FLETCHER D-PRIZE COMPETITION

2024-25 Academic Year

Health Access Challenges

Provide maintenance for oxygen concentrators in rural and peri-urban Sub-Saharan African health clinics and hospitals

We challenge you to design a ***new*** *social enterprise that services existing oxygen concentrators at risk of breaking down. Oxygen concentrators are machines that provide medical grade oxygen to patients in a hospital setting - a key treatment for pneumonia, malaria, sepsis, meningitis, now Covid-19. There has been a rush to install concentrators throughout Sub-Saharan Africa, however, without proper maintenance, these will soon break down.*

The Poverty Problem

There are few medical therapies more basic than oxygen. Unfortunately, despite it being critical for numerous medical treatments, medical oxygen remains inaccessible to many.

For example, medical oxygen is a key treatment for severe pneumonia, which is now the biggest infectious killer of children.[1] This is a disease that claims over 800,000 young lives every year.[2] Improved oxygen delivery systems could reduce childhood pneumonia–related mortality by at least 35 percent in high burden, low-resource settings.[3] Focusing just on the 15 countries where the pneumonia burden is the highest, this translates into averting 148,000 deaths of children under 5 annually.[4] In addition, medical oxygen is also a key treatment for malaria, sepsis and meningitis, and now for Covid-19.

Unfortunately, broad estimates suggest at least half of the world's population does not have access to medical oxygen.[5] In the few places where in-depth studies have been carried out, availability is critically low. For instance, in Congo, only 2% of healthcare facilities have oxygen; in Tanzania it's 8%, and in Bangladesh 7%, according to limited surveys for USAID.

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1 http://justactions.org/wp-content/uploads/2018/11/The-Missing-PieceReport.pdf
2 http://justactions.org/wp-content/uploads/2018/11/The-Missing-PieceReport.pdf
3 https://path.azureedge.net/media/documents/DRG_Oxygen_Primer.pdf
4 https://onlinelibrary.wiley.com/doi/pdf/10.1002/ppul.24656
5 https://apnews.com/df97326ec00fb7cc4abf5b3821ace984

Even in hospitals that carry oxygen, costs may be prohibitive. A large oxygen cylinder can cost between $40-85. This is enough oxygen to treat one acute adult per day, or a child for 3-4 days. Hospitals often pass on the full cost to patients. Poor and disadvantaged people are often the most acute patients needing the most oxygen, due to wasting or late care-seeking.

The Proven Intervention

Fortunately, there is a proven intervention. Oxygen Concentrators are small, robust machines that produce medical oxygen. They are appropriate for low-resource hospitals and health clinics and are cheaper than using oxygen cylinders. Once installed, and with regular maintenance, these machines will keep producing oxygen for years.

Oxygen concentrators are essentially a ‘plug and play’ hardware that can easily be used in remote settings. They work using a method called ‘Pressure Swing Absorption’ (PSA) to filter and concentrate the air around us to a higher 95% medical-grade purity. That oxygen can then be provided to up to 4 paediatric patients at their bedside.[6]

Concentrators have the added benefit of reducing costs. A well-run oxygen concentrator system, with stable power and appropriate preventive maintenance and repairs, may reduce oxygen supply costs for hospitals by 51%.[7]

Because of these benefits, concentrators are already present throughout Sub-Saharan Africa, and as a response to Covid-19, the delivery of concentrators is growing significantly. The WHO has already procured 14,000 oxygen concentrators and plans to procure 170,000 more in the next 6 months, at a cost of $100 million. Other multilateral organisations are also procuring more for numerous countries.

However, without preventative and regular maintenance, these concentrators will break down. Global estimates suggest that 40% of equipment physically in possession of low-resource hospitals all over the world is not usable.[8] Additionally with over-stretched health care workers, maintenance schedules are erratic even at tertiary/referral level hospitals. This situation is only likely to become more difficult, given the recent rush to distribute concentrators.

Your Distribution Challenge

Fletcher D-Prize will award up to $20,000 to teams that can create a new organization that services existing oxygen concentrators that otherwise are at risk of breaking down.
You must have a vision to grow and serve at least 100 low resource hospitals or health clinics within five years. Our award is meant to enable the first step toward this vision by supporting a

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[6] https://findanexpert.unimelb.edu.au/news/5929-saving-lives-in-poor-countries-is-about-adapting-to-what's-already-working-there

[7] Implementation and 8-year follow-up of an uninterrupted oxygen supply system in a hospital in The Gambia. B. D. Bradley,* J. D. Light,† A. O. Ebonyi,‡ P. C. N’Jai,‡ R. C. Ideh,‡ B. E. Ebruke,‡ E. Nyassi,‡ D. Peel, S. R. C. Howie

[8] https://www.researchgate.net/publication/319193358_Methods_for_medical_device_and_equipment_procurement_and_prioritization_within_low-_and_middle-income_countries_Findings_of_a_systematic_literature_review

small test pilot that services 15-20 oxygen concentrators across 2 or 3 small to medium hospitals with pediatric in-patients (a proxy metric we use to gauge hospital size).

