

This paper will describe a possible emergency substitutions for the protection of N95 masks and we will discuss how to improve the aerosol prevention of a common 3D printed visor.

The SARS-CoV-2 presents a unique challenge because it is not a more typical blood born pathogen -- it attacks the respiratory system through entry into the nasal, oral and lacrimal head areas through aerosols or tactile touch of the head areas. The small particle size and ability to be in the air for several minutes to hours make having a good mask/respirator important. The rapid spread of the virus and inability of the supply chain to keep pace with demand has led to multiple problems. The obvious one is lack of supply for healthcare providers in the most vulnerable circumstances, rampant counterfeiting and skyrocketing prices. Many healthcare resources have discussed extended use of what originally were single use disposable masks. While extended use helps with supply demands it trades safety of cross contamination from other diseases like TB for safety from corona virus.

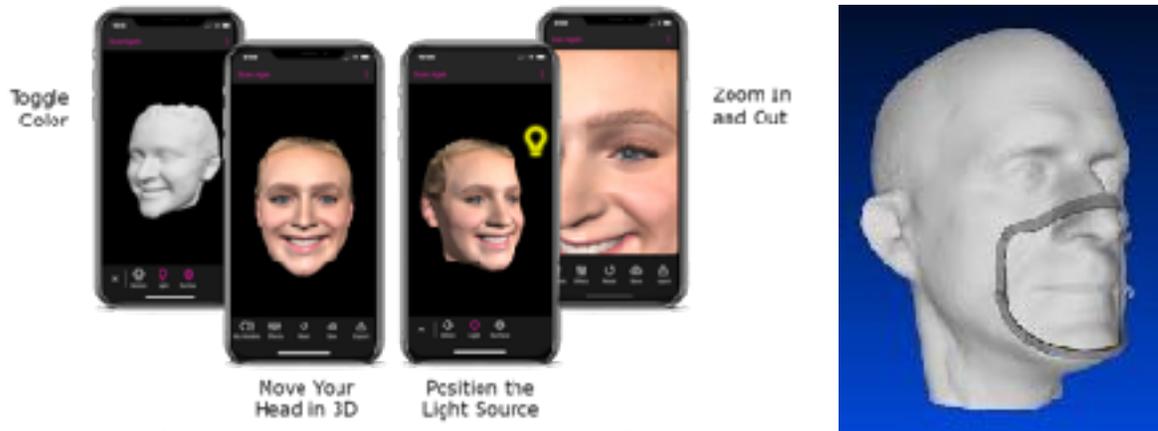
Creating your own mask leaves known testing on the shelf but under the emergency circumstance this may be a reasonable risk -- making your own mask means you've at least put your best knowledge forward to create a solution. Can this be worse than using known inferior masks or unknown counterfeit masks?

In the magazine PerioAdvisor an article was published by Washington State Dentists illustrating the use of air-conditioning filter material. Issues with this technique was the deconstruction of the filters without creating holes in the material as well the material itself has components of spun fiberglass that could be a concern if unintentionally breathed into the lungs. To ensure that a minimum standard of N95-like functionality is preserved, it is desirable to find a source of filter material that does not contain fiberglass and is commonly available which having a performance rated using commonly accepted standards. Merv 11 to 16 will trap particles larger than .03 microns. This means it should be able to trap the SARS-CoV-2 corona virus. Aprilaire makes an accordion style filter made of fibrous cellulous that does not have any wire reinforcement of cardboard frame glued to the material. Making masks from this material require only a pattern and a pair of scissors to cut out individual masks. Using a mask face frame through Bellus 3D or using older conventional methods like an alginate full face impression and orthodontic acrylic to shape a custom frame a good form fit can be achieved to hold and seal the mask in place. Although this material is advertised for use in hypoallergenic air filtering systems it is unknown exactly if the fibrous cellulose material may be dangerous if particles are filtered into the lung. For this reason the author is recommending a level I mask be used between the material and your face to avoid any inadvertent particles settling in the respiratory system. It is theorized based on the filtering material data that such a mask could be comparable to an N90 to N99 depending on the filter materials MERV rating.

