

Home-made Non-Invasive CPAP Ventilator Concept Design

Emphasis on easily available parts

Back to the basics, first principles design

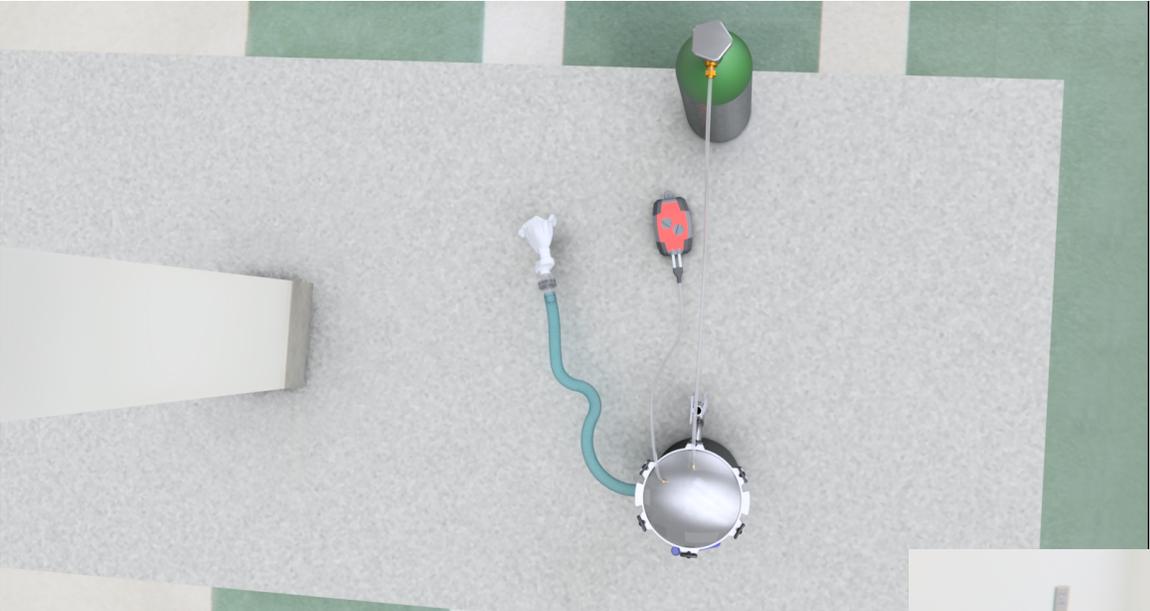
Device is **NOT** FDA approved and must **NOT** be used without further study/development/jurisdiction specific approval process.



Exploded view showing how the parts come together



Potential crowd-sourced creation by people with basic hands-on engineering degrees



