The L V Prasad Eye Institute's **Rural Eye Health Pyramid**

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Preamble

I have been trained in, and practicing the methods of optical spectroscopy to study the structure-function relationship of proteins in solution. In this theme, I have also been using the novel technique of Photoacoustic Spectroscopy (PAS) to gather similar information about protein assemblies and pigments that are not transparent, but cloudy and opaque.

When I went over to present our PAS work at the Biophysical Society Congress in Mexico City in the early 1980s, I met the late Prof. Bireswar Chakrabarti of Harvard University (an expert in the study of the proteins called crystallins, which assemble to form the transparent lens of the human eye). He suggested that we use PAS to study cataract, the eye disorder wherein the crystallins become insoluble, making the lens lose transparency.

How I changed to become an eye biologist

This important meet changed my research focus and I decided to concentrate on the study of eye lens proteins, cataract biology, its mechanism, prevalence and related aspects. My students and I at CCMB would go along with cataract surgeons at Hyderabad, who would arrange rural eye camps once a month or so in small towns in the state, offer treatment and also do cataract surgeries to restore sight. We would pick up these discarded lenses, bring them to the lab and study the details of the protein modifications (such as their stability, changes in amino acid sequences, photochemical changes in them leading to colouration, and so forth).

The second important meet was in 1987, when Dr. Gullapalli Nageswara Rao (GN Rao), who had recently returned to India in order to set up the non-profit, non-govt., L V Prasad Eye Institute (LVPEI) at Hyderabad. He visited us at CCMB and we began interacting together. His clinical colleagues would visit CCMB once a week, and we would visit LVPEI once a week. This grew fast, and we began an active collaboration. We had one of their microbiologists come and work at CCMB and obtain her Ph.D. degree. They placed a geneticist (Dr Chitra Kannabiran) at CCMB in order to do her cataract genetics work on the patients seen at LVPEI, for a couple of years before her lab was getting set up there.

Table 1

Causes of the disorder	Prevalence in the state	Blindness among the people
Cataract	0.81%	44.0%
Refractive errors	0.3 %	16.3%
Retinal Diseases	0.2 %	10.9%
Glaucoma	0.15%	8.2%
Corneal diseases	0.13%	7.1%
Optic atrophy	0.11%	6.0%
Amblyopia (lazy eye)	0.08%	4.3%
Microphthalmia	0.02%	1.1%
Other disorders	0.04%	2.2%
Total	**1.51%**	**100%**

A: Blindness Burden in the (undivided) State of Andhra Pradesh (in the early 1990s)

Causes of the disorder	Seen in the urban area	Seen in the rural area
Cataract	0.45%	0.95%
Refractive errors	0.15%	0.35%
Retinal Diseases	0.22%	0.19%
Glaucoma	0.16%	0.14%
Corneal diseases	0.19%	0.12%
Optic atrophy	0.16%	0.08%
Amblyopia (lazy eye)	0	0.11%
Other disorders	0.03%	0.05%

B: The Urban- Rural Divide

Epidemiology and the Birth of the Rural Heath Pyramid

It is important to note that LVPEI has not been planned to be just an ophthalmic hospital, but an Institute with activities beyond clinical ophthalmology- namely basic scientific research, clinical research, microbiology, eye bank, computer-based records of the details of each patient, methods to aid low vision (and no vision) patients, public health and epidemiology, and innovation. In 1990, they started their first epidemiological study of the blindness burden in the state, called the Andhra Pradesh Eye Disease Study or APEDS. In this study, a team of ophthalmologists, along with epidemiological experts,

