



The **Power** of Impact Investment to Improve **Vision**

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Executive Summary

This report assesses the potential for impact investment to drive improvements in eye health in low- and middle-income countries. The central message is that impact investment is an emerging market waiting to be tapped and that eye health is very well placed to capitalise on it. Specifically, there are several features of eye care service provision that are well suited to impact investment: there are clearly measurable and attributable social outcomes, and there can be real prospects for financial returns.

The persistence of avoidable blindness among poorer cohorts in low- and middle-income countries is largely a problem of resource allocation. Despite the existence of effective treatments for avoidable blindness, the level of eye care services is constrained by a lack of financial resources. By providing the funding required to increase the accessibility of services, the impact investment market may thus offer a new avenue for eliminating avoidable blindness.

Sound investment propositions need to be developed before this new funding source can be tapped for eye health. This report suggests that a combination of the ease of treatment, cost-effectiveness, social impact and prospect of financial return means treatments for cataracts, uncorrected refractive error and trachoma are the most suitable interventions for early-stage impact investments in eye health. Selected examples of potentially viable investment propositions are provided, though it is important to note that there are many investment options that could be explored.

The unique value of this report is that it sheds new light on the potential for private capital to finance eye health in low- and middle-income countries. The findings should, therefore, inform a conversation among service providers and investors alike about how impact investment can actually create positive impact on the ground.

For charitable organisations involved in development, such as The Fred Hollows Foundation, impact investing offers a potentially new avenue for leveraging social impact and also a break from business-as-usual activities. This report should, therefore, also help kick-start discussions about how impact investing might work alongside existing operating activities, including how it fits into development strategies; how it could complement programming activities; whether donors can be further engaged; and whether complementary reporting systems can be developed.

Introduction

Impact investment has attracted considerable interest since the term was first coined in 2007. It is an investment approach that intentionally seeks to create both financial return and positive social or environmental impact, which is actively measured.¹ Excitement exists about the potential for impact investment to achieve increased social impact through improved access to finance and the application of a private sector-led approach to service delivery. It has been estimated that the sector could reach between US\$400 billion and US\$1 trillion globally by 2020.²

Adequate provision of eye care remains a challenge in low- and middle-income countries. According to World Health Organization (WHO) estimates, in 2010 there were an estimated 285 million people worldwide who were visually impaired, of whom 39 million were blind.³ Among children aged 15 and younger 19 million were visually impaired and 1.4 million blind.⁴ It is estimated that around three quarters of visual impairment is *avoidable*, to the extent that it can be prevented or treated. Despite the potential for significant social impact, a key reason why avoidable blindness persists is because services are not universally accessible; in particular, a lack of funding restricts the overall level of service provision, which disproportionately affects the most poor and vulnerable.

This report explores whether impact investment can provide some of the additional funding required to reduce avoidable blindness in low- and middle-income countries. Impact investment in eye health is an emerging area, and while there have been some successes already, there may be opportunities to build on these in the future. However, it remains to be proven whether social impact and commercial returns can coexist at scale in this market.

The report methodically describes the impact investment market, including the different types of investors and the different funding and delivery models. It then identifies causes of blindness for which treatment or prevention delivers high social impact for the known intervention costs, as these are likely to be the most appealing investment targets and the outcomes of most interest to beneficiaries and donors – defined as development agencies and philanthropic organisations.

Services for eye conditions, such as cataracts, uncorrected refractive error and trachoma can achieve significant social impact for a relatively low cost. They therefore appear to be the most suitable candidates for early-stage impact investments in eye health. For each of these high-impact interventions, a specific example of how impact investment could be used to expand service provision is provided. These examples are based on the success (or not) of models previously applied and seek to show how impact investment could be leveraged, rather than conclusively defining the best approach for doing so.

¹ World Economic Forum. (2013).

² O'Donohoe, N., et al. (2010).

³ World Health Organization. (2013). Universal eye health: a global action plan 2014-2019.

⁴ Ibid.

Social enterprise models have already been applied, with some success, to treat cataracts and uncorrected refractive error. This report concludes that potential exists to refine these models and use impact investment funding as a way to increase their reach. New financial instruments such as Development Impact Bonds (DIBs) could also be leveraged to deliver additional services in certain circumstances. Ultimately, the appropriateness of a specific financing model in any given context depends on the targeted social impact and the levels of interest of potential partners.

The unique value of this report is that it provokes new ideas about how eye health can be financed. For investors seeking to become involved in the market, it examines why eye health may potentially be a worthwhile investment. For charitable organisations, donors and service providers, it demonstrates the power of this new market improve vision.

The Power of Impact Investment to Improve Vision

Emergence of Impact Investment

Development assistance from official donors has historically been a key source of funding for low- and middle-income countries, but it now represents a declining share of financial flows.⁵ In 2012, Official Development Assistance represented only 28 per cent of all public and private flows from OECD countries.⁶ The remaining 72 per cent came as either finance provided by public bodies at close to market terms (e.g. World Bank and International Finance Corporation loans) or private finance at market terms (e.g. secured debt and equity investments).⁷

In 2012, there was about US\$9 trillion (mostly from domestic tax revenues and private investment) available to finance development in low- and middle-income countries.⁸ Despite this significant pool of resources, most of these countries still face major development challenges, as evidenced by mixed progress towards the UN's Millennium Development Goals.⁹ Looking forward, considerable additional finance will be required in the subsequent Sustainable Development Goals period to provide the essential products and services needed to ensure an acceptable minimum standard of living for all.¹⁰

The upshot is that demand for funding still far outstrips the supply of affordable capital. While aid will doubtless have an important ongoing role to play, it is unlikely to be sufficient to meet the most intractable social challenges. It is important, therefore, to look beyond traditional funding mechanisms for complementary sources of international development finance.

While the quantum of development financing rightly receives significant attention, stakeholders, including donors, are also increasingly focused on how effective aid is in delivering its intended impact.¹¹ This has led to the development of innovative financing instruments that are more flexible and results-oriented, that work with a wider range of funding sources and that rely on collaboration across a broader spectrum of actors.

Health is one area where innovative financing models have already had an impact. The pooling of resources between private foundations and traditional public sources has allowed significant progress to be made in preventing and treating diseases such as HIV-AIDS and malaria. Private philanthropic organisations, such as the Bill & Melinda Gates Foundation, have increased their collective funding for international development from US\$3 billion in 2003 to US\$30 billion in 2012.¹² The majority of this funding has been directed at health issues. New types of incentive structures are also gaining importance in combating disease. For example, US\$1.5 billion has been pledged to the Advanced Market Commitment, which is a legally binding agreement in which donors agree to subsidise the purchase of vaccines at a pre-determined price. This provides incentives to pharmaceutical companies to develop future generations of vaccines that would otherwise be unprofitable. Unsubsidised vaccine prices reflect the significant costs inherent in research and development that are typically beyond the means of developing countries.

⁵ OECD. (2014).

⁶ Ibid.

⁷ Ibid.

⁸ European Commission. (2013).

⁹ United Nations Conference on Sustainable Development. (2014).

¹⁰ Greenhill, R., Carter P., Hoy, C. and Manuel, M. (2015)

¹¹ Social Impact Investment Taskforce of the UK's Presidency of the G8. (2014).

¹² Ibid.

Overview of the Impact Investment Market

Into this space created by the acute need for resources and the need to focus on impact has been the emergence of impact investment. It is an investment approach that intentionally seeks to create both a financial return and a positive social or environmental impact, which is actively measured.¹³ It represents a new form of international development financing that is grounded in the view that it is possible to “do well by doing good” and facilitate the development of markets at “the bottom of the pyramid”.¹⁴

Impact investors typically provide funding for private enterprises that serve a broader social mission – known social enterprises – in order to increase the scale of their operations. This can be achieved through direct investments, or indirectly, through pooled investment funds. A prominent example of successful impact investment is *d.light*, which has improved energy access for 45 million people through the manufacture and sale of affordable solar-powered lamps. While the US\$15 million Eye Fund I is an early example of an investment vehicle that pooled together various investors to channel funding to cataract hospitals. Alternative financial instruments, such as development impact bonds (DIBs), are also being viewed as a potential way to tap new funding while retaining a firm focus on outcomes and giving service providers the flexibility to allocate their resources efficiently.

Capital available for impact investment continues to grow, but deployment is limited by the quality of proposals. Respondents to the 2014 Global Impact Investing Network survey reported that a total of US\$12.7 billion had been planned for impact investment deals in 2014. This includes a 31 per cent year-on-year increase in the planned number of deals, to 6,419, with an average deal size of roughly US\$2 million.¹⁵ Despite the market’s strong growth, impact investors have highlighted a “shortage of high quality investment opportunities with [a] track record” and a corresponding “lack of appropriate capital across the risk/return spectrum” as the main constraints to deployment of capital.¹⁶ This report will focus on these concerns when assessing the potential for impact investment in eye health in low- and middle-income countries.

Impact investments span the traditional recipients of funds, as well as asset classes. They can therefore be structured as part of a balanced investment portfolio. Impact investments can be made into for-profit or non-for-profit organisations that are at the start-up phase or already established. They can be in the form of debt, equity or hybrid structures.

- **Debt** is lending money by one organisation to another on the condition that it is paid back at a later date, usually with a defined rate of interest.
- **Equity** is stock or any other security representing ownership in an organisation or asset.
- **Hybrid** instruments combine features of debt and equity.

¹³ World Economic Forum. (2013).

¹⁴ Rodin, J. and Brandenburg, M. (2014)

¹⁵ Saltuck, Y. et al. (2014).

¹⁶ Ibid.

As in the commercial market, debt may be preferable when future cash flows are fairly predictable and secure, such as in mature enterprises, while equity and hybrid structures may be preferable when they are not, such as in early-stage enterprises. In each case, however, the specific form of investment is likely to be dependent on the priorities and needs of the investor and recipient, respectively.

Recently, there has also been a trend towards impact investments being directed toward broader social programming activities where a market may not necessarily exist. Innovative financing vehicles have emerged to facilitate these types of investments. A notable example is impact bonds, which are being used to channel up-front funds from private investors to social organisations, with a third party (usually a government) repaying investors a financial return out of the savings created as a result of the successful performance of the intervention. From the perspective of investors, these models are effectively contingency loans, since payment is contingent on successful performance.