Low footprint

Must follow jurisdiction specific appropriate sterilization protocols

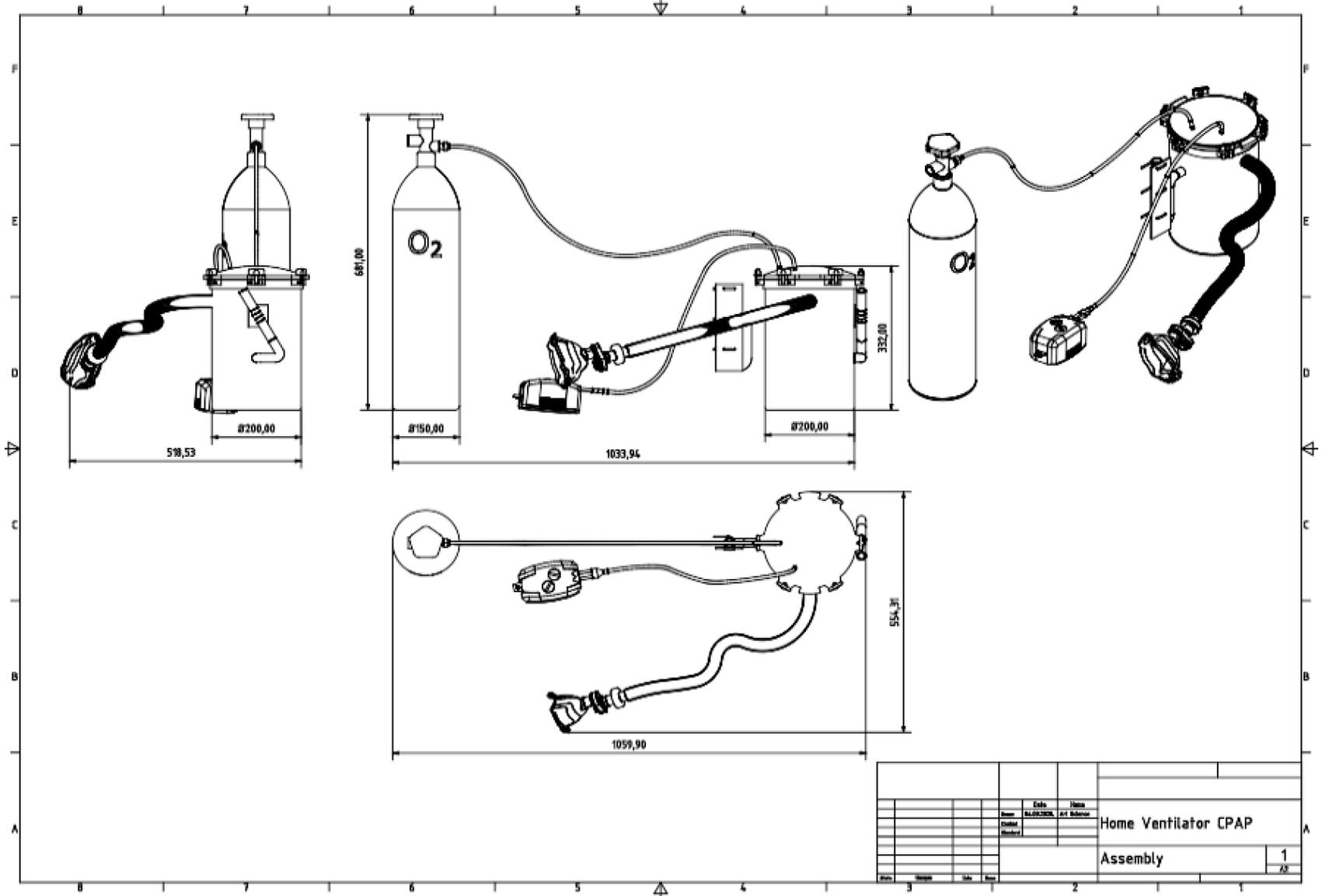




Design available free of charge