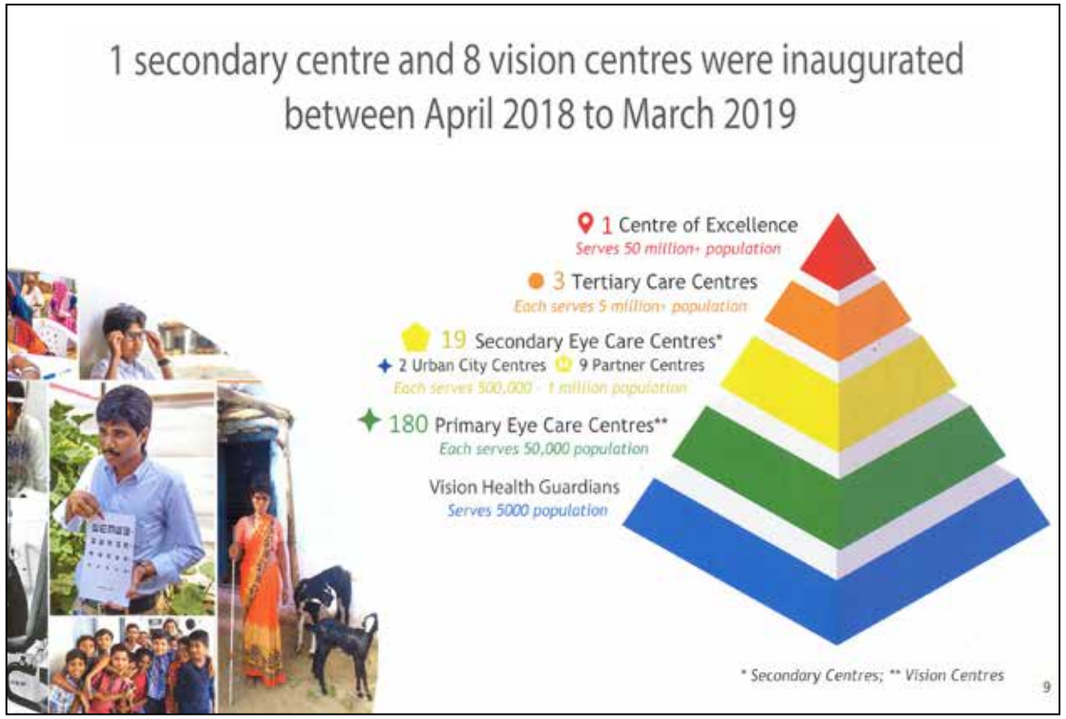
would visit various parts of the state, examine the conditions of the eyes of people in villages and towns, while the epidemiologists would gather details about their family members, occupation, diet, health conditions, work and income, and so forth. The results of APEDS-1 (conducted during 1990-95, and the data analyzed until 2001) were published in a series of papers, which have been an 'eye opener'! They showed that 1.8% of the people in the state were visually handicapped. Extrapolate this to India, it means that about 2.3 crore people across India are visually handicapped in one form or other!

The numbers presented in Table 1A highlight the types of blindness burden, and how they differ remarkably between the urban areas and the rural villages and small towns. All forms of blindness are seen to be higher in the villages. We know that cataract is an easily treatable disorder, and vision is restored by a simple surgery. The urban patient has access to eye care surgeons and gets his treatment done. But, a person in the rural area has no easy access to it. He has to come all the way to the nearest city (along with a care-giver), stay there and get back, losing two days of income. Sadly enough, while India has about 25,000 registered ophthalmologists, hardly a handful practice in the rural areas. Hence, the periodic rural eye camps conducted by concerned city-based ophthalmologists, where they offer free cataract surgeries, but sadly again, post-operative care is missing, and infection of the eye ends up as a result.

Likewise, refractive error can be treated in minutes and eye sight improved; all that is needed is a trained optometrist (not an MD but a certified license holder) to diagnose and offer corrective eyeglasses. India has about 55,000 certified optometrists, and most of them are in urban areas.