Despite being highly structured investment vehicles requiring considerable technical expertise, social impact bonds are being increasingly employed in developed markets, including Australia. In the development context, however, the market remains in its infancy. Early indications are that the model may be useful for increasing the scale of genuinely philanthropic activities at the economic and geographic periphery where current funding models are inadequate and there is little or no prospect of cost recovery. They can also be used to improve the effectiveness and reduce the risk of aid spending, as investors – not donors – bear the risk of failure. Returns to investors can be paid by a third-party donor with a specific interest in the development outcome.

Investor Profiles

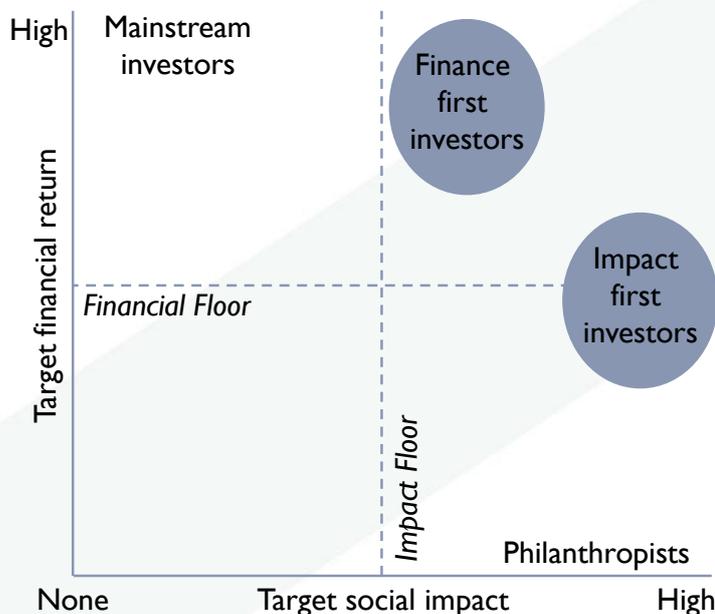
Impact investors can typically be categorised as either impact-first investors or finance-first investors (Diagram 1).¹⁷

- **Impact-first investors** seek to optimise social or environmental impact while achieving some minimum level of financial return. Often impact-first investors are philanthropically focused and prepared to take a lower-than-market rate of financial return in order to achieve targeted social or environmental goals.
- **Finance-first investors** seek to maximise financial returns consistent with seeking a minimum level of social or environmental outcomes. Often finance-first investors are commercially focused organisations that source investments that offer market-rate returns.

Given the early stage of the market for impact investment in eye health, impact-first investors have been selected as the core focus of this report.

¹⁷ Evenett, R. and Richter, K. (2011)

Diagram 1: Types of Impact Investors¹⁸



Impact-First Investments – Where Can Financial Returns Come From?

While impact-first investors tend to prioritise creating positive social impact, financial returns, or at least a return of capital, is a secondary goal.¹⁹ Approaches to impact investment are therefore likely to be guided, at least in part, by how investments generate revenue. Conventionally, impact-first investors have focused on funding social enterprises where user fees from the intervention itself provide a revenue stream. Recently, however, there has been a trend towards impact investments being directed toward delivery mechanisms where government contributes some, or all, of the financial return. This could include donor’s or government’s promises to pay for agreed outcomes, subsidies, or direct government purchasing of services through local insurance schemes (as is sometimes the case in health).

Impact-first investment is therefore a sufficiently flexible vehicle to increase the scale of social impact through a variety of different delivery and funding arrangements. Table 1 provides details of some of the conditions for success of each of these arrangements. However, broadly:

¹⁸ Adapted from Monitor Institute. (2009).

¹⁹ Wilson, K.E. (2014), p7

- A fully user-financed social enterprise model is suitable where the organisation is able to remain financially solvent and serve a broader social mission via customers' willingness to pay for a services. Different business models, such as franchising, micro-finance and cross-subsidisation can be adopted to ensure that low-income customers are able to access the services they need.
- Where a social enterprise cannot remain financially sustainable and provide services to a targeted cohort, external support from governments or donors may be required. In these cases, a direct subsidy can be provided to a business to ensure that targeted customers are able to access the services they need.
- Where a donor or government is prepared to provide services free at the point of service, or users have no capacity to pay, a fully donor-financed model may be most suitable. For these types of arrangements, it is important to ensure that the delivery of services is likely to achieve the targeted results, and service providers have the working capital required to deliver services without upfront payments from donors.

Table 1: Current Service Delivery Approaches Compatible with Impact-First Investment

Delivery and Funding Arrangement	Definition	Results Targeted	Financing	Application Criteria	Advantages	Disadvantages
User-financed social enterprise models (in which a private provider <u>can</u> remain solvent and serve a social mission)						
<i>Franchise</i>	Business model where licensed service providers have access to an entity's proprietary knowledge, processes and trademarks in order to allow the party to sell a product or provide a service	Expand quantity of a service or product while maintaining quality	Service provider finances operations, although seed grants may be provided by a donor agency or government	Product or service that can be easily replicated Sufficient market size to enable economies of scale to be captured	Leverage private enterprise to achieve greater social impact Focus on client-centred service delivery May provide a clear path to sustainability	Self-financing may be difficult to sustain due to low willingness of customers to pay Potential focus on non-poor customers High administrative costs for monitoring and evaluation
<i>Microfinance</i>	Business model where products or services sold to customers are financed through small loans that do not require collateral	Improve affordability of a service or product	Service provider finances operations, although seed grants may be provided by a donor agency or government	Operational model that enables affordable pricing Sufficient market size to enable economies of scale to be captured	Leverage private enterprise to achieve greater social impact Focus on client-centred service delivery May provide a clear path to sustainability	Self-financing may be difficult to sustain due to low willingness of customers to pay Potential over-exposure of poor customers to microfinance Potential focus on non-poor customers
<i>Cross-subsidisation</i>	Business model where higher prices are charged to one group in order to subsidise the lower prices for another group	Improve affordability of a service or product	Service provider finances operations, although seed grants may be provided by a donor agency or government	Product or service that is attractive to both high and low income customers	Leverage private enterprise to greater achieve social impact Potentially able to target poor customers May provide a clear path to sustainability	Self-financing may be difficult to sustain due to high last mile delivery costs Potential leakage to non-poor customers

Subsidised social enterprise models (in which a private provider cannot remain solvent and serve a social mission)

<i>Production Subsidy</i>	Grants or in-kind contributions that lower cost of production	Expand quantity of a service or product	Service provider finances operations and receives subsidies from a donor agency or government	Demand is sufficiently elastic to ensure service or product volumes increase Targeting possible by service provider or type of service	Leverage private enterprise to achieve greater social impact May be able to target poor customers May provide a clear path to sustainability	Subsidy not passed on to consumers Quality of services delivered may be low Leakage to non-poor customers
<i>Consumption Subsidy</i>	Vouchers or reduced prices for target customers	Expand consumption of a service or product by target customers	Service provider pre-finances operations and receives subsidies at or after sale from a donor or government	Demand is sufficiently elastic to ensure service or product volumes increase	Leverage private enterprise to achieve greater social impact Able to target poor customers Focus on client-centred service delivery	High administrative costs for management of vouchers and subsidies Quality of services delivered may be low Unlikely to provide a clear path to sustainability

Donor financed delivery models (in which a donor or government has an appetite to provide services free at the point of service, or users have no capacity to pay)

<i>Output Based Aid</i>	Output payments for service delivery to complement/replace user contributions	Outputs such as increased health services for the poor	Service provider pre-finances the project and receives output payments from a donor agency	Service provision/ accessibility can be improved through output payments	Funding received only for the delivery of measurable outputs Able to target poor customers	High administrative costs for monitoring and evaluation Possible leakage to non-poor Does not necessarily provide clear path to sustainability
<i>Performance Based Quality Financing</i>	Financial incentives given to service providers provided they meet quality benchmarks	Improved quality of delivery of health services	Service provider pre-finances the project and payment is for specified services, linked to degree to which services are of approved quality	Service quality can be measured Targeting by service provider or type of service	Funding received only for the delivery of measurable outputs Focus on quality services	High administrative costs for monitoring and evaluation Possible leakage to non-poor Does not necessarily provide clear path to sustainability
<i>Development Impact Bond</i>	Risk capital provides up-front financing. Flexible and adaptive implementation, including through use of real-time data	Achievement of target outcomes	Investor pre-finances the project, and donor repays capital plus a return contingent on the success of the programme	Complex intervention that requires adaptive management; or philanthropic interventions where scale and cost recovery is not feasible with current funding models Outcomes attributable to intervention Near- real-time data available	Private investors take impact risk and bring their resources and skills Incentives for investors/ intermediaries to establish adaptive management Focus on client-centred service delivery	Potentially higher costs of programme management, and need to provide returns to investors Possible leakage to non-poor Need for reliable data flow Does not necessarily provide a clear path to sustainability

Priority Causes of Avoidable Blindness for Impact Investment

Global Prevalence of Visual Impairment

²⁰ Baltussen, et al (2004); Danquah et al. (2014); Finger R, et al. (2012) for more information.

²¹ DALYs are a conventional metric for ascertaining the cost-effectiveness of health interventions; being widely used by health policy makers in resource allocation decisions. The measure derives from the Global Burden of Disease project and places different health considerations on like terms by combining the mortality and morbidity burden into a single metric. DALYs *averted*, therefore, are a measure of improvements in quality of life from improved health outcomes.

²² Pascolini, D. and Mariotti, S.P. (2012). Blindness is classified as scoring less than 3/60 in a visual acuity test where 3 is the distance in metres away from a vision testing chart that the person is reading; and 60 refers to the size of each character in the line being viewed. A visual acuity of worse than 6/18, but better than or equal to 6/60 is considered moderate visual impairment.

²³ Ibid.

²⁴ World Health Organization. Global trends in the magnitude of blindness and visual impairment. Based on a straight line extrapolation using 2010 data.

²⁵ Naidoo, K., Gichuhi S. et al. (2014); Keeffe, J., Taylor, H. R. et al. (2014).

²⁶ Pascolini D, Mariotti S. (2012); Gilbert C, S. Shah, M. Jadoon, et al. (2008); Brilliant G. and L. Brilliant (1985).