Cross-sectional view





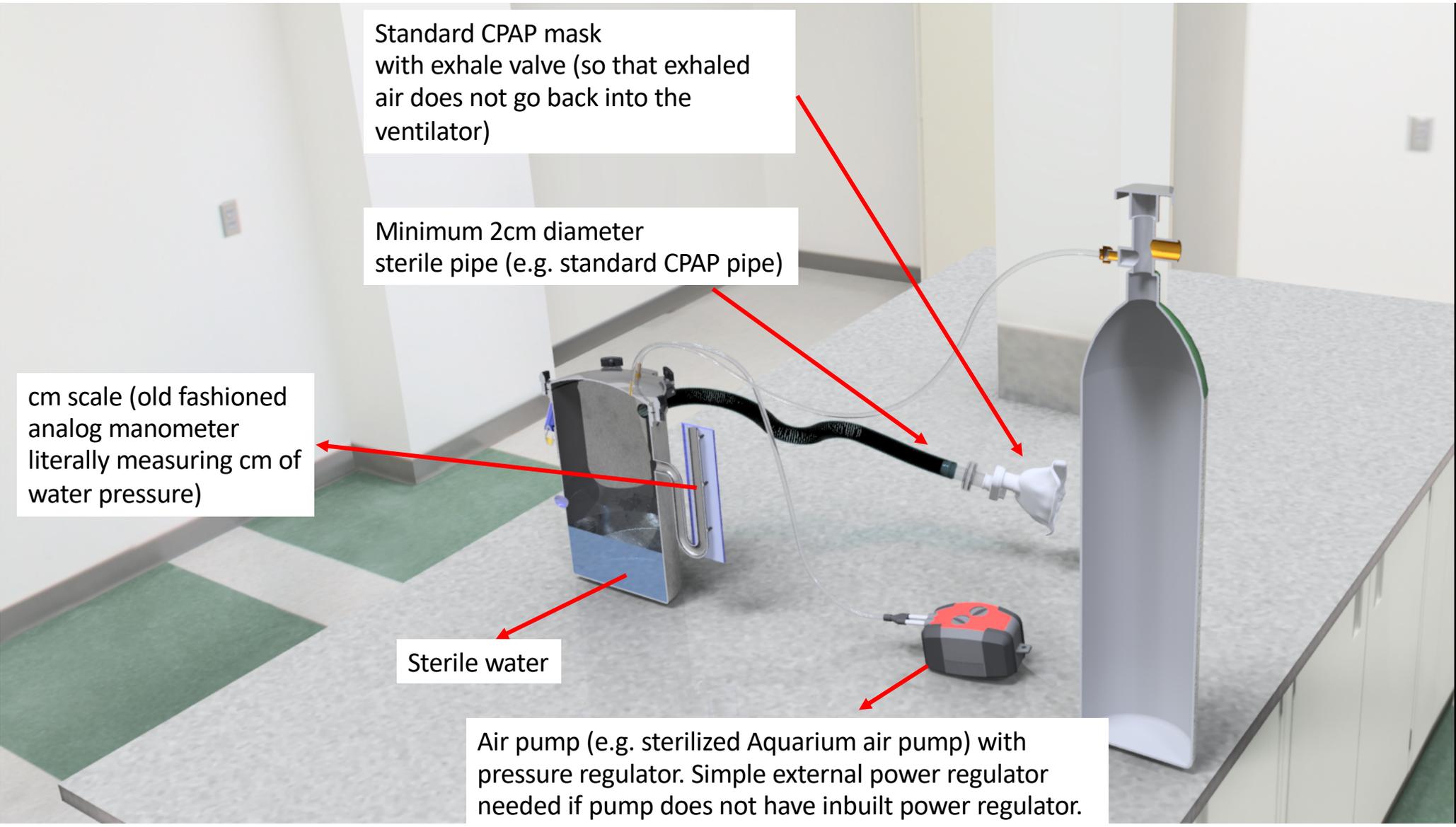
Standard CPAP mask with exhale valve (so that exhaled air does not go back into the ventilator)