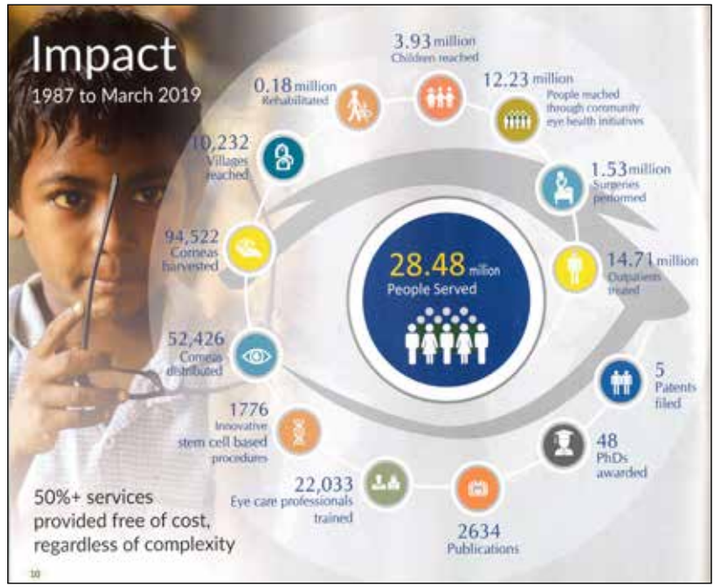
What then is needed is to develop an eye care model that can reach the unreached, in a manner that is appropriate, available, affordable and accessible.

A model of this kind, which can be spread across the country would be of great help in India achieving its declared goal of 'vision for all', and what the WHO has declared as 'Vision2020', such that by the year 2020, people across the globe achieve what the eye care professionals term as 20/20 vision,



or perfect eyesight. This is what LVPEI decided to do as its mission.

Look at the numbers in Table 1 again. In order to diagnose the refractive error and offer spectacles to the needy, one does not need an eye doctor or an optometrist. If we can train high school graduates from villages and small towns for 6-12 months at a high quality eye institute such as LVPEI, and once certified as fit, they are put them back as 'Vision Technicians' (or VT) at home, in what is called Vision Centres (VCs), offer them the necessary basic equipment, and monitor their work real time from Hyderabad, they can do their job well. Such VTs, located in VCs, can help reduce 16.3% of the blindness burden. They check for refractive errors and offer spectacles, diagnose other advanced vision defects, and refer them to appropriate nearby eye centre for treatment. Some of them also help in rehabilitation of the visually handicapped people.



Setting up of such VCs has come about through financial help from local donors, and civil society organizations such as the Lions Club, Rotarians and international organizations as well. Self-help groups such as ASHA, which are in contact with the villagers, guide them to approach the local VCs. We call these groups as Vision Guardians (VG).

Since its start over two decades ago, LVPEI has set up about 180 such VCs across Telangana, Andhra Pradesh, Odisha and in Assam. Each of these offers free consultations, and has both paying customers and free customers. If a patient cannot pay, he is treated totally free, true to the motto 'so that all may see'. During the year 2018-19 alone, about 3,49,014 have been served by these VCs, and about 70% of them totally free of charge. (Indeed this cross-subsidy model has worked out quite well right through the four tiers of the Pyramid).

The next tier above in the Eye Health Pyramid is the Secondary Centre (SC). We now have about 30 of them across Telangana, AP and Odisha. These are regular eye hospitals, located within about 50 km from the VCs, and each SC caters to 10 VCs, plus the local patients nearby. Here again, admission and treatment are free for the needy. Government ration cards serve as admissible for free treatment. Each SC has a team of about 25 people - one or two ophthalmologists, optometrists, nurses, biomedical team, and a management team. Each SC handles typically about 200 patients, doing cataract, glaucoma, corneal treatment, patch for improving the lazy eye (cf. Table 1B), diabetic retinopathy, pediatric ophthalmology, and occasional corneal transplants. Meticulous medical records are kept about the clinical and other relevant details of each patient are kept digitally, so that they may be used for any additional care, plus for research (this is also done in the VCs). Each one of the SCs is named after the donor, thanks to whose magnanimity the building and parts of its infrastructure came about.

To give one example, the Kuchakulla Ramachandra Reddy Eye Centre, at Thoodukurthy, Telangana, celebrated its 20th Anniversary last year: In the past 20 years, this centre has served 266,849 outpatients and performed 33,153 surgeries. About 60% of the patients who came there for service were treated totally free of charge. 11 Vision Centres are connected to it today, and 303,088 people have been screened through them, during these 20 years.

