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## *Christmas 2016: Being Well*

### **Arlight: a pocket ophthalmoscope for the 21st century**

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The Arlight is a cheap, solar powered ophthalmoscope and otoscope developed for users in low and middle income countries inspired by a BMJ Christmas article from 2000<sup>1</sup>.

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*"Wow, it really works!"—rural health worker, Malawi, 2016*

*"Less is more"—Peter Behrens, Architect, 1868-1940*

Around 285 million people in the world are estimated to be visually impaired,<sup>1</sup> and 360 million hearing impaired,<sup>2</sup> with the majority of cases considered preventable or treatable if diagnosed promptly. Ophthalmoscopes and otoscopes are typically designed for wealthy countries and are complex, heavy, and expensive; their basic designs have remained relatively unchanged for over 100 years.<sup>3</sup> Very few practitioners in low and middle income countries have these essential tools. If they do, they are typically hand-me-downs that don't work because they need parts that are hard to find or expensive, such as bulbs and batteries.<sup>4</sup> The vast majority of cases of vision and hearing impairment are however found in these countries with least access to diagnostic tools. The Lancet Commission has recommended greater focus on frugal technologies designed for the needs of low and middle income countries.<sup>4</sup>

### **Frugal inspiration from *The BMJ* at Christmas**

In 2000 the Christmas issue of *The BMJ* contained an article describing a cheap, homemade ophthalmoscope.<sup>5</sup> This inspired the Arlight; a prototype pocket sized (110 mm × 26 mm × 9 mm, weight 18 g) ophthalmoscope, otoscope, and loupe powered by a slim rechargeable lithium battery that is charged by an integrated solar panel and illuminated by a patented LED light source (figs 1 and 2).

**Fig 1** How Arlight works

**Fig 2** A pocket sized ophthalmoscope, otoscope, and loupe

The Fred Hollows Foundation offered seed development funding to develop the prototype into a device ready for market. The simplified design has considerably lower production costs, and the Arclight is now available to low income users through the standard list of the International Agency for Prevention of Blindness at a fraction of the cost of traditional devices.<sup>7</sup> Several thousand devices have been distributed to countries around the world, including Malawi, Ethiopia, Kenya, Tanzania, Rwanda, Ghana, Fiji, Indonesia, and the Solomon Islands, enabling healthcare workers to perform comprehensive eye and ear examinations for the first time.

## Changing care

The Arclight is tailored to the conditions and needs of low resource settings<sup>8</sup> so that it can be used to identify the most common causes of vision and hearing loss. Although it is still in the early stages of evaluation, preliminary studies from Scotland, Malawi, and Tanzania indicate that the device is more effective than traditional tools for teaching ophthalmoscopy<sup>9 10</sup> and is just as accurate for screening for signs of diabetic retinopathy and glaucoma.<sup>8 11</sup> Studies for other conditions requiring a “red reflex” examination, such as congenital cataract and retinoblastoma, which if diagnosed late can lead to poor visual outcomes and even death, are currently under way. Consequently Sense International is using the Arclight in a large screening programme of infants aged 0-3 years in Kenya and Uganda.<sup>12</sup> The loupe of the device is being used by the Fred Hollows Foundation in Ethiopia to screen for trachoma for the prevention of blindness that is estimated to affect over three million people worldwide.<sup>13 14</sup> The otoscope has also been used in Malawi to identify and treat middle ear disease and cerumen impaction as part of a hearing impairment prevention programme.<sup>15</sup>

Feedback from formal training with users in Malawi identified several barriers to care, including the need for access to relevant training material and local referral guidelines.<sup>[8]</sup> The next iteration of the Arclight contains a memory chip loaded with a multimedia training program accessible through a smartphone app.<sup>[19]</sup> The Arclight can also acquire digital images for remote interpretation and for training purposes by clipping to a mobile phone camera (fig 3).

**Fig 3** Device can be attached to a mobile phone

The development of this device has created a piece of disruptive technology that has the potential to transform care in low and middle income countries. It all started with a paper in the millennial Christmas issue of *The BMJ*. So please keep reading the festive issue of the journal; you never know what ideas might light up.

Competing interests: We have read and understood the BMJ policy on competing interests and declare the following interests: JSS had his travel paid for by Arclight Medical to attend the IAPB

conference in Hyderabad in 2012. AB is seconded to the University of St Andrews from NHS Fife. The University owns a social enterprise subsidiary company, for which AB acts as an unpaid adviser, which sells the Arclight to users in the UK with all profits being used to fund distribution and education exercises of the device in low income countries via the Global Health Implementation team at the University of St Andrews.

In memory of Sandy Holt-Wilson.

Provenance: Not commissioned; externally peer reviewed.

