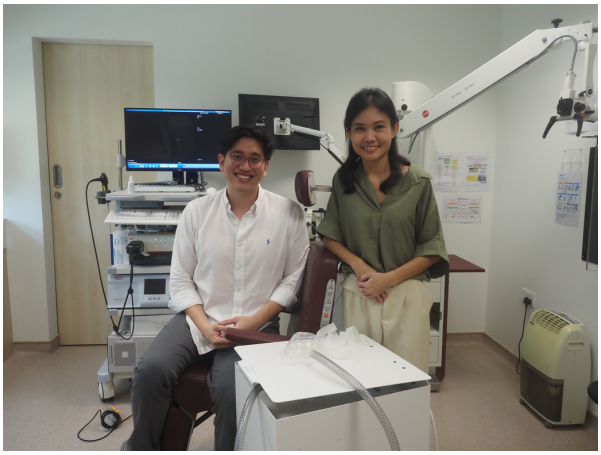
AERODROP DUO: A DUO FUNCTION PROTECTIVE SCOPE MASK AND FILTRATION SYSTEM

A recipient of the Ng Teng Fong Healthcare Innovation and Productivity (HIP) grant, Dr Chew Hui Sing, Consultant, Tan Tock Seng Hospital, shares more about the Aerodrop Duo, an innovative duo function protective scope mask and filtration system for Aerosol Generating Scope procedures.

By Tjut Rostina, CHI

Deeply entrenched in the battle against the spread of COVID-19, ENT consultant Dr Chew, and her colleagues have had to defer non-urgent aerosol generating procedures (AGPs), such as nasoendoscopy and laryngoscopy during the peak of the pandemic. As COVID-19 can be transmitted through respiratory droplets and contact routes, AGPs were seen as high-risk procedures in the effort to minimise contamination.



“During these procedures, the scope would be inserted through the nose and into the upper airway, sometimes causing patients to sneeze or cough, resulting in aerosol or droplets going into the environment, thus contaminating the surroundings. There is also the worry that the aerosol in the air and droplets on the surfaces may cause disease transmission to the healthcare workers or patients and visitors within the vicinity,” shares Dr Chew.

These AGPs are, however, essential diagnostic and therapeutic procedures. In pre-pandemic years 2017 &2018, an average of 10,000 nasoendoscopy/ year was performed by the ENT department.

With Covid-19 becoming endemic, with asymptomatic community transmission and new variants arising time, , there was a need to modify practices to ensure that clinical services can resume without compromising healthcare workers’ and patients’ safety and comfort; and to carry this out in a logistically sustainable manner.

In addition, Dr Chew reiterated that from the history of pandemics, we know that Covid-19 will not be the last pandemic we are to encounter. Hence, the importance of being prepared for the next disease X.

The Problem

Based on the recommendation by the infectious disease experts, other than requiring AGPs to take place in a single room (ideally negative pressure if available), all surfaces need to be wiped down after every single scope procedure.

This presented a logistical challenge, because all the clinic consultation rooms and facilities built in the pre-Covid era are not negative pressured. Converting the existing consultation rooms to negative pressure room is also not feasible logistically or financially.

Prior to the pandemic, all these procedures were conducted in the doctor's individual consultation rooms, and open shared settings such as in the wards and in the emergency departments. For emergency scopes, such as urgent airway consultations in the ward or emergency departments, it is also not possible to shift the unstable patient to a single room for the scope to be performed to minimise contamination to the other patients/ healthcare workers in the vicinity.

Nasoendoscopy are crucial diagnostic and therapeutic procedures. During the peak of Covid-19 pandemic cases, non-urgent cases were deferred. Dr Chew shares, "As Covid-19 becomes endemic and clinical load resumes, we don't have the capacity to support the full resumption of clinical load, while adhering to the stringent recommendations to control infectious disease. For example, our clinic rooms are not negative pressured rooms, and it's also not feasible that after every single scope, we spend 20-30 minutes wiping down all the surfaces. This will affect the turnaround for each patient coming through to the clinic, the waiting time and the number of cases that can be seen."