Following a successful Round 1 concept note submission, D-Prize can facilitate access to logistics and industry advisors to help with a full proposal.

Designing Your Social Enterprise

There are a number of challenges that we think a successful organization must eventually solve. Your pilot should plan to focus on building and testing just a few of these pieces.

- *How will you develop and manage your team of skilled maintenance technicians?* A successful team must solve a potential shortage of skilled labor. Qualified biomedical technicians usually go through a 2 year certification program, and are required to do major repairs and replacement of parts, at roughly six month intervals. Yet these technicians can be hard to find.[9] For comparison, in 2017 the United States reported 0.68 Biomedical Technicians per 10,000 people compared 0.16 in Ghana, 0.05 in Togo, and <0.05 in Uganda, Malawi, Kenya and Zambia. As a tip, some countries may have cohorts of newly graduated biomedical technicians that are underemployed.

  Your service team will likely also include a second tier of electrical or mechanical technicians, (who may be existing facility staff), who you may recruit and train for this job. Their tasks generally would include weekly cleaning, drying of filters, and electrical safety and alarm checks. One expert has suggested two of the most common but easily resolvable issues for concentrators are dust in filters and replacement of valves.[10]

  A winning proposal will outline a plan to recruit, train, manage, and motivate/incentivize a strong service team. A proposal should also include details on labor costs, as this could affect ability to scale. As a rough baseline, a biomedical technician may cost $400-500 USD monthly in salary (however, this could be lower in certain countries)[11].

- *How will you access spare parts and accessories?* Understanding <u>where</u> you can access spare parts is a critical first step. In some cases, spare parts and consumables will be available via existing distributors in the capital cities in larger or more developed countries. If unavailable, you may need to consider more innovative sourcing of non-brand specific consumables. And for major spare parts that are brand specific, it may be worth investigating the costs of procuring a new concentrator to disassemble for its parts.

  Understanding <u>what</u> parts are needed is also critical. Concentrators often require that major

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[9] https://www.researchgate.net/publication/282741943_Improving_African_healthcare_through_open_source_biomedical_engineering
This article talks about the lack of BME graduate and post graduate programs.

[10] Ebrima Nyassi, former Biomedical Engineering Department at the Medical Research Council (MRC) Unit in The Gambia, now CEO Ecomed Scientific, Every Breath Counts Coalition Call, 29 June 2020. (We approved we can quote him)

[11] http://www.salaryexplorer.com/salary-survey.php?loc=35&loctype=1&job=582&jobtype=3

parts be replaced using the same brand. To scale your program, you will need to consider how to maintain service for more than one brand.

Your client hospitals may try to leverage your supply chain for other needs. For instance, additional consumables to deliver oxygen to the patient, like nasal canulae and masks, are in demand. These are not necessarily in the purview of this challenge, but you may decide to address this if your facilities have supply gaps.

- *What are the logistics of servicing hospitals?* There are three factors that make service hospital clients complicated:

  (i) Service interruptions: an effective program requires an alternative medical oxygen source is available during maintenance down-time. This could be a back-up concentrator or an oxygen cylinder. In theory, all facilities using oxygen concentrators should keep a back-up cylinder in case of power outage, but this does not always happen, especially in remote locations.

  (ii) Power interruptions: voltage fluctuations, both spikes and low or 'brown' power periods, can cause major damage to the concentrator motor. One of the simplest ways to prevent this is by ensuring a stable power supply. As a start, permanently attaching a voltage regulator to the oxygen concentrators should be considered if a facility does not have uninterrupted power.

  (iii) Other scheduling and logistics: teams should consider: transportation needs for both routine maintenance and major repair teams; location of repairs (whether suitable covered space is available); and coordinating with point-of-contacts around patient loads.

- *Demand Generation & Pricing:* Generally, the cost of a concentrator purchased in large volumes is around $600 USD, but if procured locally with a 1-2 year service contract could increase the cost to approximately $2,000. There are several factors to consider when building relationships with your hospital clients on this agreement:

  (i) Resource competition: health facility staff are stretched, budgets are tight. A key aspect of a great proposal will be a clear understanding of how to motivate hospital administrators to allocate a budget and contract for maintenance and service of oxygen concentrators.