²⁷ Bourne, R. R., Stevens, G. A. et al (2013); Pascolini, D. and Mariotti, S.P. (2012); PwC and Three Rivers Consulting. (2011). The other major causes of blindness and visual impairment are glaucoma and age-related macular degeneration. Glaucoma is also considered to be among the 'avoidable' class of blindness in Bourne, R. R., Stevens, G. A. et al (2013), however, the fact that vision loss from glaucoma is irreversible and there is a general paucity of feasible treatment options in low- and middle-income countries means that it was not included among the five priority diseases by *VISION 2020: The Right to Sight* and is not generally a focus of development programming.

Causes of blindness and visual impairment for which treatment and prevention achieve high social impact relative to the cost are likely to be most attractive for impact investment. A large and deepening evidence base shows that there is a clear link between improving an individual's vision and improving their economic and social well-being.²⁰ This report focuses more closely on specific social returns from investment, given that benefit-to-cost ratios are a useful metric for evaluating competing investment proposals, as well as being indicative of interventions that might attract user payments or donor funds as a means to generating a financial return. Accordingly, for each of the major causes of avoidable blindness the benefits of treatment, presented as disability-adjusted life years (DALYs) averted, are compared to the typical cost of treatment.²¹ Based on this assessment, treatments for several eye health conditions are then selected as a focus for early-stage impact investment propositions.

In 2010, there were an estimated 285 million people worldwide who were visually impaired, of whom 39 million were blind – the rest being moderately and severely visually impaired (MSVI).²² Of these, 1.4 million children aged 15 and younger were blind and 19 million were visually impaired.²³ WHO estimates that by 2020 there will be 76 million people with avoidable blindness.²⁴ Low- and middle-income countries bear a disproportionate share of global prevalence of visual impairment, representing around 95 per cent of all reported cases.²⁵ Within countries, the poorest members of any society are more likely to suffer from vision loss.²⁶

It is estimated that three quarters of visual impairment is *avoidable* – that is, it can be prevented or treated. The six main causes of avoidable blindness and visual impairment globally are cataracts, uncorrected refractive error, diabetic retinopathy, trachoma, onchocerciasis, and vitamin A deficiency (xerophthalmia).²⁷ Detailed descriptions of each cause of vision loss, treatment options and effectiveness are presented in Tables A1 and A4 in Appendix 1.

Table 2: Summary statistics by cause of avoidable blindness in low- and middle-income countries

Eye Condition	Share of avoidable blindness (per cent) ²⁸	Share of avoidable visual impairment (MVISI) (per cent)	DALYs per 100,000 ²⁹
Cataracts	58	25	69
Uncorrected refractive error	36	71	81
Diabetic retinopathy	4	3	680*
Trachoma	2	1	5
Onchocerciasis	1 ³⁰	n/a	7
Vitamin A deficiency	n/a	n/a	12**

*Total diabetes; around one third of people with diabetes will develop some form of vision impairment.³¹

**Total vitamin A deficiency; 3 per cent of preschool-age children who were vitamin A deficient had xerophthalmia in 2009.³² Percentages may not sum to 100 due to rounding.

Across the world, the vast majority of all reported cases of avoidable blindness in low- and middle-income countries are untreated cataracts and uncorrected refractive error (Table 2).³³ Cataracts represent around 58 per cent of all blindness, while uncorrected refractive error comprises 36 per cent. Diabetic retinopathy and trachoma contribute a modest 4 and 2 per cent, respectively.³⁴ Similarly, with avoidable MVSI uncorrected refractive error and cataracts are most prominent, though in reverse order, accounting for 71 per cent and 25 per cent, respectively. To the extent that the interventions for both cataract and uncorrected refractive error are effective and relatively low cost, (see Table A4 in Appendix 1) these results highlight the potential for achieving large scale social impact relatively cheaply.

Due in part to the average age of onset for each condition, there are some variations in disease burdens between adults and children. Cataract blindness is correlated with advanced age while diabetic retinopathy is a late-onset symptom of poorly managed diabetes and is, therefore, predominantly in adults. In contrast, trachoma is estimated to be the fourth most prominent contributing factor of avoidable blindness cases globally but is a leading cause of avoidable blindness in children. Trachoma is an infectious disease and is easily spread where there are poor hygiene practices or water and sanitation infrastructure. Young children are the most susceptible to infection because good hygiene is not usually well established in childhood. An estimated 350,000 children are blinded every year as a result of vitamin A deficiency, most of whom die within a year of developing symptoms.³⁵

²⁸ Bourne, R. R., Stevens, G. A. et al (2013)

²⁹ Murray, C. J. (2013).

³⁰ Center for Disease Control and Prevention. (2013).

³¹ International Diabetes Federation. (2013).

³² World Health Organization. (2009). Global prevalence of vitamin A deficiency in populations at risk 1995-2005.

³³ Bourne, R. R., Stevens, G. A. et al (2013); in this context low- and middle-income countries is all World Bank regional groupings except Western Europe, North America High Income and Asia Pacific High Income regions.

³⁴ It is important to note that reported prevalence of diabetic retinopathy is known to be much lower than actual prevalence. As per McDonald and Taylor "Current estimates from the GBD study indicate that diabetic retinopathy is relatively small as a share of total blindness and visual impairment (equivalent to around 4.5 million people). However, back-of-the-envelope calculations suggest that diabetic retinopathy may be underestimated in the blindness statistics given that one third of the 382 million people currently estimated to have diabetes equates to 126 million people. While such statistical anomalies are cause for concern, the implication of this analysis remains the same: the prominence of diabetic retinopathy in overall visual impairment is likely to increase over time"; McDonald, L. and Taylor, K. (2014); International Diabetes Federation. (2013); World Health Organization. (2012). Global data on visual impairments 2010.

³⁵ World Health Organization. (2009).

Benefit-to-Cost Ratio of Eye Conditions

Given the high prevalence of trachoma and vitamin A deficiency in children, prevention and treatment of these conditions hold the potential for significant social impact, as measured in DALYs averted at the individual level (see Table A3 in Appendix 1).

In addition to observed variances of burden rates by age group, some regions have disproportionately high burden rates for certain conditions. Trachoma is estimated to cause 8 per cent of blindness in East Africa and 5 per cent of blindness in West Africa, compared to less than 1 per cent of blindness in other regions.³⁶ Onchocerciasis is highly concentrated in Central and West Africa due to the limited geographies in which the disease's blackfly vector lives.³⁷ Uncorrected refractive error is responsible for 36 per cent of blindness and 65 per cent of MSVI in South Asia.³⁸ This is significantly higher than the rates observed in other regions that range between 13 and 14 per cent of blindness and between 44 and 47 per cent of MSVI.³⁹ Between 1995 and 2005, xerophthalmia caused 2 per cent of blindness on the Africa continent, compared to between 0.2 and 1.2 per cent in other regions.⁴⁰ The concentration of some eye conditions in specific regions, such as trachoma and vitamin A deficiency, enables identification of potential target regions for an impact investment. It also highlights the possible economies of scale of delivering interventions, and thus the potential for achieving social impact at a relatively low cost.

Of the causes of avoidable blindness, treatment of cataracts, uncorrected refractive error, trachoma and xerophthalmia exhibit the highest benefit-to-cost ratio of treatment, expressed in terms of the cost per DALYs averted.⁴¹ High cost-effectiveness has the key benefit of improving the ability to attract donor funds (as required for pay-for-performance models) and user payments (as required for social enterprise models), and therefore the financial viability of an impact-first investment.

Cataracts involve a clouding of the lens that inhibits clear vision. Treatment is quick, straightforward and relatively inexpensive. Manual small incision cataract surgery (MICS), which is the preferred high volume cataract treatment in low- and middle-income countries, costs between I\$54-106 per DALY averted in low-and middle-income countries.⁴² In developed countries the phacoemulsification method is the standard model of care for cataract surgery. However it is considerably more expensive given the need for sophisticated equipment, including lasers, and the cost of the lenses inserted during surgery. Importantly, research shows that despite the cost differences there is no discernible difference in assessed visual outcomes and quality of life between the two approaches, suggesting that MICS is a viable and cost-effective treatment option in low-resource settings.⁴³

³⁶ Bourne Smith, J., Flueckiger, R. R., Stevens, G. A., Hooper, P., Polack, S., Cromwell, E. et al. (2013).

³⁷ Naidoo, K., S. Gichuhi et al. (2014).

³⁸ Keeffe, J., H.R. Taylor et al. (2014).

³⁹ This prevalence variance may be attributed to higher detection rates in South Asia.

⁴⁰ World Health Organization. (2009). Global prevalence of vitamin A deficiency in populations at risk 1995–2005.

⁴¹ A conventional threshold for determining a very cost effective health care intervention is that it averts a single DALY for less than the per capita income of the country in question (see Hutubessy et al. 2003, p6). This suggests that most eye care interventions identified in this report are highly cost effective.

⁴² I\$ is an abbreviation for international dollar, which is US dollars adjusted for purchasing power parity. It is therefore directly comparable to US\$. Source for I\$ per DALY averted for cataract surgery is Grimes, C., Henry J.A., Maraka, J. Mkandawire, N C. and Cotton, C. (2014).

⁴³ Wormald R.P. (2007). The only difference is that recovery times are quicker for phacoemulsification.

Uncorrected refractive error occurs when the shape of the eyeball inhibits the ability to focus. It is the leading cause of visual impairment and causes the majority of visual impairment in children. Individual cases are relatively cheap to treat, with the cost of screening and correcting refractive errors in children ranging from I\$67 per DALY averted in developing Asia and I\$168 in Africa.⁴⁴ However, treatment requires behavioural change to be effective and annual screens are recommended.

Trachoma is an infection with *chlamydia trachomatis* that causes a roughening of the inner surface of the eyelids and trichiasis.⁴⁵ While only representing a small share of all blindness, it is geographically concentrated and treatment is highly cost effective, at a cost of I\$13 to I\$78 per DALY averted.⁴⁶ It also affects both adults and children, increasing potential DALYs averted through treatment.

Xerophthalmia is the leading cause of blindness among children and is concentrated in specific countries in Africa. It can be effectively treated through supplements that cost US\$23–\$50 per DALY averted.⁴⁷

Diabetic retinopathy is a complication of diabetes that involves damage to the blood vessels that nourish the retina, and in some cases a detached retina or swelling of the retina. Approximately one third of people with diabetes are expected to develop some form of vision impairment.⁴⁸ Treatment has a relatively low benefit-to-cost ratio – largely because detection, diagnosis and treatment are all expensive and encounter considerable technological challenges. While pharmaceutical treatments exist, they are still in their infancy.