Personal protective equipment only protects the healthcare workers, and only if worn correctly. It is also uncomfortable for the HCWs when worn for prolonged duration.

Standalone HEPA filters only filters the air, and takes time to do so. It also does not take care of the droplets which would have otherwise landed on surfaces. More needs to be done to reduce the environmental contamination that occurs during the AGPs to protect the patients and visitors.

Various innovations such as ventilation hoods and improvised surgical masks had been described in the literature during Covid-19, but are not suitable for ENT scope purposes.

Ventilation hoods are typically huge and bulky devices which are not suitable with scope access or use in erect sitting in ENT clinic.

Improvised surgical mask whereby a hole is made in normal surgical mask with cut gloves lining the opening have also been described. This surgical mask is opaque, and does not afford good visualisation for instrumentation. It also does not protect against leakage of aerosols/droplets from the corners of the mask, especially for masks that have a poor fitting.

The Idea

To combat this challenge, Dr Chew and her team came up with a design of a scope mask and filtration system that can be used during the conduct of aerosol generating ENT scope procedures. The system can also double up as a standalone fully titratable HEPA filtration system at all times.

Dr Chew's idea is based on 2 simple concepts:

1. Development of a dedicated "negative pressure" containment scope mask designed for patient wear during the conduct of ENT procedure.
2. Development of a dedicated dual function HEPA filtration system capable of powering the containment mask while filtering ambient clinic air to provide a safer clinic space for everyone.

In addition, environmental friendliness, portability of the device and noise level of the filtration system were also key considerations in the product design.

This is a multidisciplinary project in collaboration with infection disease specialist to ensure that the device meets infection disease standards, engineering expertise to help reduce the concepts into practice and ophthalmology department to assist in the development of a cough scatter software to detect the fluorescein droplets.

The Solution

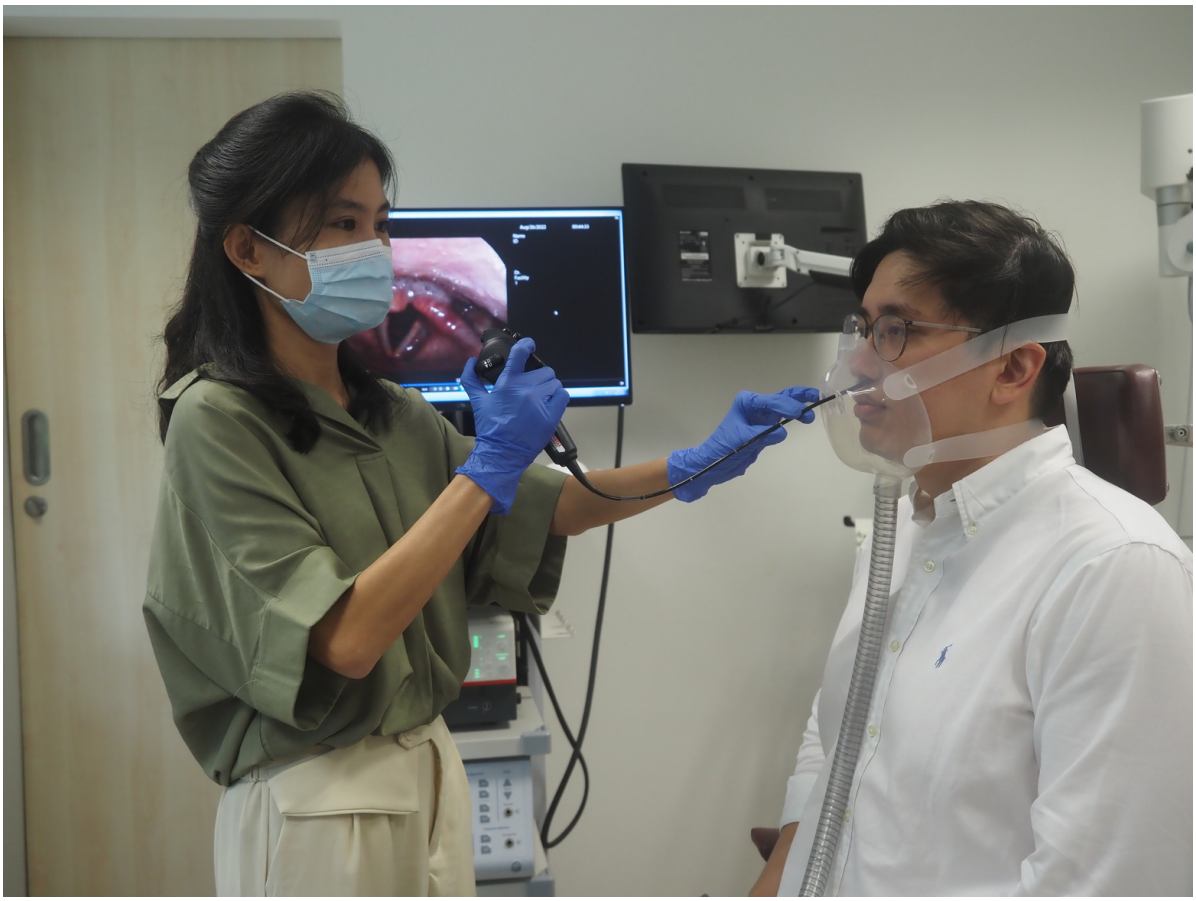
The innovation provides 3 layers of safety:

1.Direct containment of droplets and aerosols generated during ENT procedure
2. Negative pressure (> -60 Pa) generated through exhaust suction to HEPA unit
3.Ambient air filtration capable of providing at least 6 air cycle filtration in a standard ENT clinic room

This provides for fully adjustable air exchanges to meet the various clinic room sizes requirements.

This device's efficacy in containing aerosol and droplet contamination was validated through a pilot particle counter study (for determination of aerosol contamination) and a fluorescein droplet study (for droplet contamination) on healthy volunteers performing aerosol generating activities- breathing, talking, singing, coughing.

Cough scatter software was developed jointly with the ophthalmology department and an overseas vendor for the detection of the fluorescein droplet. The device's clinic end user acceptability and feedback were also gathered through a clinic end user survey that was conducted in December 2021.



Demonstrating how the Aerodrop Duo is used.

Challenges

Once the experts were assembled, the first challenge in realising the innovation was securing a suitable source of funding to develop and evaluate the product. That was when Dr Chew came across the Ng Teng Fong Healthcare Innovation Programme.

The programme funds and supports healthcare innovation in collaboration with its partners through five tracks – Strategic Training, Innovation, Community Enabling, Strategic Innovation, and Strategic Research.

With assistance from the team at the Centre for Healthcare Innovation, the team secured the required funding for their innovation.

Subsequent challenges encountered during the study- included technical issues with the prototype designs, study experiments and evaluation, which were resolved after multiple rounds of troubleshooting with the engineering expertise from the external collaborator (The Biofactory).

There were also considerable delays to the study due to Covid-19 restrictions/ halts and delays in the supply chain for raw materials. Dr Chew also learnt about various tedious innovation related research administrative requirements as she went about doing up the collaboration and service agreements, the filing for intellectual property, waiver of competition applications, HSA checks and other legal documents.

Dr Chew was thankful for the kind support and guidance provided from CMTI and CRIO on these matters.

What's Next

Since starting initial project discussions in mid-2020, the team had completed the prototype and its evaluation. The results has been published in September 2022 issue of *Laryngoscope Investigative Otolaryngology Volume 7 Issue 5 P.1376-1383.*

Five of TTSH ENT consultation rooms have been equipped with this device, with plans for sequential budgeting and equipping of all the ENT clinic rooms.

Given the efficacy of this device, ID has allowed AGP to be conducted with normal surgical masks (without the need for full PPE) when the system is in use, even during the earlier phase of pandemic before recent MOH's step down in PPE.

What this means is that this product also provides greater comfort for healthcare workers, in addition to the safer environment it provides for the HCWs and patients/ visitors. The team is presently looking at marketing of this device to benefit the wider community locally and overseas.

The Aerodrop Duo.

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