The next higher rung in the pyramid are the Tertiary Centres, the Kode Venkatadri Chowdari (KVC) centre in Vijayawada, the GMR Varalakshmi (GMRV) centre at Visakhapatnam and the Mithu Tulsi Chanrai (MTC) centre in Bhubaneswar, each one named after its donor (just as LVPEI in Hyderabad is named after the famous film producer, late Shri L V Prasad, who donated 5 acres of land and Rs 1 crore to set up in 1987). These are full- fledged eye hospitals, comparable to the best in the country, but which also in addition conduct clinical and public health-related research. Research connections are made with the local universities, for joint research. They have eye banks, rehabilitation centres for the visually handicapped, and offer short and long term fellowships, thus acting as training centres as well. Each of them connects with the SCs in its region, and connects with the Kallam Anji Reddy (KAR) clinical campus LVPEI at Hyderabad, which is the top of the Pyramid (often also called the Centre of Excellence, or CoE).

Figure 1A shows the LVPEI Rural Eye Health Pyramid, and how during the year 2019-20, one SC and 8 VCs were added, and Figure 1B shows the overall performance of the Pyramid, and how we could serve 2.84 crores of people during these 32 years.

APEDS 1 has been followed by APEDS 2, ten years later, wherein the analysis and update of what has been achieved and what needs to be corrected or added; we are now involved in APEDS 3.

Research Activities at LVPEI

APEDS had offered such a wealth of data on the people interviewed, such as the types of clinical conditions, family details such as age, number of family members and their eye conditions, hereditary factors, any other clinical conditions, types of work engaged in, diet, exposure to sunlight and other details. These triggered activities not only in clinical research, but also in basic research on the biological aspects such as genetics of primary congenital glaucoma, cell and molecular biology, stem cell biology of the eye, microbiology and the ocular microbiome, vision psychophysics, tissue engineering, public health, and innovative products of use to the eye. A research centre called the Hyderabad Eye Research Foundation (HERF) was set up as part of LVPEI, recognized by government agencies for extramural funding for research. (This enormous possibility of working with clinicians in conducting what is known as Translational Research attracted me so much that I took voluntary retirement from the Directorship of CCMB to join LVPEI as its Director of Research in May 1998, help set up the lab facilities, recruited scientists in the above areas, applied for and started obtaining competitive grants).

Research at the LVPEI is done across all its Hyderabad, Bhubaneswar, Vizag and Vijayawada campuses, and is focused on what is known as Translational Research in all the above areas. It involves the clinical results obtained by the ophthalmologists and optometrists at the 'bedside' of the patient, discussing them with the scientists and technologists working on the lab 'bench' to find the basis behind the disorder; and also whether what is seen in the 'bench' can be used at the 'bedside'- indeed a virtuous cycle - and whether these efforts can be translated to the community.

Towards this, about 30 scientists and technologists across the 4 campuses meet with all the clinicians and optometrists and all the research scholars and clinical fellows, almost daily, at 7 AM for an hour, discussing their ideas and suggestions. It is this (compulsory) 7 AM classes that have been the backbone of translational research at LVPEI, and a unique one indeed.

HERF has been recognized by funding agencies across India (it is a Centre of Excellence for the study of the basis of eye disorders by DBT India) and the Wellcome Trust - DBT India Alliance, the Champalimaud Foundation of Portugal, German agencies, and NIH, USA. Our scientists and clinicians have won many awards (e.g., Bhatnagar, Wellcome Trust Fellowships), prizes and recognition across the world, published important papers in the field of vision science and treatment. Figure 1B points out the number of publications, Ph.D., degrees awarded, novel methods and products innovated (e.g., simple limbal epithelial transplantation or SLET, pediatric perimeter, drone slit lamps, polymer based contact lenses and corneal transplant materials).

HERF interacts and collaborates with several other eye institutions across India (e.g., Aravind Eye Care System at Madurai, Sankara Nethralaya in Chennai, RP Centre at AIIMS, Delhi), and with the Association for Research in Ophthalmology (ARVO) whose India Chapter has been established. And it has set up strong connections with some of the best eye centres across the world, and receives ophthalmologists from many countries (particularly developing nations) for short and long-term fellowships. And in 2018-19, we have helped establish a full-fledged eye hospital at Monrovia, Liberia, thus extending the eye health pyramid beyond our shores!

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