However, prevention of all diabetic symptoms has a potentially high benefit-to-cost ratio, where benefit is defined as improvements in health more generally. Diabetes causes 680 DALYS per 100,000 persons globally.⁴⁹ The number of people with diabetes is expected to surge from 366 million people in 2011 to 552 million people by 2030, with the largest increase expected in low- and middle-income countries.⁵⁰ If detected early, symptoms of diabetes can be reduced through control of blood sugar, pressure and cholesterol. Such interventions are relatively low-cost, although some issues exist around detection of diabetes and the behavioural change required of affected persons. Overall, while the management of diabetic symptoms has a potentially high benefit-to-cost ratio, the focus is not specifically on eye health, though there may be spillover benefits for eye care from improved diabetes care.

⁴⁴ Baltussen, R. Naus, J and Limburg, H. (2009)

⁴⁵ Trichiasis is a condition caused by abnormally positioned eyelashes that grow back toward the eye and scratch the cornea or conjunctiva.

⁴⁶ Baltussen, R. et al. (2005).

⁴⁷ Chow, J. et al. (2010).

⁴⁸ International Diabetes Federation. (2013).

⁴⁹ Murray, C. J. et al. (2012).

⁵⁰ Whiting et al. (2011).

Models for Impact Investment in Eye Health

In all, the combination of the ease of treatment, cost-effectiveness, social impact and prospect of some financial return mean that cataracts, uncorrected refractive error and trachoma are the most suitable candidates for early stage impact-first investment in eye health. Diabetes management is also a possible area for impact investments focused on achieving health improvements, though probably not direct treatment of diabetic retinopathy at this stage.

Sound investment propositions will need to be developed before impact investment capital can be tapped to increase the scale of each of these treatments. This section provides examples of financing approaches that could be used to leverage impact investment in a target region. Models include:

- **Cataracts:** Social enterprise with cross-subsidisation model in South-East Asia
- **Uncorrected refractive error:** Social enterprise with output payments in South Asia
- **Trachoma:** Development Impact Bond in East Africa
- **Diabetes:** Development Impact Bond for the Pacific Islands

Target regions have been selected based on the prevalence of each eye condition, as outlined in the section above. Each model is based on financing approaches previously applied. They seek to provide an example of how impact investment may make a positive contribution to reducing avoidable blindness in each case, rather than to definitively propose the best financing model, the best target region, or even assess the full feasibility of each model. Indeed, for each eye condition, there are likely to be numerous investment options that could be explored beyond those outlined in this section.

Cataracts: Social Enterprise with Cross-Subsidisation Model in South-East Asia

Barriers to Eye Care

Cataracts remain the leading cause of avoidable blindness and a significant cause of visual impairment.⁵¹ As discussed above, highly cost-effective treatments are available (costing around US\$25 to \$40 per operation⁵²). Social enterprise models have been developed that extend treatment to the poor by using wealthier patients' willingness to pay for services to cross-subsidise free services for the needy. However, limits on funding prevent these models from being established and taken to scale.

Proposed Delivery Model

High-volume cataract hospitals have emerged as an acclaimed social enterprise model for the treatment of cataracts. The business model applies a combination of rigorous cost control, tiered pricing and cross-subsidies

⁵¹ Bourne, R. R., Stevens, G. A. et al (2013)

⁵² Givewell (2012); Hutton, D. et al. (2014); conversation with LRBT high-volume cataract hospital, Pakistan.

from higher value-adding goods and services to provide free cataract surgery to the poor (between 10-50 per cent of all services), while remaining profitable.⁵³

The model has been replicated by over 300 hospitals around the world. Many have become key eye health providers in their respective countries. In India, where the model originated, the Aravind Eye Care System carries out 60 per cent as many eye surgeries as the UK's National Health Service with fewer complications, at one-thousandth the cost.⁵⁴ In Pakistan, LRBT hospitals, which also applies the model, undertake approximately one in every three eye surgeries in the nation.⁵⁵

Patients are offered a sliding scale of fees based on their willingness to pay for amenities (such as more luxurious rooms or special meal services), with free the lowest price. The cost to the patient for different levels of accommodation increases by more than the cost to the hospital, thereby allowing cross-subsidisation and the provision of free surgeries.

Critical to the financial model is patient volume and very low operating costs, which rely on economies of scale and a "production-line" approach. Nurses work with two operating tables, preparing patients before surgery on one and bandaging them afterwards on another, with a surgeon operating in between. Surgeons can then perform 2,000 surgeries a year.⁵⁶ Importantly, high volumes have not compromised quality.⁵⁷

The financial performance in 2013 of some prominent social enterprise hospitals include:⁵⁸

- The Aravind Eye Care System in India (which generated a 33 per cent annual net operating margin on cataracts); the He System in China (17 per cent margin); Magrabi eye hospital in Egypt (20 per cent margin); and Lumbini hospital in Nepal (generating a \$222,000 profit on cataracts).
- In Nepal, Tilganga institute of Ophthalmology a key partner of The Fred Hollows Foundation, 34 per cent of the 90,000 surgeries performed in 2010 were non-full paying (of which around half were free) with a net operating margin on cataract surgery of more than 10 per cent.

To date, capital constraints have been a key barrier to both the establishment and growth of cataract hospitals willing to adopt the social enterprise model. In general, hospitals have had to rely on slow, unreliable or relatively expensive forms of finance, such as donations and grants, local debt, and retained earnings of service providers, to purchase property and equipment at both the start-up and expansion phases.

⁵³ Matalobos, A. et al. (2010).

⁵⁴ Vickers, T. (2011); Rosenberg, T. (2013). A Hospital Network with a Vision.

⁵⁵ <http://www.lrbt.org.pk/>

⁵⁶ Rosenberg, T. A Hospital Network with a Vision.

⁵⁷ Lewallena S., and Thulasiraj, R. D. (2010).

⁵⁸ World Health Organisation and The Fred Hollows Foundation (2015). *Technical Consultation on Models of Innovative Financing for Eye Health*, Meeting Report, 2–3 December 2014 Manila, Philippines

Potential exists for impact investment to help to increase the reach of the high-volume cataract model. This includes expansion into new areas with high population density, such as South-East Asia, as well as expansion of existing hospitals. However, to do so requires detailed feasibility planning, including careful selection of the target population, as well as disciplined delivery. Successful expansion of the model would require:

- A strong grounding in both the demand and supply sides of large-scale cataract surgery in developing countries, especially in harder-to-reach rural areas.
- Flexible, innovative and data-driven performance management that allows effective roll-out in challenging markets.
- Strong financial management that reassures investors of the model's viability, and access to investors.

Proposed Financial Structure

Replication of a successful social enterprise model into other high-prevalence regions where the conditions are conducive to business development is likely to be an attractive proposition to impact-first investors.

Moreover, sizeable impact-first investments have already been made into such models. For instance, Deutsche Bank's Eye Fund I is a \$15 million investment fund that provided long-term debt and technical assistance to leading high-volume cataract hospitals using the cross-subsidy model in South America, Africa and Asia in order to purchase fixed assets to increase their capacity. This was the eye care industry's first fund ever to be created and was the first commercial-like debt taken by the eye hospital borrowers. It was also one of the first non-microfinance impact investment funds.⁵⁹ Initial discussions are underway for establishment of a second, larger, fund: Eye Fund II. Equity investments and grants have also been made in Aravind-like models by various impact investors and venture philanthropists.

The specific impact investment product in any given context will depend on the stage of the venture. Where a new cataract hospital is to be established, and thus where there is relative uncertainty around future cash flows, equity (or some other form of revenue-sharing agreement) is likely to be the most suitable form of investment – combined with a concrete exit strategy. Where an existing eye hospital converts its operating model to replicate elements of the social enterprise model, or a hospital already operating with the model wishes to expand its operations, fixed-term loans are likely to be a more suitable form of finance, given the relative predictability of future cash flows. At the economic and geographic periphery, where there is little-to-no capacity to pay and funding models are inadequate, alternative financing vehicles may need to be devised.⁶⁰

⁵⁹ Deutsche Bank. Global Social Investment Fund: Eye Fund I.

⁶⁰ An example is where a hospital is looking to take its philanthropic cataract surgeries – that is, treatment of the most poor and vulnerable – to a larger scale without the cross-subsidising revenue to provide financial support. In these contexts, pay-for-performance models may provide the basis for enticing impact investors into funding large-scale increases in cataract surgeries. In vehicles such as Development Impact Bonds, the promise of a third party to pay for performance is what provides investors with the prospect of a financial return.

Uncorrected refractive error: Social Enterprise with Output Payments in South Asia

Donors and philanthropically minded organisations can play an important role in facilitating impact investment into high-volume cataract hospitals. For instance, providing guarantees and being prepared to accept losses before other parties in specific investments can guarantee partial or full return of principal to investors, and thus crowd-in more commercial capital.⁶¹ Philanthropic funders and donors can also facilitate impact investment through the provision of technical assistance and grants to service providers to get them into position where they are ready to receive outside funding.

Barriers to Eye Care

Uncorrected refractive error is the leading cause of MSVI in both adults and children globally. In 2004, it was estimated that 12.8 million children under 15 years were visually impaired due to uncorrected refractive error.⁶² Visual impairment in children significantly reduces learning outcomes. Randomised control trials conducted in China have found that uncorrected refractive error in school children significantly reduces academic achievement.⁶³ As a proportion of MSVI, uncorrected refractive error is responsible for almost 50 per cent more cases in South Asia than in any other region.⁶⁴ While this may be due to better detection rates in South Asia, it indicates a clear need for improved services.