<eref>1 World Health Organization. Visual impairment and blindness fact sheet August 2014. <http://www.who.int/mediacentre/factsheets/fs282/en/>.</eref>

<eref>2 World Health Organization. Deafness and hearing loss. Fact sheet. 2015. <http://www.who.int/mediacentre/factsheets/fs300/en/>.</eref>

<jrn>3 Keeler CR. 150 years since Babbage's ophthalmoscope. *Arch Ophthalmol* 1997;115:1456-7. [PubMed doi:10.1001/archoph.1997.01100160626017](http://pubmed.ncbi.nlm.nih.gov/10.1001/archoph.1997.01100160626017/)</jrn>

<jrn>4 Howitt P, Darzi A, Yang GZ, et al. Technologies for global health. *Lancet* 2012;380:507-35. [PubMed doi:10.1016/S0140-6736\(12\)61127-1](http://pubmed.ncbi.nlm.nih.gov/10.1016/S0140-6736(12)61127-1/)</jrn>

5. Armour RH. Manufacture and use of home made ophthalmoscopes: a 150th anniversary tribute to Helmholtz. *BMJ* 2000;321:1557-9.

<eref>7 IAPB. Standard list. Arclight. 2016 <https://iapb.standardlist.org/get-arclight/>.</eref>

<ths>8 Blundell R. A mixed-methods evaluation of a novel solar powered low cost ophthalmoscope (Arclight) by healthcare workers in Malawi using the technology acceptance Model [Thesis]. University of Dundee, 2015.</ths>

<ths>9 Hyrtis M. A cross-over trial comparing skill acquisition between the traditional direct ophthalmoscope and the Arclight ophthalmoscope. University of Dundee, 2016.</ths>

<ths>10 Tuteja S. *Comparison of a novel, low-cost, solar-powered pocket ophthalmoscope with a conventional device*. University of St Andrews, 2016.</ths>

11. Lowe J, Cleland CR, Mgaya E, et al. The Arclight ophthalmoscope: a reliable low-cost alternative to the standard direct ophthalmoscope. *J Ophthalmology* 2015;2015:743263.

<eref>12 SENSE International. Research study into the effectiveness and impact of Early Intervention for infants aged 0-3 with complex sensory impairments in Kenya and Uganda. [www.senseinternational.org.uk/research-study-effectiveness-and-impact-early-intervention](http://www.senseinternational.org.uk/research-study-effectiveness-and-impact-early-intervention) (2016).</eref>

<eref>13 Fred Hollows Foundation. Trachoma control. 2016. <http://www.hollows.org/au/eye-health/trachoma>.</eref>

<jrn>14 Bourne RR, Stevens GA, White RA, et al; Vision Loss Expert Group. Causes of vision loss worldwide, 1990-2010: a systematic analysis. *Lancet Glob Health* 2013;1:e339-49. [PubMed doi:10.1016/S2214-109X\(13\)70113-X](http://pubmed.ncbi.nlm.nih.gov/10.1016/S2214-109X(13)70113-X/)</jrn>

<jrn>15 Mulwafu W, Nyirenda TE, Fagan JJ, Bem C, Mlumbe K, Chitule J. Initiating and developing clinical services, training and research in a low resource setting: the Malawi ENT experience. *Trop Doct* 2014;44:135-9. [PubMed doi:10.1177/0049475514524393](http://pubmed.ncbi.nlm.nih.gov/10.1177/0049475514524393/)</jrn>

<jrn>16 Ekeland AG, Bowes A, Flottorp S. Effectiveness of telemedicine: a systematic review of reviews. *Int J Med Inform* 2010;79:736-71. [PubMed doi:10.1016/j.ijmedinf.2010.08.006](http://pubmed.ncbi.nlm.nih.gov/10.1016/j.ijmedinf.2010.08.006/)</jrn>

<jrn>17 Sivaprasad S, Gupta B, Crosby-Nwaobi R, Evans J. Prevalence of diabetic retinopathy in various ethnic groups: a worldwide perspective. *Surv Ophthalmol* 2012;57:347-70. [PubMed doi:10.1016/j.survophthal.2012.01.004](http://pubmed.ncbi.nlm.nih.gov/10.1016/j.survophthal.2012.01.004/)</jrn>

<jrn>18 Gilbert C, Wormald R, Fielder A, et al. Potential for a paradigm change in the detection of retinopathy of prematurity requiring treatment. *Arch Dis Child Fetal Neonatal Ed* 2016;101:F6-9. [PubMed doi:10.1136/archdischild-2015-308704](http://pubmed.ncbi.nlm.nih.gov/10.1136/archdischild-2015-308704/)</jrn>

<eref>19 Williams CD, Sandford-Smith J, Waddell KMOC. Ophthalmology: Multimedia Learning for Health Workers Worldwide - Africa. World Medical Education <http://learning.worldmedicaleducation.org/> (2015).</eref>