sucks instead of blows. This conversion is described at the end of this chapter.

If you are installing individual suction machines in every patient care area (operating room, casualty bay, recovery room, intensive care unit,) here are some helpful modifications to make:

- Enclose the suction machine in a box fixed to the wall to keep the noise down. You can connect the plug to a switch so that the units are easy to turn on and off.
- Include 2 canisters in series so that fluid does not arrive at the motor.
- Plastic canisters can be made to last a little longer without cracking if you don't remove the entire lid, but instead empty it and clean it through one of the small ports. Note that this technique will not be effective if the material in the cannister contains hardened clots or debris.
- Suction machines should be portable so that they get to the patient, but not too portable so that they easily go to other services. Build a cart or strap them to a stool.
- Once fluid gets into the motor, it will need to be taken apart and the bearing changed. The bearing type and name can be found stamped on the seal of the motor.
- If dedicated plastic suction tubing is difficult to source in-country, silicone tubing works well and can be steam sterilized.
- Use glass or polycarbonate bottles rather than plastic ones. The latter are intended for single use; if reused they will eventually develop cracks which will decrease the effectiveness of the suction.

Glass (left) or polycarbonate plastic (right) suction bottle with rubber seals in the lids. These will last longer than plastic ones. The rubber seals can often be purchased separately when these wear out and compromise the suction.

This plastic suction canister was originally intended for single use in a high-resource setting. As it has been reused multiple times, "patchwork" is needed to repair it and maintain suction. Such canisters are probably more trouble than they are worth in a low-resource setting. If it is possible to empty and wash the cannister through one of the smaller holes on the lid, rather than removing the lid itself, this can prolong the lifetime of the cannister.

The suction apparatus in an operating room, housed inside a wooden box for noise reduction (the front cover has been removed. The suction bottle can be seen below the box. A wall switch (Black arrow) allows the machine to be turned on and off without opening the box.

Guide: Converting a Fish Tank Aerator for Use as a Suction Device

Name brand negative pressure wound therapy machines (KCI Wound Vac®) can be expensive and often have proprietary, single use parts which can be also expensive and hard to acquire in resource-limited settings. And yet, negative suction wound care is excellent for many types of wounds. It also decreases the demand for nursing care. Maintaining suction on chest tubes, when indicated, also requires continuous low-pressure suction.

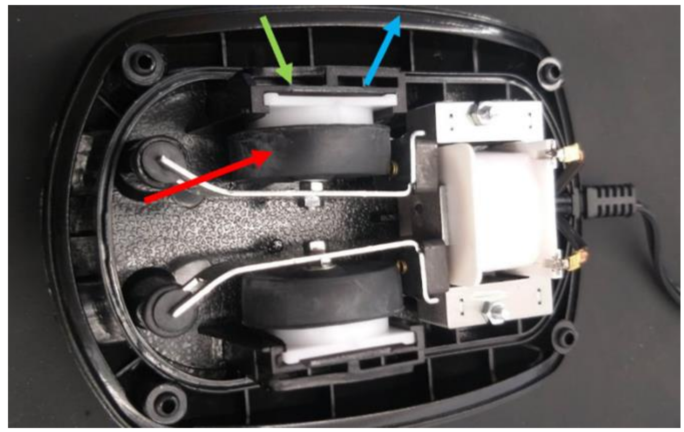
It is possible to use a portable suction machine for this purpose, such as the machine described above. But these are often not designed to be in operation for days at a time. Furthermore, they are noisy. Fish tank aerators, on the other hand, are made to function constantly and quietly, and they are relatively inexpensive. The only issue is that as manufactured, they push air, instead of pulling air. It is possible to modify many types of fish tank aerators such they pull air and allow for a very effective, yet inexpensive negative pressure wound therapy device.

The air pump in the photos below was sourced in the USA through Amazon.com. There are different sizes available. This one is for a 40-60 gallon (150-225L) fish tank size and it works well for negative pressure wound therapy. The one pictured here is 110v and so you will need a very small transformer to run it (it only uses 4 watts of power). Ideally, source the pump in your country, or in a country that uses the same voltage that yours does.

One example of a commercially available, small fish tank aerator. This one is made for a 60 gallon (225L) aquarium, which in our experience generates the proper amount of suction when modified as shown below.

Even if your hospital does not have constant power, this uses such a small amount of wattage that you could use an inverter and car battery to keep it running for many hours at a time.

There are many different brands of fish tank aerators, but most are the same on the inside. The process shown here can easily be adapted to any aerator that uses a similar mechanism: the main idea is to find the pump itself, which usually connected to a rubber bellows that is driven by an electric motor. Disconnect the bellows from the pump, remove the pump, reverse its orientation, and reattach it to the bellows.



