

Research Proposal: Improving Cataract Surgical Rates through Better Incidence Estimation

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1 Introduction

Surgically removable cataracts remain the leading cause of blindness worldwide. The disease is much more common in developing countries due to the absence of ophthalmologists who can perform cataract surgery. Though many factors influence cataract development, the vast majority of cases are age-related and develop in persons over 50 years old. Studies show that women are more susceptible to cataracts and, in Africa, they tend to have less access to treatment. The World Health Organization's VISION 2020 project, which seeks to eliminate the main causes of avoidable blindness by 2020, includes an important focus on increasing the number of cataract surgeries in Africa [4]. Ideally the number of surgeries performed each year would equal the number of incident cataracts (new cataracts developed) that year. Unfortunately, measuring cataract incidence directly would require surveying the same group of people over a number of years to see when cataracts were developed, a procedure that is often impossible in Africa. For the past several years, because of the lack of data, sub-Saharan Africa has been assumed homogeneous in terms of cataract incidence, and cataract surgical rate (CSR) targets have been equal in these regions.

While cataract incidence is difficult to measure, new Rapid Assessment of Avoidable Blindness (RAAB) surveys provide data about age-specific cataract prevalence (the percentage of the population with cataracts in one or both eyes). The challenge is therefore to estimate cataract incidence from prevalence. In simple diseases that are not age-dependent and do not affect death rate, there is a simple dependence between incidence, prevalence, and disease duration, such that any of these can be calculated from the other two. However, cataracts have been shown to affect death rates, and age dependence is an important factor. In a 1986 paper^[3], M. Podgor and M. Leske propose one strategy for incidence estimation, which was used in the methods developed by S. Lewallen et. al.^[1]. Initial results showed a surprising amount of variation between different parts of sub-Saharan Africa,

suggesting genetic or environmental differences. These results imply a significant re-allocation of human resources in this region, potentially allowing ophthalmologists to serve many more people. They also suggest that the analysis of additional countries, as well as efforts to improve the incidence estimation technique, would be very useful.

2 Proposed Research

To begin, I will examine code^{[1][2]} written by summer research student Brian Stock that applied Podgor's method^[3] to RAAB data on different sub-Saharan African countries. I will extend his proof-of-concept work to additional countries (as data becomes available) and separate the data based on gender to test the common belief that cataract incidence rates are higher among women. My hope is that this analysis will provide the best information possible to VISION 2020 policymakers.

Secondly, as the main theoretical component of my thesis, I will investigate alternative methods of incidence estimation. In particular, Podgor uses a very simple probabilistic model (exponential distributions) for the possibilities of death without cataracts, development of cataracts, and death in the presence of cataracts. It is likely that survival analysis techniques using available survey or census data on age-dependent death rates could improve significantly on this model. Also, Lewallen et. al. pooled data from different countries provided that 95% confidence intervals for their prevalence data overlapped for most age groups. I could explore more sophisticated data clustering techniques that weight these age groups by population, allowing us to take into account the fact that there are many more people 50-55 or 55-60 years of age than in other groups.

In addition to considering the underlying assumptions of the existing method (either validating them or using more realistic assumptions in developing new methods), I would like to test the accuracy of the results produced by different methods. There exist small datasets containing both incidence and prevalence data. While these data were not sufficient to uncover variability in incidence in sub-Saharan Africa, they can be used to validate and compare incidence estimation methods. If I am able to improve incidence estimation techniques, they will not only be used for future CSR rate calculations in this area, but could be applied to estimate age-specific incidence from age-specific prevalence data for any disease with differential mortality.

If time permits, I could also recommend areas where it is most important to conduct additional RAAB surveys to improve our data and better

understand cataract incidence variations in sub-Saharan Africa.

3 Prior Research

In 1986, Podgor proposed a strategy for incidence estimation that assumed independent exponential distributions for death in the absence of the disease, occurrence of the disease, and death in the presence of the disease^[3]. Based on this model, his method can be used to calculate incidence (related to the parameter in the distribution for occurrence of the disease), given disease prevalence at two different times. A literature search is needed to determine whether, in the 23 years since this paper was written, alternative strategies seem have been proposed or tested. However, it seems there is room for creativity and thoroughness in developing, testing, and/or utilizing alternatives.

Last summer, Brian Stock and Professor Williams successfully applied Podgor's method to RAAB data giving prevalence at two times (5 years apart) in different regions of sub-Saharan Africa. They discovered surprising variability between regions, with incidence in Eastern African countries (Kenya, Tanzania, and Rwanda) about 2.7 times lower than in other sub-Saharan countries surveyed (Eritrea, Mali, and The Gambia)^{[1][2]}. This is an immensely useful result since previous CSR rate target planning had lacked any data on regional variability. The problem clearly merits future work.

References

- [1] S. Lewallen et. al., *The variation in prevalence and incidence of vision-reducing cataract in Africa* (unpublished draft).
- [2] S. Lewallen et. al., *Calculating target cataract surgical rates for Africa* (unpublished draft).
- [3] M. Podgor & C. Leske, *Estimating Incidence From Age-Specific Prevalence for Irreversible Diseases With Differential Mortality*, *Statistics in Medicine*, Vol. 5 (1986) pp. 573-578.
- [4] *Vision 2020 Mission, Goals, Aims and Objectives*, <http://www.v2020.org/page.asp?section=000100010009> (4 Sep. 2009).