Uncorrected refractive error can be easily and cheaply treated through spectacles fitted by optometrists, nurses and, in some cases, vendors. However, user adoption remains a significant challenge. Studies have found that while purchase cost can be a barrier, there is a willingness to pay in most circumstances (between \$4 and \$7.50 in South Asia – or slightly more than a day's wage for a semi-skilled labourer).⁶⁵ Other significant barriers to adoption of spectacles include lack of awareness, negative perceptions about wearing glasses.⁶⁶

- In a study from Andhra Pradesh, India, 23.8 per cent of the 2,615 respondents identified as having a refractive error said they did not think their vision impairment was serious.⁶⁷ 20 per cent of respondents indicated that they had other obligations that prevented an eye check-up or clinic visit, and an additional 17 per cent stated that they could not afford eye glasses.⁶⁸
- A study in East Timor found that 78 per cent of people who were unwilling to use glasses did not like their appearance or expressed concerns about their community's perception of eyeglass wearers.⁶⁹ Other perception-related barriers include the objection of household heads because of a belief that glasses worsen eyesight, and refusal on the part of the child.⁷⁰

⁶¹ This was the case in the Eye Fund I, which combined a small tranche of private funding that yielded a market rate of return and received first-loss protection, with additional, larger, tranches of funding from philanthropically minded investors that yielded a lower rate of return and assumed relatively greater risk.

⁶² Resnikoff, S., Pascolini, D., et al. (2008).

⁶³ Glewwe, P., Park, A., and Zhao, M. (2014). Ma, X, et al (2014)

⁶⁴ Keefe, J. et al. (2014).

⁶⁵ Keay, L. et al. (2010); Sarker, et al (2015)

⁶⁶ Cherrier, P., and Jayanth, B. (2009).

⁶⁷ Nirmalan, P. K. et al. (2006).

⁶⁸ Ibid.

⁶⁹ Ramke, J. et al. (2007).

⁷⁰ Ibid.

- A study in China found that only 70 per cent of visually impaired students accepted free spectacles.⁷¹

Accordingly, any intervention focused on uncorrected refractive error requires a focus on reducing the cost of spectacles, as well as behaviour change – particularly among children.

Proposed Delivery Model

VisionSpring is one of the most well-known, and long-running, social enterprises focused on refractive error, applying a micro-franchising model to dispense spectacles. In 2013 VisionSpring sold 481,000 pairs of reading glasses across 26 countries.⁷² It is not, however, a widely replicated model, nor a model that has expanded beyond several countries. Accordingly, this section reviews the potential, through modification of the micro-franchising model, for impact investment to drive improvements in the provision of spectacles in South Asia.

VisionSpring distributes spectacles through wholesale pharmacy channels, branded optical shops in cities and “vision entrepreneurs” in remote communities.⁷³ Optical shops are located in densely populated regions in India and El Salvador to enable a high volume-low margin business model. “Vision entrepreneurs” provide basic vision screenings, sell reading glasses to the far-sighted and refer patients who need more advanced care back to optical shops where optometrists provide comprehensive eye exams. A range of frames, from basic to premium, are offered by all sales channels.⁷⁴ “Vision entrepreneurs” retain a portion of the income made per sale and return the remaining income to VisionSpring. Income earned by VisionSpring partially covers the operating cost of the enterprise.

While VisionSpring is effective at distributing reading glasses, it is not, to date, been a replicable or self-financing model. In 2009, its earned revenues covered only 19 per cent of total operating expenses, with the deficit being filled by philanthropic donations and grants.⁷⁵ A significant source of donations is Warby Parker’s *Buy a Pair, Give a Pair* program, under which a donation equal to the cost of sourcing a pair of reading glasses is paid to VisionSpring for every pair purchased. Warby Parker is a unique company that combines high-end design with a social mission. Accordingly, it might be difficult to convince a competing optical retailer to establish such a generous donation programme. Similarly, donors are unlikely to have the requisite capabilities to establish a successful cross-subsidisation optical business. Furthermore, while VisionSpring has been effective in distributing reading glasses, it is unclear how many spectacles have reached those who are most in need, including persons rendered blind due to uncorrected refractive error and visually impaired school children. Given the need for these groups to travel to optical shops for service, they may not be effectively serviced by VisionSpring’s model.

⁷¹ Glewwe et al. (2014).

⁷² Hassey, K. and Kassalow, J. (2014).

⁷³ VisionSpring. VisionSpring’s proprietary distribution channels; Ross School of Business, University of Michigan. (2008).

⁷⁴ Ibid.

⁷⁵ Ibid.

A model that combines VisionSpring's micro-franchising approach with donor subsidies for high-priority outputs, such as provision and direct marketing of spectacles to visually impaired school children, could be highly impactful on the social front and financially self-sustaining. Basic spectacles could be offered for a small nominal fee—and premium spectacles offered for a higher fee—to visually impaired school children and those blind due to uncorrected refractive error. The cost of providing these spectacles could then be subsidised through output payments from donors for every spectacle distributed and worn by these target groups. Given the significant reduction in DALYs and potential increase in economic output through treatment of uncorrected refractive error, donors are likely to be interested in making payments for such outputs, as well as for monitoring to verify outcomes. Accordingly, a combination of margins on premium frames sold and output payments could support a business model that corrects refractive error at scale, and for those most in need.

Success of this model is dependent on an operating model that can secure a high volume of customers while maintaining low costs. This will require selection, and ultimately establishment, of optical stores in areas that are densely populated but not currently well serviced. A marketing and outreach strategy will need to be developed that can attract customers at a low cost and encourage the ongoing use of glasses. This strategy will need to align with a pricing structure that is both attractive to target customers and can generate sufficient profit margins. Finally, a compelling case for output payments will need to be made. This will involve agreeing a payment schedule and independent verification process for spectacles distributed to the target population.

Proposed Financial Structure

The untested nature of the model means that a proof of concept is likely to be needed before enterprises are ready to receive external funding. Donors could therefore help incubate the model via a “bootstrapping” process. This involves pledging a limited amount of seed funding for new entities, and giving them a mandate to grow without the need for external repayments. Donors could provide additional support through output-funding commitments to ensure the enterprises optimise both social impact and financial returns, as well as grants to support marketing and monitoring activities. Once the enterprise is established, and the concept proven, it could receive additional impact investment, perhaps in the form of equity, to fuel further growth.

To the extent that this model focuses on reducing visual impairment in children in South Asia, a well-developed investment proposal is likely to garner interest from a range of potential funders. These include donors, venture philanthropy funds and impact investors alike, which are all active in the region. In addition, there might also be interest from eye health corporates.

Trachoma: Development Impact Bond in East Africa

Barriers to Eye Care

Trachoma is a leading cause of blindness in children. In Africa, almost 100 million people live in areas where the prevalence of active trachoma is above 10 per cent.⁷⁶ It is highly concentrated, causing 8 per cent of blindness in East Africa (particularly Ethiopia) and 5 per cent of blindness in West Africa, compared to less than 1 per cent of blindness in other regions.⁷⁷ The World Health Organization recommends an integrated package of interventions, known as the 'SAFE strategy', which combines:⁷⁸

- i) Surgery for trichiasis when the disease is advanced;
- ii) Antibiotic distribution to treat active infections;
- iii) Education in the importance of facial cleanliness to reduce chances of disease transmission; and
- iv) Better access to clean environments via improved water and sanitation systems and increased awareness of personal, domestic and community hygiene.

A truly sustainable reduction in prevalence of avoidable blindness from trachoma is, ultimately, dependent on clean environments. However, the other components of the 'SAFE strategy', which are important for treating the symptoms and preventing the spread of the infection, are intrinsically low cost and highly effective.

Trichiasis surgery is effective approximately 70-80 per cent of the time and has a cost effectiveness ranging between I\$13 and I\$78 per DALY averted.⁷⁹ Pfizer also makes large-scale donations of Azithromycin, a highly effective, non-invasive antibiotic for patients that can be taken orally, though the associated cost of training health workers in the use of antibiotics must still be incurred.⁸⁰

The main obstacle to an effective delivery mechanism rather than intrinsic cost barriers. Unfortunately, reliable delivery and compliance is a complex challenge, especially since in endemic areas interventions need to be coordinated and sustained across the whole community. Effective education campaigns require protracted delivery efforts that may be insufficient to affect behavioural change. And surgery, while relatively low-cost, requires a specialised two-week training course for ophthalmic assistants or nurses, and local availability of anaesthetics.⁸¹ In addition to supply-side problems, generating demand has its own obstacles. Thus even where surgery is free of charge, uptake is often low because sufferers may be unaware that surgery can help, and some patients cannot easily afford the cost of travel, or lack a companion to accompany them.⁸²

Proposed Delivery Model

A DIB focussed on trachoma treatment and control in high endemic areas in East Africa could be highly effective at reducing the prevalence of trachoma. Traditional approaches to development, with their emphasis on inputs and processes, are ill-suited to address the barriers to designing and managing an effective delivery mechanism for trachoma treatment. A DIB, with its strong emphasis on adaptive performance management, feedback loops and use of real-time data, could help overcome the following three obstacles to effective intervention:⁸³

⁷⁶ Smith, J., et al. (2013).

⁷⁷ Ibid.

⁷⁸ World Health Organization. (2014). Trachoma. Factsheet No. 382.

⁷⁹ Baltussen, R. M. et al. (2005).

⁸⁰ Pfizer. International Trachoma Initiative.

⁸¹ Wondu, A., and Bedri Kello, A. (2010).

⁸² International Coalition for Trachoma Control. Surgery.

⁸³ International Coalition for Trachoma Control. (2011).

- *Behavioural change to improve facial hygiene is not easily achieved.* Behavioural change programmes often suffer from an excessively input-driven approach, a lack of adequate monitoring, and insufficient understanding of what is and is not working on the ground. The performance management embedded in a DIB can help address these shortcomings by providing: (i) a metric of changed behaviours rather than implementation of specific education programmes as the goal of service providers and their managers; (ii) continuous collection and analysis of data on what is working and what is not; and (iii) intensive use of this data analysis to guide improvements in programme design and implementation. Some of these data-driven approaches have already been put in place as part of Development Media International's programme in Burkina Faso to reduce child mortality through behaviour change.⁸⁴
- *Large-scale administration of antibiotics faces significant operational obstacles in many markets.* Effective distribution to target populations can be hampered by an absence of established distribution channels and a lack of working capital to establish new distribution networks. Health workers may need retraining in the correct use and monitoring of new antibiotics. Inventory control and management practices may also be deficient. A DIB can help address these constraints by introducing a more private-sector outlook to the design, financing and management of distribution channels, and a more results-based approach to monitoring the success of treatment campaigns in each individual target area. Together with the pay-for-success aspect of a DIB, these elements ensure that all levels of an antibiotic administration programme are focused on the single goal of effective uptake, and that they adapt and improve quickly based on detailed evidence of effectiveness.
- *Increasing availability of effective trichiasis surgery.* While training trichiasis surgery operatives is, in theory, straightforward, there are significant difficulties in practice in delivering surgery to patients in rural and peri-urban areas. The International Coalition for Trachoma Control has identified five obstacles:⁸⁵ (i) high surgeon attrition rates; (ii) low productivity due to lack of materials and lack of supervisory support; (iii) cultural barriers limiting uptake of treatment; (iv) difficulty assessing trichiasis burden among hard-to-access populations; and (v) regulatory challenges to using non-physicians as part of surgery programmes. The DIB model could help overcome some of these obstacles by introducing more readily available working capital, transforming incentives to focus only on successful outcomes, and introducing innovative data-gathering techniques such as mobile technology to track demand and improve performance management.