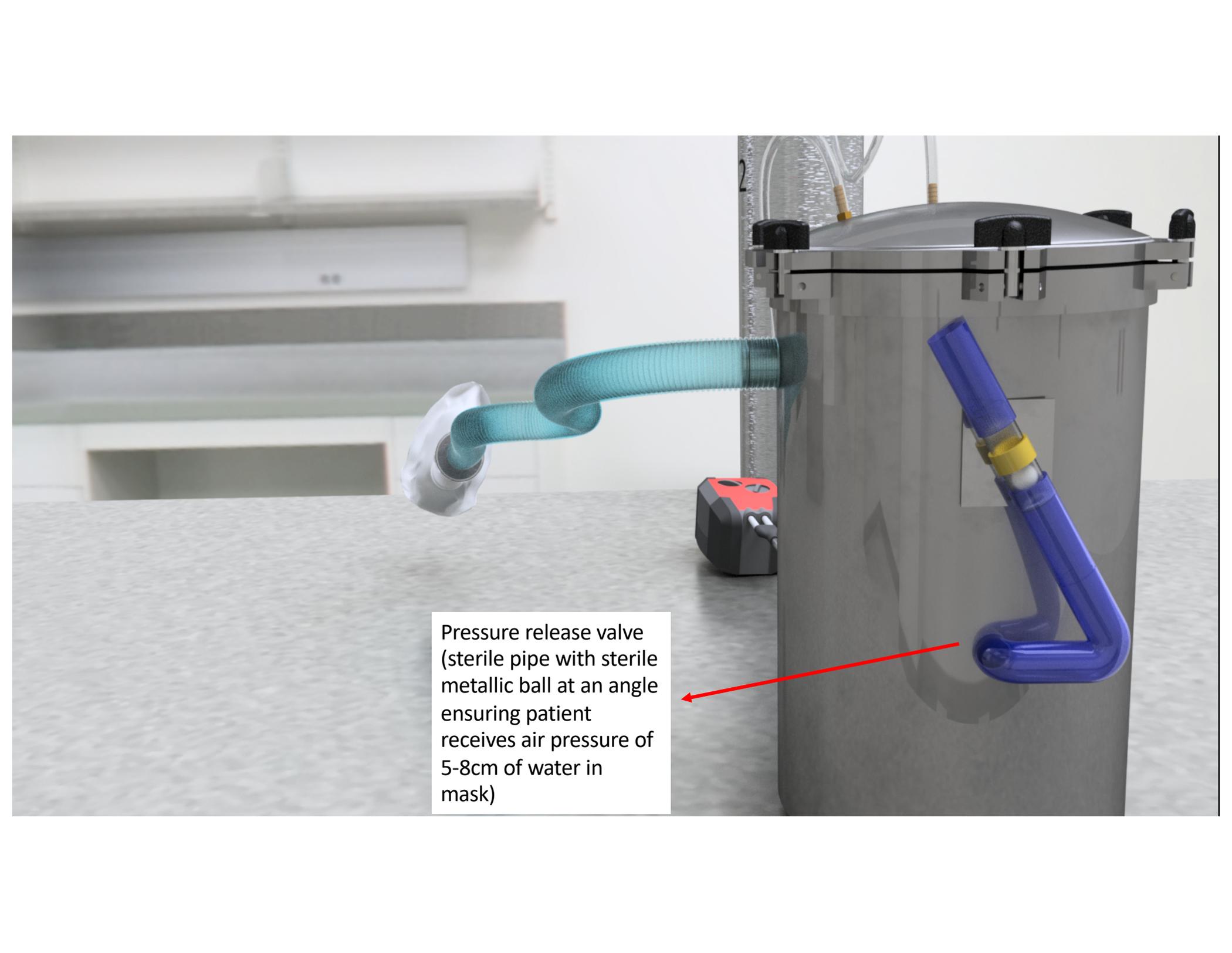
Minimum 2cm diameter sterile pipe (e.g. standard CPAP pipe)

cm scale (old fashioned analog manometer literally measuring cm of water pressure)

Sterile water

Air pump (e.g. sterilized Aquarium air pump) with pressure regulator. Simple external power regulator needed if pump does not have inbuilt power regulator.





Pressure release valve
(sterile pipe with sterile
metallic ball at an angle
ensuring patient
receives air pressure of
5-8cm of water in
mask)

Household part ideas for re-use into Homemade Non-Invasive CPAP

- Obviously any cannibalized parts must be sterilized appropriately and according to specific jurisdictions.
- Dentist's office, dishwashers generally might have multiple part options (tubing, pump, etc.).
- Metallic reservoir container preferred as it can potentially be boiled, autoclaved or put through sterilization processes approved in particular jurisdictions.