Procedure: Acquire [BestAir Pro SGMPR-2 Replacement for Aprilaire # 201 Filter](#) material MERV 11 or Aprilaire 213 Replacement Air Filter for Aprilaire Whole Home Air Purifiers Merv 13. Using a KN95 mask as a pattern trace out multiple masks onto the flat material. A typical KN95 mask is usually shaped with rounded posterior section that covers cheeks and angular front area -- straight lines on the front -- once you have the filter material laid out position the pattern so one flat edge of the mask is on the accordion fold. -- these masks usually open up and they have a fold at top or bottom and on two angles they are mechanically sealed (joined) the key is to place the fold part against the fold of the accordion filter material - - images will illustrate as this is hard to explain in writing. Putting the fold of the mask against the fold of the accordion filter material you draw your pattern and cut the two layers simultaneously making sure not to cut the fold part seam. Because you don't own a machine to seal the two angular cut piece areas of the mask you use sterilization masking tape to join these segment -- two segments -- I like to add the tape to the fold section as well to prevent tearing -- so your mask will now have a round back section and three angular sections with nicely placed tape to the front leading side of the mask -- put a regular level I earloop mask on your face and then open the cone shaped filter you created (it looks a lot

like a coffee filter shape) Open the cone with round edge posteriorly and form gently to your face -- place your face frame over the top to seal the mask against your face and you now have a well fitted N90-N94 with MERV 11 or N95-N98 with MERV 13 equivalent mask – For MERV 11 the cost is .50 to .70 cents a mask and are then disposable after one use. If multiple frames are used the masks are completely changed after every patient and you can disinfect the frames at end of day. The wearer is protected and cross contamination with other contagions like TB are lessened.

Creating a mask frame:



This free app can be used to capture a 3D image of the face and it has a built in option to build a medical mask frame to fit over most medical masks and improve their seal.

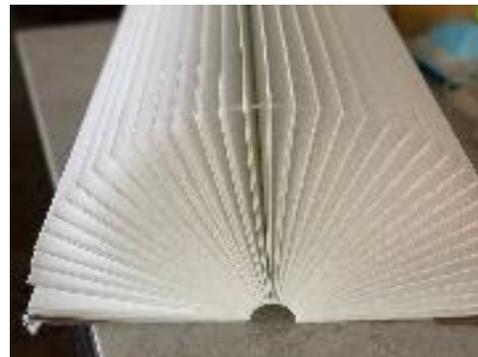
An “old school” method would be to take a conventional full face alginate impression using tin foil to create a tray and straws to allow for breathing when taking a facial impression. The alginate is poured up in dental stone and used to create a frame with orthodontic acrylic.



Figures 1-4 Straws in nose to breath, impression being taken, impression and poured face in stone



Figures 5-8 Beginning mask frame, finished frame, comparison of Bellus and models and frames with cut out of Merv 11 fibrous cellulose filter material.



Figures 9-10 filter material, no cardboard or wire mesh only fibrous cellulose Merv 11 filter material to deal with.





Figures 11-12 Pattern taken from KN95 and transferred to Merv 11 filter paper for cutting



forming.

and

Figures 13-14. Two edges need to be taped to close mask. The mask fit is tested on the facial



model and the design at this stage can be modified to improve fit and reset the final pattern.

Figure 15 Completed Merv 11 mask, By Dr. Shorey. Notice that a level I mask is on with the filter material covering mask and providing protection from aerosol particles. Silicone swim straps used in this example. The outer frame seals all the periphery of the mask. The design is still in progress as new patterns are opportunities to change the overall fit and shape.



Figure 16 , 17. The outer frame creates a tight seal without need for constant adjustments. Elastic shoe laces used in this example to hold the frame tight to face. Room for glasses to be worn is created through proper frame design. The Merv 11 filter material is backed by a level I,II or III surgical mask. A Bellus 3d frame can also be used with this Merv 11 outer mask to hold in place and create a good seal.