⁸⁴ DMI. Proving Impact.

⁸⁵ International Coalition for Trachoma Control. (2011).

Proposed Financial Structure

A DIB focused on trachoma would be comprised of both outcomes funding commitments and impact investment. Outcomes funding commitments and impact investment are likely to be available for a suitably developed DIB proposition. The Alliance for the Global Elimination of Blinding Trachoma by the year 2020 has driven a focus on trachoma. Many donors fund trachoma control, including the USAID, UK's Department for International Development, Conrad N Hilton Foundation and the Queen Elizabeth Diamond Jubilee Trust, among others. Several development finance institutions and asset managers have expressed interest in investing in DIBs. Accordingly, it is possible that the support of key stakeholders could be generated to fund and launch a DIB focused on trachoma.

A donor could support development of a DIB focused on control of trachoma through both providing development funding and outcomes funding commitments. DIB development is an intensive, iterative, analytical process that requires strong stakeholder engagement. It involves definition of the target population, detailed design of the intervention model and target outcomes metrics, development of sensitised payment mechanism and overall management and governance structures. DIBs need to be designed in consultation with key stakeholders, particularly potential outcomes funders, investors and service providers. If successful, the design process would culminate in securing outcomes funding commitments and raising investment capital. Where the capital requirement is so high that there is a need to crowd-in more commercial capital, donors could also provide a first-loss guarantee. Such a guarantee is unlikely to be required where impact-first investors can meet the entire capital need.

Diabetes: Development Impact Bond in the Pacific Islands

About 8 per cent of the world's population suffers from diabetes.⁸⁶ In the small island developing states of the Pacific, the problem is particularly acute, with prevalence rates among the highest in the world.⁸⁷ And, as noted earlier, diabetic retinopathy (DR) is a frequent complication of poorly managed diabetes, and can eventually cause blindness.

Where interest exists to prevent DR before it manifests and facilitate broader health benefits, a focus on funding diabetes management could be well justified. Treatment for advanced DR entails prohibitively high costs for the vast majority of the populations of low- and middle-income countries. Furthermore, treatment of DR has no role in prevention and only solves one of the many potential complications of diabetes. Accordingly, as discussed above, a narrow focus on impact investment funding the treatment of DR is not recommended. However, a broader focus on diabetes management could have significant impact, and be a highly cost-effective intervention when all the benefits of diabetes prevention or control are taken into account.

⁸⁶ Akter, S. et al. (2014).

⁸⁷ IDF (2014).

An Impact Bond could be an effective approach for improving diabetes management. Social Finance Israel is currently designing a Social Impact Bond (SIB) focused on diabetes management. SIBs share the same structure as DIBs, with the exception that the outcome funder is the national government or foundation rather than an external donor. In the Social Finance Israel SIB, 1,500 pre-diabetics who are at high risk of developing type 2 diabetes will be selected to participate in a two-year intervention programme. The proposed intervention is based on a well-known and widely replicated clinical study that aims to achieve five lifestyle and dietary objectives, via subsidized gym membership, frequent nutritionist meetings and personal training sessions.⁸⁸ Participants of the Diabetes Prevention Program received intensive individual counselling and motivational support on diet, exercise and behaviour modification and successfully reduced their risk of developing diabetes by 58 per cent.⁸⁹ Outcome payments will be based on the performance of the selected cohort against a matched control group on several metrics, including the number of type 2 diabetic cases. It is expected that quantifiable cost savings, in the form of medical, welfare and disability expenses and improved economic productivity will be generated as a result of the programme. Accordingly, Social Finance Israel is in discussions with several government ministries that could benefit from the SIB to secure outcomes commitments.

The Impact Bond under development by Social Finance Israel is a replicable model. A donor could develop a DIB focused on diabetes management in, for example, the Pacific Islands, with outcomes funding sought from donors who operate in the region. Impact investors have already invested over US\$100m in Impact Bonds, and are likely to have interest in a suitably developed proposition if it can be shown to be applicable to a region with different physiological and cultural circumstances.

Comparison of Models

The preceding section has outlined financing models that could be applied to help provide much-needed capital to address each of the identified causes of avoidable blindness. Each model differs in its approach to service delivery and revenue generation (Table 3). Sources of revenue typically follow a sliding scale from being fully generated by user payments, such as in a traditional social enterprise model, to being fully generated by donor payments, such as in a DIB.

⁸⁸ Steyn, N. P. et al. (2004).

⁸⁹ National Diabetes Information Clearinghouse. Diabetes Prevention Program.

Table 3: Overview of example models

Cause of blindness	Beneficiaries	Geography	Service provider	Source of revenue	Source of upfront finance	Approach to development
Cataracts	Visually impaired and blind adults	South-East Asia	Social enterprise	User payments	Likely to be impact investors	Source partner enterprise
Uncorrected refractive error	Visually impaired children and adults	South Asia	Social enterprise	User payments and donor contributions	Likely to be impact investors	Seed new enterprises
Trachoma	All persons in affected areas	East Africa	Non-profit organisation	Donor contributions	Likely to be impact investors	Develop instrument
Diabetes	Pre-diabetic adults	Pacific Islands	Non-profit organisation	Donor contributions	Likely to be impact investors	Develop instrument

The different sources of revenue and the different players involved mean that the approaches to actualise each of these models will differ greatly. For instance, deals involving investments in social enterprise models could be led independently by service providers or investors, or even facilitated by donors through seed funding and capacity-building programmes. In contrast, development of DIB models requires the collaborative effort of both outcome funders, investors and service providers who will need to pull together a viable proposition. Ultimately, the determining consideration in the selection of any impact investment model is the level of interest of potential partners in the proposition.

Conclusion

This report indicates that potential exists for impact investment to improve the accessibility of eye care services in low- and middle- income countries but that further examination of the issue is warranted. It has been estimated that the impact investment market will expand rapidly in coming years, which means that there is feasibly a significant new pool of capital that could be made available to help eliminate avoidable blindness. For this capital to be tapped, however, propositions that enable both social impact, through improvements in eye health, and financial return need to be developed.

This report identifies the treatment of cataracts, uncorrected refractive error and trachoma as the most suitable focus areas for impact-first investments in eye health. Interventions for these conditions were found to have high benefit-to-cost ratios, which improve the ability to attract donor funds and/or user payments as required for impact-first investments. Diabetes management was also identified as a possible area for impact investments, where the investor is focused on achieving health improvements in general, rather than improvements in eye health specifically.

For each of the identified eye conditions, this report developed models of how impact investment could be leveraged. These included funding the expansion of a self-sustaining social enterprise cataract surgery model; funding the expansion of a social enterprise model in conjunction with donor outcome payments; and two separate development impact bond models, in trachoma and diabetes.

Each model represents one approach for how impact investment could be applied, rather than defining the best or only approach for leveraging impact investment. While service providers could independently develop some models, donors, foundations and social entrepreneurs can play a key role in bringing many of these models to life; funding the development of specific models, as well as supporting their implementation with financial and in-kind assistance.

Great opportunity exists to increase the pool of capital available for eye care through leveraging impact investment. To do so will require a new way of thinking for most of the key players. However, the potential upsides of embracing market-based solutions that achieve both improvements in eye health for those in need and a financial return for investors are enormous.

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Appendix 1: Assessment of the Causes of Blindness and Visual Impairment

Table A1: Characteristics of Causes of Blindness and Visual Impairment⁹⁰

Eye Condition	Description	Causes	Avoidable	Blind (per cent)*	MSVI (per cent)*	Prevalence		
						Children	Region ⁹¹	Trends ⁹²
Cataracts ⁹³	Clouding of the lens that inhibits clear vision	Aging, genetics (present at birth sometimes), injury or inflammation, other eye disease	Avoidable (treatable)	33	18	Low - onset typically age related	Prevalent globally - with above average prevalence in Asia and Africa	Decreasing – due to socioeconomic development and effective interventions
Uncorrected refractive error ⁹⁴	Eyeball shape inhibits the ability to focus. The most common types are myopia, hyperopia, presbyopia, and astigmatism	Aging, genetics	Avoidable (treatable)	21	53	High - causes the majority of visual impairment in children	Prevalent globally - with significantly above average prevalence in South Asia	Decreasing - due to socioeconomic development

⁹⁰ Source for percentage of total prevalence is Bourne, R. R., Stevens, G. A. et al. (2013). Global data on visual impairments 2010. Percentages are of all blindness and visual impairment and the entire world.

⁹¹ Bourne, R. R., Stevens, G. A. et al. (2013).

⁹² Stevens, G. A. et al. (2013).

⁹³ Brian, G., & Taylor, H. (2001).

⁹⁴ Naidoo, K. S., & Jaggemath, J. (2012).

Eye Condition	Description	Causes	Avoidable	Blind (per cent)*	MSVI (per cent)*	Prevalence		
						Children	Region	Trends
Diabetic retinopathy ⁹⁵	Damage to the blood vessels that nourishes the retina, and in some cases a detached retina or swelling of the retina	Poorly controlled diabetes mellitus – approximately one third of people with diabetes will develop some degree of eye damage (though it can be as high as 60 per cent) ⁹⁶	Avoidable (type 2 diabetes preventable) and somewhat treatable	3	2	Low - onset typically age related	Prevalent globally - with particularly high rates of diabetes in developing countries	Increasing - with growth in diabetes
Trachoma ⁹⁷	Scars on the cornea caused by in-turned lashes that inhibit vision	Infection with the <i>chlamydia trachomatis</i> organism - spread through contact with hands and clothing of infected people and infected flies	Avoidable (preventable and treatable causes of blindness)	1	1	High - infection typically spread by children	Concentrated in East Africa – in particular Ethiopia – with high prevalence also in West Africa	Decreasing - due to socioeconomic development and effective interventions ⁹⁸
Onchocerciasis (River Blindness) ⁹⁹	Inflammation of the cornea that causes opaqueness	Infection with a onchocerca volvulus parasitic worm - spread through bites from infected black flies that live near rivers	Avoidable (treatable)	1 ¹⁰⁰	0 ¹⁰¹	Med - infection contracted by adults and children	Concentrated in Central and West Africa - with some prevalence in other regions ¹⁰²	Decreasing - due to socioeconomic development and effective interventions

⁹⁵ Mayo Clinic. (2014). Diseases and conditions: Diabetic retinopathy.