Potential Low-Cost Sterilization Approaches of the Homemade Non-invasive CPAP Ventilator Design

Factors for consideration:

- Level of disinfection depends on the object. Ventilators are classed as semi-critical instruments as they touch the mucous membrane, and require minimally high-level disinfection with strict adherence to guidelines to prevent nosocomial infections (1).
- Ventilator tubes and devices are important sources of hospital acquired infection (1). They are more susceptible to infection of pathogenic microorganisms due to the warm, airtight environment inside the tube combined with the cold air outside of the tube (2).
- Many of these devices are temperature sensitive and require low-temperature chemical methods rather than steam sterilization (1).
- Manual immersion cleaning of these devices allows bacterial growth and contamination to occur due to the natural air exposure and pro-longed drying time (2), therefore mechanical cleaning methods are preferred for preventing nosocomial infection.

6% Hydrogen Peroxide Gas Plasma for 30 minutes: An affordable method, and compatible with more than 95% of tested medical devices and materials (3).

- Liquid hydrogen peroxide is inserted into the sterilizer and heated up in a vaporizer (e.g. vaping instrument) in order to turn it into gas, which is heated at an even higher temperature to turn into plasma. Materials are simply placed into a perforated bag which goes at the bottom of a porous bucket in a gas sealed jar (3,4).
- This method is safe for the environment, leaving no toxic residues, only requires an electrical outlet, and is appropriate for instruments which are heat and moisture sensitive as the process temperature is less than 50°C (5). It also does not require airing time, preventing bacterial growth and contamination to occur as is often observed in manual sterilization and drying techniques(5).

Sodium Hypochlorite : Inexpensive and fast-acting, with a broad range of antimicrobial activity (3).

- Equipment which can be manually immersed to sufficient levels (CPAP reservoir, canister, CPAP pump), can be immersed into a 1:50 dilution of 5.25% -6.15% sodium hypochlorite for 3 minutes (3).
- Sodium hypochlorite serves for many purposes with its bactericidal, tuberculocidal, fungicidal, virucidal, and sporocidal activity (6).

Steam Sterilization: Inexpensive, widely used, and the most dependable method of sterilization (3). All metallic materials can be steam sterilized using autoclaves between subsequent uses.

- A gravity displacement sterilizer requires a minimum exposure of 30 minutes at 250°F, whereas a prevacuum sterilizer requires 4 minutes at 270°F (3).
- These are the two most basic autoclaves used. The benefit of the prevacuum sterilizer is that it is fitted with a vacuum pump which ensures air removal from the chamber before steam enters, whereas the gravity displacement sterilization is prolonged due to incomplete air elimination(4).
- The porous sieve container must follow respective jurisdiction's biological material disposal process(3).

Potential Sterilization Approach Sources

1. Rutala WA, Weber, DJ. Reprocessing semicritical items: outbreaks and current issues. *Am. J of Inf control.* 2019; 47, A79-A89.
2. Wang P. Mechanical Cleaning Ventilator Pneumonia Reduction. *Int J Clin Exp Med.* 2019;12(1):828-835.
3. Rutala WA, Weber DJ. The Healthcare Infection Control Practices Advisory Committee (HICPAC). Guideline for disinfection and sterilization in healthcare facilities, 2008.
4. Andersen BM, Hochlin K, Daling JP. Cleaning and decontamination of reusable medical equipment, including the use of hydrogen peroxide gas decontamination. *J Microbial Biochem Technol.* 2012;4:57-62.
5. Rutala WA, Weber DJ. Disinfection, sterilization, and antisepsis: An overview. *Am. J of Inf control.* 2019;57,A3-A9.
6. Rutala WA , Weber DJ .Disinfection and Sterilization in Health Care Facilities: An Overview and Current Issues. *Infec Dis Clin North Am.* 2016.30(3): 609–637.

Cross functional international collaboration

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Next Steps

- Prototype building across multiple jurisdictions to assess viability of design and materials availability
- Potential sterilization protocol testing
- Concept communication: academic paper (may be particularly relevant in low-cost areas of the world)

DISCLAIMER

- Device is **NOT** FDA approved
- Any actual use in any jurisdiction must follow jurisdiction specific approval processes and jurisdiction specific sterilization processes

An emergency social concept project



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