Review Article

Ophthalmic registries for rare eye diseases

Mohita Sharma, Neha Jain[1], Vibha Singh, Silkee Singla, Insha Aftab

The prevalence of rare diseases has been estimated to be around 6%–8%, most of which are genetic in origin. Rare eye diseases constitute a critical public health concern. The major concerns for people suffering from these conditions are diagnosis, treatment, rehabilitation, limited resources, and health infrastructure. Also, as the number of people suffering from these disorders is less, it becomes difficult to study the epidemiological distribution and natural course of the disease. Thus, there is a need to establish registries for such rare disorders. This will help in creating a database of those suffering from rare eye diseases and will prove advantageous for both the patients and the researchers. For patients, it will be helpful as it will provide them will access to families suffering from similar problems, provide rehabilitation services, and provide access to clinical trials working on the development of new treatments for these rare disorders. From the researchers' point of view, it will be beneficial for them as they will then have access to a pool of data that can be used as a starting point of research on these rare disorders. At present, very few registries exist around the world and none in India. A systematic review of registries for rare eye diseases on Google and PubMed was done for existing registries, their methodology, services provided, applications, and advantages.

Access this article online

Website: www.ijo.in

DOI: 10.4103/ijo.IJO_302_22

Quick Response Code:

Key words: Database, India, ophthalmic registries, rare eye diseases, research and clinical trials

A disease is called rare if it occurs infrequently in a population. Rare eye diseases are a public health concern due to limitations in the diagnosis and management of these conditions. Many of these are genetic with poor visual prognosis and no established treatment protocols. Thus, making registries of such patients will help create a database that is advantageous to both patients and clinicians, but very few such registries exist, and currently, there is no registry for any rare eye disease in India. We conducted a systematic review on Google and PubMed for existing registries for rare eye diseases, their methodology, services, applications, and advantages.

Definition of Rare Diseases

As per the Organization for Rare Diseases-India (ORDI), three elements define if a particular disease is rare for a country: (i) total number of people having the disease, (ii) prevalence of the disease, and (iii) non-availability of treatment for that disorder. According to the World Health Organization (WHO), a rare disease is one with a frequency of less than 6.5–10 per 10,000 people. In the United States of America (USA), any disease or condition that affects less than 200,000 persons is considered as rare, whereas in Japan, the frequency defined is 50,000. In China, a disorder is rare if it affects less than 1/500,000 people or one with neonatal morbidity of less than 1/10,000. If defined in terms of prevalence per 10,000, the number used in the USA is 7.5, 5 in Europe, 4 in Japan, 4 in South Korea, 1.1 in Australia, and 1.0 in Taiwan. Thus, the most appropriate way for a country to define any particular disease as rare is in context to its population, health care system, and resources. India, like many developing countries, currently has no standard definition. Considering the large population of India, ORDI suggests a disease to be defined as rare if it affects 1 in 5000 people or less.

Till now, 5000–8000 rare diseases have been recognized, most of which have genetic origin. The prevalence of rare diseases is estimated to be 6%–8%.[1] At present, national registries for rare diseases exist in North America and Europe, whereas certain countries have registries specific for certain disorders or groups of disorders. Also, certain databases and initiatives are present that identify patients with rare diseases, such as Orphanet for rare diseases and orphan drugs, the Rare Disease HUB (RD-HUB), National Organization for Rare Disorders (NORD), NIH/NCATS GRDR program, and Rare Disease Clinical Research Network (RDCRN).[1-4] At present, certain registries exist for cancer, cystic fibrosis, Gaucher's disease, etc., as managed by the National Institution of Health.[2]

Rare Eye Diseases

Eye health and vision-related conditions related to rare diseases constitute a critical public health concern. Over several decades, clinicians and scientists have collected data from families of patients with rare eye diseases, which has led to the recognition of rare genetic diseases.[5] There is an ever-growing need for

Department of Ophthalmology, Tirupati Eye Centre, Noida, Uttar Pradesh, [1]The Cornea Institute, KAR Campus, LV Prasad Eye Institute, Hyderabad, Telangana, India

Correspondence to: Dr. Mohita Sharma, Tirupati Eye Centre, C-53 C, Sector-33, Noida, Uttar Pradesh - 201 301, India. E-mail: drmohita@tirupatieye.org

Received: 30-Jan-2022 Revision: 14-Mar-2022
Accepted: 20-Mar-2022 Published: 30-Jun-2022

Cite this article as: Sharma M, Jain N, Singh V, Singla S, Aftab I. Ophthalmic registries for rare eye diseases. Indian J Ophthalmol 2022;70:2225-30.

identification and surveillance of rare eye disease because vision impairment and blindness are major public health problems.[6]

Rare-disease registries have been set up in various countries to record, document, counsel, and treat patients. At present, very few medical registries exist for ophthalmology in the world.[7] Currently, no registry for rare eye diseases is present in India.