  Changing mindsets is a critical part of this. We are inspired by how commercial cold chains for vaccines are prioritized by hospitals. Vaccines must be kept cold, and fixing a breakdown is the highest priority. A successful team will be able to convince that oxygen concentrators get the same prioritization.

  (ii) Pricing: we discourage plans that promote a 'user pays' pricing system, which can further disadvantage the poorest patients. An alternative could be an oxygen surcharge levied on all facility inpatients. We are excited to see more locally-appropriate ideas.

- *What data will you collect to prove you are creating an impact?* Ultimately the goal of this challenge is to save lives that otherwise would be lost to lack of medical oxygen. This will be hard to directly track.

  A successful team will suggest simple, trackable metrics. A few ideas:
    - Number of patients accessing oxygen treatment vs. a historical baseline
    - Cost of oxygen treatment vs. historical baseline
    - Purity of oxygen vs. historical baseline across all concentrators
    - No. of clinicians confident in oxygen provided vs. baseline

Market Conditions

1. *Where will you work?* We recommend you seek out hospital partners who serve the most marginalized. As a proxy metric, you may consider how hospitals charge patients for oxygen treatment, and whether that cost is affordable for the poorest people in that region.

   Generally, rural and low income locations have the highest need. This is typically where the government and health care industry are not ready to invest in maintenance and distribution systems.

   There are already many concentrators that are out of warranty period, and may already be broken. Servicing this backlog of machines could quickly lead to higher provision of medical grade oxygen.

   Before embarking upon the work to undertake this challenge, it will be a good idea to carefully consider your local and national regulations on medical equipment, availability, its import and spare part availability, as well as access to staff and labour.

2. *Paths to future funding:* If the pilot is successful in increasing access to oxygen and generating demand for service contracts, additional funding direct from one of our partner foundations may be available to expand your venture.

3. Additional notes:
    - *Technician Tools:* Your pilot program will need access to essential tools including, oxygen analyzers, digital pressure meters, electrical safety analyzers, multimeters, plus the standard biomedical technician toolkit of pliers, screwdrivers, wrenches, allen keys and cable ties.

    - *Background on overlap with Pulse Oximetry:* Pulse oximeters identify who needs oxygen, when and how much. They work by measuring the oxygen saturation in the blood and identifying hypoxemia, the condition that requires oxygen therapy. They are essential tools for clinicians, are handheld, relatively cheap, easy to train, and almost maintenance free. There are large organisations and institutions working in this space, such as Lifebox.

It is important to know that oxygen delivery goes hand in hand with pulse oximetry and is critical to oxygen therapy solutions. However, the core of this challenge is maintenance, not procurement and clinical training.

- *Background on other organizations working in the space:* the challenge of oxygen access has come to light in the past few years via a number of good organizations and advocates working on childhood pneumonia – like the Every Breath Counts coalition, Clinton Health Access Initiative and PATH respiratory consortium.

- *Background on Oxygen Production:* The WHO defines medical grade oxygen as acceptable at levels of greater than 85% purity.[12]

  Medical oxygen is produced mainly in two ways. PSA technology is used by both oxygen concentrators and in small oxygen plants, often found on-site at larger referral facilities. These plants can produce oxygen up to 95% purity that is either piped directly to the patient bedside, or compressed to fill cylinders with pressurised oxygen that can be transported by the bedside or used in oxygen cylinder manifolds (again which is piped to the patient bedside). The construction costs to build a PSA plant can be upwards of $300,000, however the cost of maintenance, piping, plus transport and logistics of moving cylinders, easily doubles or triples this cost in LMIC contexts.

  The other way is the production of liquid oxygen which is stored cryogenically. Some larger referral/tertiary level hospitals in LMICs store liquid oxygen on site, which is converted to gas and piped to the patient bedside. The production and distribution of this oxygen is expensive and beyond the scope of this challenge. Oxygen purity can reach up to 99% by this method of production.

Helpful Resources

- Past D-Prize winners include HealthPort (Nigeria) and Oxicare (India).

[12] https://apps.who.int/iris/bitstream/handle/10665/329874/9789241516914-eng.pdf?ua=1

Ready To Apply?

Download a First Round Application Packet and start creating your proposal at https://sites.tufts.edu/dprize/.

Questions? Email Kaushik Chaudhuri at Kaushik.Chaudhuri@tufts.edu.