Once this aerator has been opened, the bellows (Red arrow) is clearly seen attached to the pump itself (White plastic piece.) When the bellows is activated, air enters the pump as shown by the Green arrow and exits as shown by the Blue arrow.

The first step of the conversion is to detach the bellows from the pump. If possible, this should be done without disconnecting it from the motor, as shown here.

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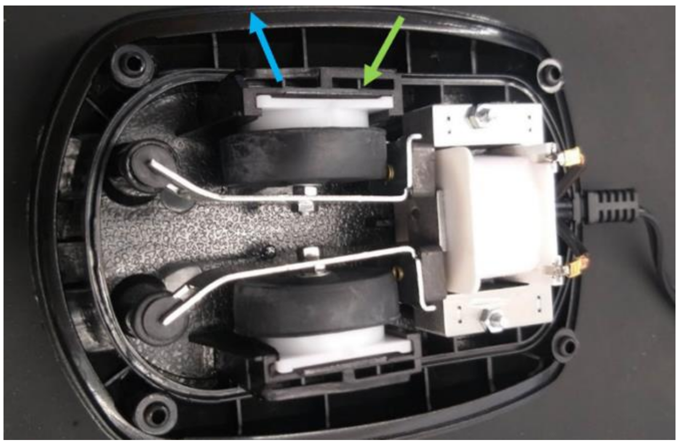
The pump is then removed from its slot and reversed, so that its entry and exit are now facing the opposite directions from before.



Once the pump is reinserted, it is reconnected to the bellows. Now the motor drives the air in the opposite direction, as shown by the Green and Blue arrows. This process is repeated on the other pump and bellows, if two are present as in this device.

After the cover is replaced, the air will flow through the pump in the opposite direction: it now "sucks" instead of "blowing" air as it did before.

Here, the modified pump draws 100mmHg of pressure; the ideal is within 50-125mmHg.

When connecting the device to a patient, be sure that the canister stays upright and prevents any wound exudate from getting into the aerator, otherwise, it will need to repaired. When this happens, it is not difficult to dismantle and clean the device: disconnect and remove the pump bellows in a similar way to that shown above, wash and dry them, out, and reassemble.

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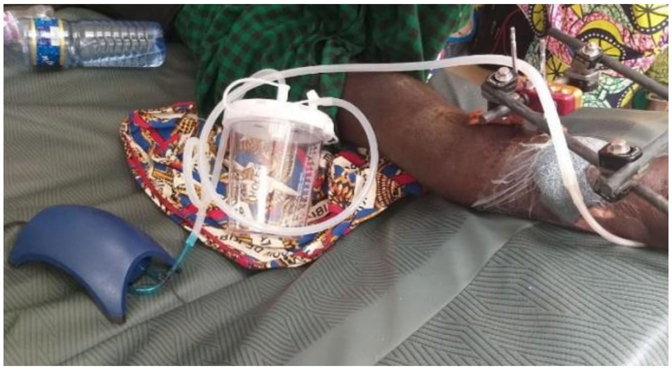

The entire negative pressure assembly, including the modified pump on the left. It is important to make sure the cannister remains upright to prevent liquid from entering the pump; this can be difficult in a crowded ward.

Guide: Components of Centralized Medical Vacuum

Most high-resource hospitals have a vacuum connection at the wall in patient-care areas. A regulator connected here allows the user to adjust the level of suction and connect devices. Each wall connection is supported by tubing, which runs through the walls or ceiling, to the central vacuum apparatus.

The central vacuum apparatus consists of pumps (usually several), buffer tank, and controls. The buffer tank usually has a volume of 100 -1000L, an inlet filter, and a draining valve.

Components of a centralized medical vacuum system for hospital use: 1.Vacuum Pumps 2.Digital Electrical Control Panel 3.Bacterial Filter 4.Vacuum Reservoir 5.Non-Return Valves and Connection Pipe Source: DOI: 10.35629/5252-45122323

Centralized vacuum system in a hospital in a resource-limited setting, with a control panel in the foreground and a back-up system in the background (Red circle.)

The buffer tank of the same system as above, with a pressure gauge that can easily be checked to confirm that the system is working properly.

The pitfalls of central vacuum include the need for the pumps to be run continuously and the potential for leakage from the tubing and connecting systems. Leakage can occur at the connecting systems themselves, especially if the machinery is old. It can also occur from the pipes, which is very difficult to address if the pipes are inside a concrete or stone wall.

The wall connection is usually proprietary to the system being used: once you decide on this system, you will need to use compatible regulators to connect to the suction. When building a new hospital out of donated materials, it may be tempting to use donated regulators. Be sure that you will be able to purchase more devices in-country if you need them. “Future-proof” your hospital by using equipment that can be sourced locally.

A wall connection for medical vacuum, unconnected (left) and connected to a regulator (right). Other brands or types of regulators cannot be used with this system.

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