This lacuna was recognized by the Women Ophthalmologists Society (WOS), India. The importance of establishing registries for rare eye diseases, the positive impact it can lead to in the life of the patients, and the research opportunities it can create were recognized. The aim of the RED group is to form a National Registry for rare eye disorders and rare aspects of common eye disorders in India. For this purpose, a common cloud-based template customized as per the requirement of the individual disease that includes demographic data, clinical history, examination finding, imaging, and other documentation as may be the need of the individual condition will be created. This will give a common platform to all ophthalmologists working in private, government hospitals, or institutional setups to record and report their cases of rare eye disorders. The aim is to also provide genetic counseling and support to patients and families of those affected with these rare disorders. With these aims and objectives, national registries will be created for five rare eye diseases initially and later expanded to cover other rare eye diseases as well.

Existing Registries for Rare Eye Diseases

A list of current registries for rare eye diseases is given in Table 1.

Colombian National Registry for rare diseases[1]

This was the first attempt to create a national registry in Columbia. The aim of the registry was to record epidemiological data of rare diseases. The registry was not specifically pertaining to rare eye diseases, but the study found that among other disorders, diseases of the eye and adnexa contributed to 6.9% of rare diseases affecting patients under 18 years of age, whereas in adults, it was the second most common pathology (22.4%), second only to diseases of the blood and blood-forming organs (27%).

Orphanet[8]

It is the most comprehensive online database including almost 7000 rare diseases.[9] It includes a database of registries present in Europe and the countries associated with Orphanet. A database of 793 registries is present for specific diseases or groups of diseases. Each disease is given its own Orpha number for unique identification. The epidemiology, clinical description, diagnosis, and management options are described as well. A total of 793 registries including public, private non-profit, and private profit are included in this network. Among an extensive list of rare disorders present in this database, rare eye disorders such as bird-short chorioretinopathy, blue cone monochromatism, Axenfeld–Rieger syndrome, cone–rod dystrophy, and Behcet's disease have their own unique orphan numbers. Various registries included in the Orphanet pertaining specifically to rare eye diseases are described below; others are mentioned in Table 1.

1. **International Registry for Blue cone monochromatism- Germany**[10]

   It is an X-linked recessive disease estimated to affect 1/100,00 population worldwide. It is an international, private non-profit registry that is supported by the Blue Cone Monochromatism (BCM) Families Foundation, US. After going to the webpage, any patient can upload their data to get enrolled in this registry.[10]

Table 1: List of current rare eye disease registries

Registry	Coverage	Country
Columbian National Registry for Rare diseases	National	Columbia
Bone cone monochromatism- Patient registry	International	Germany
National Registry for Mycotic Keratitis	National	Germany
Patient registry for retinal degeneration PRO RETINA	National	Germany
ReTDis database: clinical descriptions of patients and families with inherited eye diseases	International	Germany
Neuromyelitis Optica	National	Germany
Myasthenia Gravis Registry	National	Spain
Spanish patient registry of hereditary retinal dystrophy	National	Spain
Behcet's Disease Registry	National	Spain
The Finnish Register of visual impairment	National	Finland
Cohort of patients with hereditary dystrophies of Retina	National	France
REDgistry: An interoperable sustainable European Rare Eye Disease Registry	Europe	France
Establishment of children and adolescent cohort in Behcet's disease in France	National	France
French cohort creation in retinitis pigmentosa	National	France
French patient registry in chorioretinopathy, birdshot type	National	France
French registry of patients affect by Leber amaurosis and retinitis pigmentosa to assess the clinical trial in gene therapy	National	France
National cohort on inherited retinal dystrophies	National	France
Behcet's disease registry	National	Italy
Italian Retinoblastoma Registry	National	Italy
ERN-EYE disease	Europe	26 European countries
United Kingdom Neuromyelitis Optica	National	United Kingdom
Myasthenia Gravis Patient Registry	National	USA
Blue cone Monochromatism Families Foundation	International	USA
Curing Retinal Blindness Foundation	International	Africa
Fighting Blindness Canada Patient Registry	National	Canada
Retinoblastoma Registry	National	Kuala Lumpur