⁹⁶ Helen Keller International. (2014). Diabetic retinopathy.

⁹⁷ World Health Organization. (2014). Trachoma. Factsheet No. 382.

⁹⁸ World Health Organization. (2012). Global health observatory: Trachoma.

⁹⁹ World Health Organization. (2014). Onchocerciasis. Factsheet No. 374.

¹⁰⁰ Center for Disease Control and Prevention. (2013).

¹⁰¹ Ibid.

¹⁰² World Health Organization. (2014). Onchocerciasis. Factsheet No. 374.

Eye Condition	Description	Causes	Avoidable	Blind (per cent)*	MSVI (per cent)*	Prevalence		
						Children	Region	Trends
Vitamin A deficiency (Xerophthalmia) ¹⁰³	Destructive dryness of the conjunctival epithelium	Lack of vitamin A rich foods in diet	Avoidable (preventable and treatable)	n/a	n/a	High - leading cause of blindness in children	Concentrated in sub-Saharan Africa - with prevalence globally ¹⁰⁴	Decreasing - due to socioeconomic development
Glaucoma ¹⁰⁵	Optic neuropathy present when at least one eye has both structural and functional defects	Aging, genetics (present at birth is rare) ¹⁰⁶ , poor vascular nutrition	Non-avoidable in LMICs	7	2	Low - onset typically after age 40	Prevalent globally - with slightly above average prevalence in Southern Africa	Increasing - with aging population
Macular degeneration ¹⁰⁷	Deterioration of the macula inhibiting the ability to see detail	Aging, genetics, cigarette smoking, high blood pressure	Non-avoidable	7	3	Low - onset typically age related	Prevalent globally	Increasing - with aging population ¹⁰⁸

¹⁰³ Chow, J. et al. (2010).

¹⁰⁴ World Health Organization. (2009). Global prevalence of vitamin A deficiency in populations at risk 1995-2005.

¹⁰⁵ Quigley, H. A. (2011).

¹⁰⁶ Thomas, R. (2012).

¹⁰⁷ The Fred Hollows Foundation. (2014).

¹⁰⁸ Jonas, J. B. (2014); Wong, W. L. et al. (2014).

Intervention Benefits by Cause of Blindness and Visual Impairment

Prevention and treatment of blindness results in significant improvement in the quality of life of affected people. Tables A2 and A3 below summarise the number of visually impaired persons and DALYs per eye condition.

Cataracts and uncorrected refractive error, were the eye conditions that caused the greatest DALYs in 2010, with 4.7 million and 5.6 million respectively.¹⁰⁹ This aligns with the fact that cataracts and uncorrected refractive error are the leading causes of blindness and visual impairment globally. Cataracts and uncorrected refractive error had low DALYs per an affected person, with 0.05 each.

Onchocerciasis and macular degeneration caused the greatest DALYs per an affected person, with 0.45 and 0.30 years respectively.¹¹⁰

Diabetes caused 0.13 DALYs per an affected person. However, this figure includes the impact of all diabetes complications, not just diabetic retinopathy for which there are limited data.

Despite affecting a large number of children, **trachoma** caused 0.09 DALYs per an affected person. DALYs recorded for trachoma may be underestimated due to significant data collection difficulties.¹¹¹

Vitamin A deficiency caused 0.00 DALYs per an affected person,¹¹² due to the large number of children who have vitamin A deficiency but do not develop xerophthalmia.¹¹³

In addition to improved quality of life, treatment of eye conditions results in economic benefits. A recent study by PricewaterhouseCoopers, commissioned by The Fred Hollows Foundation, estimates that the cumulative impact of lost economic activity in low- and middle-income countries from vision loss is US\$ 52 billion annually (in 2010 dollars).¹¹⁴ Treatment of visual impairment unlocks economic benefits through increased output of both affected persons and family and friends who care for these persons.

¹⁰⁹ Murray, C. J. (2013).

¹¹⁰ See Appendix Table A3.

¹¹¹ Ngondi, J. et al. (2009).

¹¹² See Appendix Table A3.

¹¹³ Imdad, A. et al. (2010).

¹¹⁴ PwC and The Fred Hollows Foundation. (2014).

Table A2: Global DALYs by cause of blindness and vision impairment between 1990-2010¹¹⁵

Eye condition		All ages DALYs ('000s)			DALYs (per 100,000)		
		1990	2010	%Δ	1990	2010	%Δ
"Avoidable" cases	Cataracts	4225	4732	12.0	80	69	-13.8
	Uncorrected refractive error	3608	5593	55.0	68	81	19.3
	Diabetes mellitus*	27706	46823	69.0	523	680	30.0
	Trachoma	144	334	132.5	3	5	78.9
	Onchocerciasis	512	494	-3.5	10	7	-25.7
	Vitamin A deficiency**	740	806	9.0	14	12	-16.1
	Glaucoma	443	943	112.7	8	14	63.7
	Macular degeneration	513	1329	158.9	10	19	99.2
	Other vision loss	4069	6240	53.4	77	91	18.0

*Total diabetes; around one third of people with diabetes will develop some form of vision impairment.¹¹⁶

**Total vitamin A deficiency; 3 per cent of preschool-age children who were vitamin A deficient had xerophthalmia in 2009.¹¹⁷

Table A3: Global Average DALYs by visually impaired person (VI) in 2010¹¹⁸

Eye condition		VI (millions)	DALYs (millions)	DALYs per VI
"Avoidable" cases	Cataracts	101.1	4.7	0.05
	Uncorrected refractive error	104.5	5.6	0.05
	Diabetes mellitus*	366.0	46.8	0.13
	Trachoma	3.6	0.3	0.09
	Onchocerciasis	1.1	0.5	0.45
	Vitamin A deficiency**	200.1	0.8	0.00
	Glaucoma	8.0	0.9	0.12
	Macular degeneration	4.4	1.3	0.30
	Other vision loss	60.2	6.2	0.10

Note: The global number of VI and the global number of DALYs are sourced from two different studies. Accordingly, there may be some inconsistencies in how the estimates have been developed, and therefore the average DALYs per VI that has been calculated.

*Total diabetes; around one third of people with diabetes will develop some form of vision impairment.¹¹⁹

**Total vitamin A deficiency; 3 per cent of preschool-age children who were vitamin A deficient had xerophthalmia in 2009.¹²⁰

¹¹⁵ Murray, C. J. (2013).

¹¹⁶ International Diabetes Federation. (2013).

¹¹⁷ World Health Organization. (2009). Global prevalence of vitamin A deficiency in populations at risk 1995-2005.

¹¹⁸ For VIs, World Health Organization. (2012). Global data on visual impairments 2010, for DALYs, Murray, C. J. (2013) and for DALYs per VI, this was calculated through dividing total VIs by total DALYs.

¹¹⁹ International Diabetes Federation. (2013).

¹²⁰ World Health Organization. (2009). Global prevalence of vitamin A deficiency in populations at risk 1995-2005.

Intervention Costs by Cause of Blindness and Visual Impairment

Cataracts hold potential to be treated effectively at low cost. A 2009 review of cost-utility calculations in various developing countries found that cataract surgery “easily meets the World Health Organization definition of very cost-effective, no matter how it is calculated, in many instances by a large margin”.¹²¹ Estimates vary, but empirical studies generally suggest that cataract surgery costs between I\$54 – I\$106 per DALY averted in low- and middle income countries (with one estimate placing it as low as I\$5).¹²²

Uncorrected refractive error can, similarly, be treated at low cost. The global cost of treating all uncorrected refractive error is estimated at US \$20-28 billion.¹²³ This can be compared to the estimated annual loss in global gross domestic product due to vision impairment caused by uncorrected refractive error of US\$202 billion.¹²⁴ Treatment is effective, though is dependent on patients continuing to wear and replace their glasses.

Xerophthalmia can be treated through the intake of supplements every few months.¹²⁵ Supplements cost of US\$23–\$50 per DALY averted.¹²⁶ Like cataracts and uncorrected refractive error, treatment is cheaper in high-density urban settings, and more expensive to deliver in rural locations. Accordingly, while challenges to delivery exist, potential exists to treat cataracts, uncorrected refractive error and xerophthalmia at relatively low costs.

Diabetic retinopathy is difficult and expensive to treat. It is generally asymptomatic in its early stages, and cases tend go undetected until permanent visual loss has occurred (in 2011 it was estimated that more than half of people affected were undiagnosed).¹²⁷ If diabetes is detected early, retinopathy can be prevented through control of blood sugar, blood pressure and cholesterol. Otherwise, complex and expensive procedures such as focal laser treatment, scatter laser treatment or vitrectomy are required.¹²⁸

Treatment of communicable eye conditions has been shown to be very effective. Eradication of communicable diseases, such as **onchocerciasis** and **trachoma**, requires community-wide and sustained interventions. Despite the complexity of delivering such interventions, efforts to reduce onchocerciasis have been very successful, with the Programme for Onchocerciasis Control now focused on elimination. Trachoma has become cost-effective to treat. It has been estimated that providing surgery to 80 per cent of those who need it would have a cost effectiveness ranging from I\$13 to I\$78 per DALY averted.¹²⁹

Table A4 on the following page summarises the data used to draw these conclusions.

¹²¹ Lansingh, V. C. and Carter, M. J. (2009).

¹²² Grimes, C., Henry J.A., Maraka, J. Mkandawire, N C. and Cotton, C. (2014)

¹²³ Fricke, T. R. et al. (2012).

¹²⁴ Ibid.

¹²⁵ Chow, J. et al. (2010).

¹²⁶ Ibid.

¹²⁷ World Health Organization. (2007).

¹²⁸ Narayan, K. M. V. et al. (2006).