These outer protective masks are relatively easy to make. A dental assistant could cut out and make 20 or more a day in about 45 minutes time. This type of mask should not be used with staff because they are not approved and can not therefore be relied on for their OSHA safety

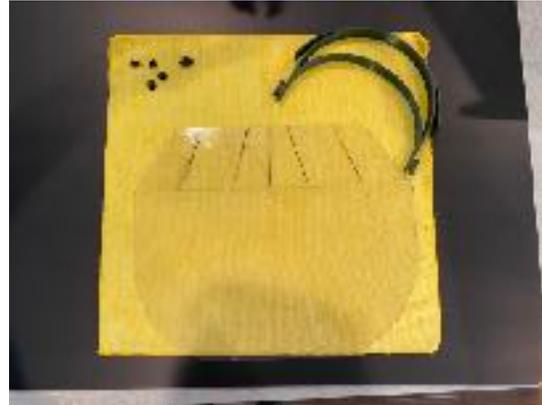
equipment guidelines. However this can be a reserve make for the dentist owner in case the supply of N95 masks become critically impossible to acquire. The overall cost is anywhere between .50 and .75 cents a mask depending on the size of the pattern. Merv 13 material will run approximately 1.00 to 1.50 a mask and is thicker.



A filter with a MERV rating of 13 to 16 captures particles greater than 0.3 micrometers. This includes bacteria, droplets from sneezing, smoke, and most other sources of pollution. This level of filtration is used in patient and surgery areas of hospitals.

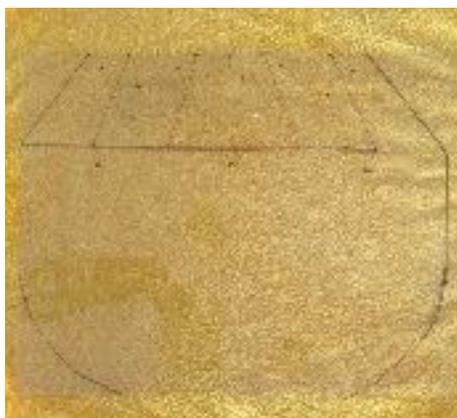
On the internet the rush to find acceptable visor shields leads to many different results both positive and negative. I purchased some 3D printed visor frames and the plastic shield replacements were very thin. The visor frame fit well and allowed room for loops but the extension of the frame forward left a void where aerosol could come into the face area from above. The solution was to make a shield that could be attached to the frame and protect from above as well as from front and side.

10 MIL clear vinyl sheets were purchased on Amazon measuring 11 inches by 17 inches. 100 sheets were purchase made by Oregon Laminations. The original vinyl sheets used with the frame was used to begin the design. A template of the final design is illustrated. The exact measurements are not supplied in the this article as the principle can work with many other shield frames with different dimensions and methods to retain the vinyl barrier sheets.



The image shows the frame and it can be seen that a space exists between the forehead area and the outer rim that retains the shield. This allows loops to be worn but allows aerosols to enter from above the shield. The pattern traced on the vinyl was created using a cardboard pattern and the traced onto the vinyl. It is important to do work on a microfiber towel to avoid inadvertent scratches to the vinyl material.

At the upper 3/4 you can see three dots. The dots are punched and used to affix the shield to the visor frame. The area above will become a shaped shield above the visor to prevent aerosols from entering the visor from above.



In the far right image you can see the beginning of forming a shaped protective dome by folding in the cut flanges and fixing them together using automatic interior car push pins.



The push pins come in various diameters, lengths and shapes. I used the small size for several and then tried the larger diameter pins and decided I liked them more. There is no difference in function as they pretty much all work.





These shields can be recreated with the cardboard pattern to renew contaminated shields or shields that become scratched after use and disinfection processing. I like them more now that my forehead is protected but I have room for my loops and light.