2. **National Registry for Mycotic Keratitis- Germany**[11]
   This was a national public registry established in 2015 with the aim to document all cases of fungal keratitis, which is rare in Germany, to better understand the disease, recognize unknown predisposing factors, and modify therapeutic approaches based on their findings.
3. **Neuromyelitis Optica patient Registry- Germany**
   Also known as Devic's disease, it is a rare auto-immune demyelinating disorder where the spinal cord and the optic nerve are destroyed. National public registry is present in Germany.
4. **Patient registry for Retinal degeneration PRO RETINA- Germany**[12]
   This is a national registry run by a private non-profit self-help organization that enrolls patients with retinal genetic disorders, including retinitis pigmentosa, macular degeneration, age-related macular degeneration, and Usher's syndrome. At present, 6000 patients are enrolled in the registry. Those enrolled can join any of the regional 50 groups for medical and social support.
5. **RetDis Database: Clinical descriptions of patients and families with inherited eye diseases- Germany**[13]
   Also based in Germany, it is an international public registry where a database is maintained by the Molecular Genetics Laboratory (MGL). The biobank has samples of patients and their families of inherited retinal dystrophies, optic atrophy, Leber's hereditary optic neuropathy, and hereditary glaucoma.
6. **Finnish Register for visual impairment- Finland**[14]
   It is a national public register to evaluate the incidence of visual impairment in Finland with the objective to prevent, treat, rehabilitate, and provide special services to those affected. According to their statistics, the most common cause of visual impairment in the 0–17-years age group are disorders of optic nerve and pathways; for the 18–64-years age group, it is hereditary retinal dystrophies, whereas for age 65 and above, it is age-related macular degeneration.
7. **REDgistry: An interoperable sustainable European Rare Eye Disease Registry- France**[15]
   It is an ongoing European public registry that is enrolling patients with rare eye disease with the purpose to create a centralized registry to evaluate data and develop standardized protocols for long-term sustainability.
8. **Italian retinoblastoma registry**[16]
   It is a national public registry. Subsequently, they analyzed the retrospective data to ascertain the mortality rate and cancers most commonly leading to mortality in survivors. This clearly establishes how a registry help in better understanding disease pathogenesis and progression and how timely screening and intervention can play a key role in such patients.
9. **The Spanish Registry of Behcet's disease (SRBD) - Spain**[17]
   This national registry was created by the Spanish Internal Medicine Society in 2009. In total, 529 patients from 16 Spanish hospitals were recruited in this registry by July 2012. Electronic medical records were used to collect epidemiological and clinical data. These data were then used to compare the clinical characteristics of the disease in their population with similar populations in different parts of the world. It also helped them understand that ocular and vascular involvements are more common in men than in women in their country.
10. **Myasthenia Gravis Patient Registry- United States**[18]
    Currently, this registry is open to adults aged 18 or older who are residents of the USA, for the purpose of patient information, treatment, and research. One can register on their website with their contact information, demographic information, medical history, family history, and lifestyle. Resources related to caregiver, employment, legal advocacy, financial services, medical equipment, medical travel, public benefit, and social services are provided as well. Services of Myasthenia Gravis support groups are provided in-person through local support groups or virtually through zoom meetings, especially during the coronavirus pandemic. These support groups help one share their experience and connect the affected families. The support group meetings are open for anybody affected in any part of the world to join virtually. A list of clinical trials currently underway is also provided, and those with myasthenia can recruit to any trial that they wish to be a part of.
11. **ERN-EYE Diseases (European Reference Network)**[19]
    It is a cross-border cooperation platform between specialists for the diagnosis of rare or low-prevalence diseases. It is a virtual platform involving healthcare providers and experts across Europe. They provide high-quality cost-effective care and facilitate discussion on rare diseases. It was started in March 2017 and spread across 26 European countries; it involves 900 healthcare units over 300 hospitals, and 24 networks have been created to deal with various rare diseases. If any doctor comes across a patient with a rare disease and needs any advice regarding diagnosis and management of the same, then they can approach the network most suitable for their patient. After obtaining the patient's consent, the patient's clinical information along with investigations and other details are uploaded in the clinical patient management system (CPMS). Then, the doctor can discuss the case with experts to seek their opinion on the same. Thus, the advantage is that the patient gets expert help without the need of travelling to various healthcare facilities at remote locations as the expertise to deal with such rare conditions may not be available at every center. The confidentiality of the patient is maintained in the CPMS. The original doctor whom the patient had initially consulted remains the point of contact of the patient.
    This helps the doctors involved in the network and helps in training, developing joint research opportunities, and formulating clinical guidelines. It also helps to expand existing knowledge regarding diagnosis and the latest treatment available for managing rare diseases.
    For rare eye diseases, the network currently has 29 health care providers in 13 full-member countries and 15 in seven affiliated partner countries to cover more than 900 rare eye diseases. There are four working groups and six transverse working groups. The working groups include retinal diseases, neuro-ophthalmology, pediatric ophthalmology, and anterior segment rare eye diseases. The transverse working groups include low vision, daily life, and patient groups; genetic diagnostics; registries and epidemiology; research, education, training, and guideline framing; and communication, management, and quality. They aim to provide timely diagnosis, care, molecular testing, clinical trials, and tools for education and communication. They also keep on having regular clinical meetings, webinars, and discussions to discuss challenging cases.

