Update in
Anaesthesia

Alternatives to traditional fibreoptic bronchoscopes for use in resource-poor settings

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Successful airway management is central to the practice of anaesthesia. In resource-rich environments, there are numerous tools of increasing complexity and cost available to deal with difficult airway management. Basic airway management is usually accomplished using laryngoscopes, endotracheal tubes and laryngeal mask airways; more difficult cases may utilise video laryngoscopes or other specialised devices. Fibreoptic bronchoscopes are reserved for particularly difficult intubations, awake intubations, or other special situations.

Traditional laryngoscopes, endotracheal tubes and laryngeal mask airways are relatively inexpensive and can be used in low-resource environments. Even slightly more sophisticated equipment such as video laryngoscopes have now become inexpensive enough and robust enough that they could be deployed to resource-poor environments. These tools, such as the GlideScope® by Verathon®, could be used as a substitute for fibreoptic bronchoscopes in some situations, for example awake intubations. However, they are unlikely to completely replace the need for fibreoptic bronchoscopes. Unfortunately, fibreoptic bronchoscopes remain relatively expensive to purchase and they require reliable electrical power, periodic maintenance and sterilisation. Because of their infrequent and specialised use, they have not benefited from the economies of scale that other airway technologies have and are unlikely to do so in the near future.

We therefore wish to discuss whether other technology could be repurposed or reused to provide fibreoptic capability in resource-poor environments.

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ALTERNATIVES TO FIBREOPTIC BRONCHOSCOPES

We identified two plausible approaches to providing a substitute for fibreoptic bronchoscopes. The first was acquiring single-use devices designed for the developed world, and sterilising and reusing these devices. The second was repurposing of commercially available scopes, commonly known as borescopes, for medical use.

Recent reductions in cost of electronic cameras have made single-use bronchoscopes feasible for resource-rich environments. For example, the Ambu® aScope™ is a single-use bronchoscope utilising a small electronic camera. At a cost in the range of hundreds of US dollars, it is much cheaper than a traditional fibreoptic bronchoscope, which costs in the range of tens of thousands of US dollars. However, to be economically viable in low-resource settings it would need to be reused, and it was not designed for this purpose.

This brings up several issues, the foremost being cleaning and sterilisation. Sterilising with heat or chemicals is likely to be problematic given that the scope was never designed with sterilisation in mind – the electronics or the plastic body are likely to be degraded. An alternative to sterilising the scope would be to mount a disposable cover over it. Although this would seem to be trivial, several problems arise. First, the ability to suction would be lost because the port would be occluded. Secondly, the light source and the camera of the Ambu® aScope™ are in close proximity. Even a transparent plastic cover would cause so much reflection back into the camera from the light source that the image would be washed out. To overcome this, there are several options – either the plastic window can be made at an angle such that the light is not reflected back into the camera, or a fluid can be introduced between the camera and the cover that matches the refractive index of the plastic and hence eliminates the reflection.

Because the aScope™ was not designed for reuse, even without sterilisation its long-term durability is unknown. Further, the aScope™ requires the purchase of a separate screen in order to visualise the output of the camera, significantly increasing cost and potentially putting it out of reach for resource-poor environments. Lastly, the aScope™ is not distributed in all countries.

Alternatively, commercially available scopes, known as borescopes, could be used. These are widely available and generally used for tasks such as pipe or wiring inspection. They have a form factor very similar to traditional bronchoscopes although they frequently use a pistol-style grip. They are also very inexpensive and widely available, priced from around US$100, and this amount includes the screen itself. They are also designed for long-term use. A photograph of a borescope with a pistol-style grip is shown in Figure 1.

Unfortunately, although they are cheaper and more widely available, borescopes suffer from many of the same drawbacks as the aScope™ as well as some new difficulties. They are not designed to be sterilised and so the above discussion applies regarding alternatives to heat or chemical sterilisation. Many borescopes may be too large in diameter to allow an endotracheal tube to be mounted on them and railroaded into the trachea (although they could still be used for external visualisation of the larynx). They also generally do not have suction ports built in. Some borescopes have steerable tips similar to those commonly found on endoscopes and bronchoscopes, but not all do. Generally, borescopes with steerable tips and thinner probes are more costly, and this may eliminate the cost advantage relative to the aScope™.

We constructed several covers for the scope shown in Figure 1 to assess their performance, including an approximate refraction-matching design using a lubricating jelly and an angled window design. We assessed the images produced by these scopes and practised intubating mannequins using the scopes. We found that a transparent cover with a sharply angled window to eliminate back-reflections was the simplest, most practical option. The primary drawback to using a cover in this shape is that, because the tubing extends beyond the camera on one side, the image in this area is obscured. Also, the relative stiffness of the cover reduces the practitioner's ability to steer the tip of the scope, and, as noted previously, any ability to suction is lost. We found, however, that the pistol-grip style scope seemed easier to use than the traditional bronchoscope form.

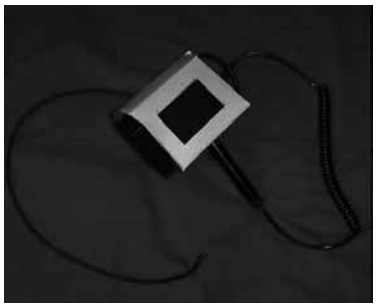

Figure 1. *Borescope with pistol-style grip. Borescopes of this style are widely available from a number of manufacturers*

CONCLUSIONS

Unfortunately, there is no obvious alternative to traditional fibreoptic bronchoscopes for resource-poor environments at this time, although we felt using commercial borescopes with an angled window held some promise. If the scope is intended for use only in life-threatening emergencies, and is thoroughly cleaned between uses (but not sterilised), then one might argue that the relative risk versus benefit is favourable to the patient. Of course, the on-going trend towards less expensive and more capable electronics may change this calculus and we certainly hope that a solution appropriate for developing countries will be available in the future.

FURTHER READING

1. Colt HG, Beamis JJ, Harrell JH, Mathur PM. Novel flexible fiberoptic bronchoscope and single use disposable sheath endoscopic system: a preliminary technology evaluation. *Chest* 2000; **118**: 183–7.