¹²⁹ Baltussen, R. et al. (2005).

Table A4: Treatment by Eye Condition

Eye Condition	Interventions	Components	Challenges	Effectiveness	Cost
Cataracts	<ul style="list-style-type: none"> Manual small incision cataract surgery (removing the cataract through a 6mm scleral tunnel and aspirating the remaining cortex) exclusively practiced in low- and middle-income countries. Phacoemulsification (an ultrasound probe enters through a 3mm incision and emulsifies the cataract nucleus – does not require sutures) practiced mainly in high income and some middle income countries. 	<ul style="list-style-type: none"> One-off procedure involving an intra-ocular lens. Laser machine for phacoemulsification. 	<p>Low, issues include:¹³⁰</p> <ul style="list-style-type: none"> Insufficient number of surgeons and inadequate facilities. Lack of uptake due to distance to services and lack of education about the condition, misconceptions about the surgery and traditional beliefs. 	<p>High, for the following reasons:</p> <ul style="list-style-type: none"> A person with a cataract can be treated surgically in approximately 20 minutes and can often see clearly the next day. The level of visual acuity in initial post-operative visual assessments are a strong predictor of the medium success of cataract surgery.¹³¹ Highly cost-effective, whether measured in terms of the economic return or of the value of restored sight to individuals.¹³² 	<p>Depends on intervention</p> <ul style="list-style-type: none"> Low for small incision surgery, with one-off costs of I\$54-106 per DALY averted in LMICs¹³³ High for phacoemulsification once
Uncorrected refractive error (URE)¹³⁴	<ul style="list-style-type: none"> Eye glasses/contact lenses Refractive surgery 	<ul style="list-style-type: none"> Eye glasses and contacts must be worn daily and contacts must be replaced. Refractive surgery is typically done once per eye. 	<p>Low, issues include:</p> <ul style="list-style-type: none"> Insufficient number of trained practitioners and inadequate facilities. Many interventions diagnose and treat only distance vision and do not address presbyopia. Lack of demand and unwillingness to pay for eyeglasses are substantial barriers 	<p>Medium, for the following reasons:¹³⁵</p> <p>Global cost of treating all URE is estimated at US\$20-28 bn. This can be compared to the estimated annual loss in global gross domestic product due to distance vision impairment caused by URE of US\$202 bn.</p>	<p>Low, with the following costs:</p> <p>US\$32 to US\$145 per patient,¹³⁶ cost of screening and correcting refractive errors in children ranging from I\$67 per DALY averted in developing Asia and I\$168 in Africa¹³⁷</p>

¹³⁰ Brian, G., & Taylor, H. (2001).

¹³¹ Congdon, N. et al. (2013)

¹³² Lansingh, V. C. and Carter, M. J. (2009).

¹³³ Grimes, C., Henry J.A., Maraka, J. Mkandawire, N C. and Cotton, C. (2014)

¹³⁴ Quigley, H. A. (2011).

¹³⁵ Fricke, T. R. et al. (2012).

¹³⁶ PwC and Three Rivers Consulting. (2011).

¹³⁷ Baltussen, R. Naus, J and Limburg, H. (2009)

Eye Condition	Interventions	Components	Challenges	Effectiveness	Cost
Diabetic retinopathy ¹³⁸	<ul style="list-style-type: none"> • If detected early, control of blood sugar, pressure and cholesterol through behavioural change; a intraocular steroid injections • If severe, focal laser treatment, scatter laser treatment or vitrectomy. 	<p>For treatment of severe diabetes:</p> <ul style="list-style-type: none"> • Vitrectomy may be followed or accompanied by laser treatment. • Procedures may be repeated if necessary over time. 	<p>High, issues include:¹³⁹</p> <ul style="list-style-type: none"> • Low detection. For instance, in 2011 it was estimated that more than half of people affected were undiagnosed. <p>Interventions are complex and expensive.</p>	<p>Medium, with the following issues:¹⁴⁰</p> <ul style="list-style-type: none"> • Legitimate concerns regarding systemic safety, cost-effectiveness and sustainability of anti-VEGF therapy • Could substantially reduce visual impairment from diabetic retinopathy, ultimately it is not a cure 	<p>High, with the following treatment costs:¹⁴¹ US\$66 to US\$2,431 per patient.</p>
Trachoma ¹⁴²	<p>“SAFE” strategy to combat trachoma in endemic areas:</p> <ul style="list-style-type: none"> • Surgery for trichiasis; • Antibiotics to treat chlamydia trachomatis infection (ointment administered into the eye is for post-surgical cases (S) and the oral administration is for treatment of the active infection (A); • Facial cleanliness (F); and • Environmental improvement (E) to reduce transmission from one person to another 	<p>Surgery:</p> <ul style="list-style-type: none"> • Follow-up in 7-10 days to remove sutures, measure visual acuity and treat infections and again in 1 year. • May be repeated if there are reoccurring infections with substantial scarring. <p>Antibiotics:</p> <ul style="list-style-type: none"> • Can be administered as ointment directly in the eye or through oral administration. 	<p>Medium – High, issues include:</p> <ul style="list-style-type: none"> • Can be treated with antibiotics in the early stages of infection. Interventions need to be coordinated and sustained across the whole community. • Treatment becomes increasingly complex and less successful as infection becomes chronic and scarring occurs on eyelids and cornea 	<p>Medium, issues include:¹⁴³</p> <p>Surgery is effective approximately 80 per cent of the time, where effectiveness is defined as no trichiasis in operated individuals after 2 years.</p>	<p>Low, average fully loaded cost of surgery of between US \$40 - \$70.¹⁴⁴ Providing surgery to 80 per cent of those who need it would have a cost effectiveness ranging from I\$13 to I\$78 per DALY averted.¹⁴⁵</p>

¹³⁸ Mayo Clinic. (2014). Diseases and conditions: Diabetic retinopathy.

¹³⁹ World Health Organization (2007).

¹⁴⁰ Cheung, N. et al. (2014).

¹⁴¹ PwC and Three Rivers Consulting. (2011).

¹⁴² World Health Organization. (2014). Trachoma. Factsheet No. 382.

¹⁴³ International Coalition for Trachoma Control. Surgery.

¹⁴⁴ International Coalition for Trachoma Control (2011), p29; and International Coalition for Trachoma Control (forthcoming); based on expert consensus, the fully loaded cost includes training, supervision, material, post-operative care, planning, both for the case finding and the actual surgery

¹⁴⁵ Baltussen, R. et al. (2005).

Eye Condition	Interventions	Components	Challenges	Effectiveness	Cost
Onchocerciasis (River Blindness) ¹⁴⁶	Vector control and community directed treatment with ivermectin.	Annual or biannual treatment with ivermectin for 10-5 years	Medium , issues include: <ul style="list-style-type: none"> At least 15 million additional people need to be reached in the next few years for elimination Ivermectin cannot be used in people co-infected with loa loa. 	High , for the following reasons: Programme for Onchocerciasis control has now shifted from control to elimination after a successful reduction in onchocerciasis	Low , with the following treatment costs: ¹⁴⁷ US\$1 to US\$181 per patient treated.
Vitamin A deficiency (xerophthalmia) ¹⁴⁸	Oral supplements; <ul style="list-style-type: none"> Food fortification; or Behavioural change relating to diet. 	<ul style="list-style-type: none"> Supplements required every few months. Fortified foods would be commonly consumed foodstuffs. 	Low , issues include: <ul style="list-style-type: none"> Difficult and expensive to deliver supplements to remote locations. Start-up costs for GM fortified foods are substantial. 	High , for the following reasons: <ul style="list-style-type: none"> Supplements consumed semi-annually can prevent vitamin A deficiency. GM fortification could avert the 18-34 m DALYs. ¹⁴⁹ 	Low , supplements cost US\$23 to US\$50 per DALY averted.
Glaucoma ¹⁵⁰	<ul style="list-style-type: none"> Eye drops; Surgical trabeculectomy; or laser trabeculoplasty 	<ul style="list-style-type: none"> Eye drops must be used daily for the remainder of the lifespan; Surgical trabeculectomy may need to be repeated after five years; and Laser trabeculoplasty may need to be repeated¹⁵¹ 	High , issues include: ¹⁵² <ul style="list-style-type: none"> Difficult to diagnose as asymptomatic in early stages – e.g. in India it is estimated that 90 per cent of cases are undetected; and Insufficient number of skilled healthcare professionals to diagnose and treat. 	Low , issues include: <ul style="list-style-type: none"> *Routine population screening is not cost-effective because “harvest rates” are too low.¹⁵³ Effectiveness contingent on compliance with follow-up and 	Depends on intervention: ¹⁵⁴ High - Upfront cost of US\$2,569 per patient for surgery /laser treatment.

¹⁴⁶ World Health Organization. (2014), Onchocerciasis. Factsheet No. 374.

¹⁴⁷ PwC and Three Rivers Consulting. (2011).

¹⁴⁸ Chow, J. et al. (2010).

¹⁴⁹ Imdad, A. et al. (2010).

¹⁵⁰ Gudlavalleti, V. S. M. et al. (2014).

¹⁵¹ Ibid.

¹⁵² Nirmalan, P. K., Katz, J. et al. (2014).

¹⁵³ Thomas R. (2012).

¹⁵⁴ PwC and Three Rivers Consulting. (2011).

Eye Condition	Interventions	Components	Challenges	Effectiveness	Cost
Macular degeneration ¹⁵⁵	If diagnosed early, treat through laser. Otherwise, slow rate of degeneration through: <ul style="list-style-type: none"> • Laser treatment • Photodynamic treatment • Drug injections • Vitamin and mineral supplements • Ocular anti-vascular endothelial growth factor (VEGF) therapy • Assist vision through magnifying spectacles and other devices 	<ul style="list-style-type: none"> • Drug injections may be required on a monthly basis and may require treatment with antibiotic eye drops to avoid infection; and • Frequency of laser and photodynamic therapy will vary. 	High , issues include: <ul style="list-style-type: none"> • Drugs are not available in low and middle income countries. • Interventions are complex and expensive. 	Low , issues include: <ul style="list-style-type: none"> • Can only be treated if diagnosed early. 	High – Although estimates not available, it is known to be very costly.

¹⁵⁵ The Fred Hollows Foundation. (2014). Macular degeneration; National Eye Institute. (2014).