12. **Curing Retinal Blindness Foundation, Africa**[20]
This organization works for children and adults suffering from rare CRB1 LCA/RP gene mutation. It is the only patient organization for this disease in the world. This rare mutation causes Leber's congenital amaurosis, retinitis pigmentosa, and cone–rod dystrophy. They provide funding to do research for treatment of this rare disorder and provide rehabilitation services to those affected. It provides a platform for families with affected members to share their journey of coping with the disorder and provide support to those going through similar difficulties. They also enable the families to seek advice from each other. They have also created a database of organizations and programs being run for education of affected children. Thus, parents of any child who has been recently diagnosed with the disorder can access their database to locate a supportive program running in their neighborhood for raising blind or visually impaired children. Once the designated facility assesses the individual need of the child, then any special requirements such as braille, mobility training, and visual aids such as CCTV are also provided. It also provides grants and gives opportunities to organizations to collaborate to conduct research on this particular gene defect.
In collaboration with the Coordination of Rare diseases at Sanford Research (CoRDS), a non-profit research institution, a patient registry has also been created for these patients. The aim of the registry is to collect clinical data of those affected that can be used for medical research and also enroll these patients in clinical trials.
13. **Fighting Blindness Canada (FBC) Patient Registry**[21]
It was established in 2004. It is a database of those suffering from inherited retinal diseases such as retinitis pigmentosa, Stargardt disease, Usher's syndrome, Leber congenital amaurosis, choroideremia, and other rare genetic eye diseases. The aim is to form a medical database of such patients and connect them to clinical trials. It encourages patients to sign up in the registry so that they can record patients suffering from rare retinal disorders in Canada and encourage new treatment modalities that earlier did not exist in Canada to be made available.
After enrolling at their designated centers and obtaining patient consent, information and investigations of the patient are collected in their pre-designed data collection form. This includes details of diagnosis, personal history, family history, retinal examination detail, and genetic testing, if done. This information is stored in the database as a reference number to maintain patient confidentiality. The information can be assessed by authorized and approved scientists for research. In case of a new clinical trial, if a reference number is deemed fit to be enrolled in that particular trial, then the enrollment center is contacted, which in turn contacts the patient to inform about the trial. If the patient is willing to participate, then he/she is enrolled. They also fund a young leaders program for developing skills in those who are blind or visually challenged between 15 and 30 years of age so that they can pursue rewarding careers. In 2021, they also launched a young leaders' mentorship program with a mentor who is a community volunteer with vision loss with an established career to guide mentees in their journey. Periodic educational events are also organized to update regarding recent developments around the world.
14. **Blue cone monochromatism (BMC) Families Foundation, USA**[22]
An international non-profit organization started in 2014 in the USA by the families affected by BMC. They regularly organize sporting events, charity dinners, auctions, etc., to raise money. On their website, one can find stories and journeys of families affected by BMC, and anyone who needs guidance or support can connect them. They have collaborated with many organizations around the world, including Orphanet and Blue cone monochromatism registry in Germany, to create a database of those affected by this disorder. They have established enrolment centers and low-vision assistance in the USA, United Kingdom, France, Denmark, Greece, and Germany. Once on their website, the patient can directly register from there as well. Personal and family history of the people affected in a family, DNA report, family pedigree, clinical report, etc., have to be uploaded. They connect the patients with low-vision centers specialized in visual rehabilitation of such patients and connect with those specially designing low-visual aids as well. The foundation is supporting research activities aimed at finding a cure for this condition.
15. **Retinoblastoma Registry- Kuala Lumpur**[23]
It was designed as a part of the Malaysia National Eye Database (NED). Demographic details, clinical presentation, treatment, outcomes, and complications were recorded. The aim of the registry is to create a national treatment protocol for retinoblastoma patients. Later, the data collected in the registry were analyzed to assess the clinical and epidemiological characteristics of patients with retinoblastoma who presented in one of the major referral centers of Kuala Lumpur. As it is a rare disease, it helped them to understand the clinical implications and risk factors leading to delayed diagnosis and thus increase awareness regarding the disease.

Features of a Registry[24]

The registries provide participants with online access where they can upload their information and documents and record their experiences. The information collected includes demographic profile, lifestyle, genetic profile, symptoms, treatment, outcome, and family history. Some registries also have the facility to upload the entire electronic medical record and investigations of the patients. This information may be accessed both by the patients and their treating physicians.

For example, on the website for registry for blue cone monochromatism, the clinical report of the patient has to be uploaded.[10] The German keratomycosis registry documented the age, gender, initial diagnosis on presentation, mean time to correct diagnosis, organism implicated, risk factors, and medical and surgical management of affected patients. The collected data were then analyzed.[11]

The Finnish register of visual impairment clearly defined the criteria of patients that had to be reported to be registered in the database as one who has vision less than 0.3 in the better eye. It is mandatory for the ophthalmologist of the ophthalmological unit of a hospital to notify if they treat such a patient. Personal data of the patient is compiled along with diagnosis, visual acuity, severity of the condition, and the mobility of the patient. Demographic details of the patients are also recorded, such as marital status, mother tongue, and education.[14]

Biobank to store biological samples[24]

A biobank is a collection of human samples and associated detailed information retrieved in a predetermined systematic approach to conduct research.[25] Samples can be collected from patients and their relatives and can be used afterward for research and genetic studies. The Molecular Genetics Laboratory (MGL) has collected DNA samples from patients and family members with inherited ocular diseases. More than 30,000 DNA samples of more than 17,000 individuals with more than 12,000 patients from 10,000 families have been collected for inherited ocular diseases. Of these 8000 patients are from 6000 families with inherited retinal dystrophies, more than 2000 patients of optic atrophy and Leber's hereditary optic neuropathy, and more than 1100 families with hereditary glaucoma.[13]

Family history[24]

It is recorded to understand risk factors, any genetic inheritance pattern and lifestyle. If a disease exists in the family, one can also ascertain any variation in age of onset and progression of disease. For example, on the website for registry for blue cone monochromatism, the patient on registration has to also give a detailed family history of the total number of people affected both alive and dead and the details of the relative who is affected.[10]

Why are registries for rare eye diseases required

It is important to create a registry specifically for rare eye diseases so that centralized data is available. With the advancement in digital technology and increasing use of electronic medical records in health systems have led to the dramatic growth in large clinical data sets. Thus, it has become easier than before to collect data in a centralized format which can easily be reviewed later when required. This can be useful to access patient information for many purposes.

- By having a data of all patients with a particular rare eye disease at one place, it is easier to track patient and monitor their response to particular therapy.
- Improved identification of currently undiagnosed patients with rare eye diseases.
- Support groups can be formed where families suffering from similar problems can share how they cope up and help each other.
- Genetic counselling and rehabilitation services can be provided as needed.
- It will help in accurate assessment of incidence and prevalence of a particular rare eye disease in a community, region and country.
- It will also aid in research work to assess the demographic pattern, common and uncommon clinical features, epidemiological data and family history that can aid in understanding the pattern of the disease, its pathogenesis and open future avenues for treatment. For e.g., a retrospective analysis of the Italian Retinoblastoma Registry was done to assess the mortality amongst the survivor of retinoblastoma from second tumor. They found that the most common cause of mortality amongst the survivors of hereditary retinoblastoma is cancers of the bone and soft tissue. Such information can help in better monitoring of these patients and prevent mortality.[16]
- In the advent of any new treatments or clinical trials, it will become easier for the patients and the authorities to contact each other.
- As the proportion of rare diseases affecting the population is less, only if the data is present in one place, an adequate sample size for data analysis can be reached for any significant understanding.
- International cooperation and knowledge sharing will become easier to understand the pattern and management of such conditions.

Lacuna and Way Forwards

There is a need to develop new treatment modalities for rare eye diseases for which clinical trials are required. As patients with these rare eye disorders are few, conducting research at a single center might not give significant and relevant results. Thus, it is required to create a database of such patients in one place. Hence, it can clearly be understood that the national registry for rare eye diseases will benefit patients, clinicians, and scientists. A centralized system where patients with rare eye diseases can register themselves will create a national database, which has not been done yet in India. With this aim, Women Ophthalmologists' Society aims to create a difference in the lives of those affected and collaborate with ophthalmologists at a large scale to conduct research in this area.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Mateus HE, Pérez AM, Mesa ML, Escobar G, Gálvez JM, Montaño JI, *et al*. A first description of the Colombian national registry for rare diseases. BMC Res Notes 2017;10:514.
2. Workshop on National Registries of RD. 2014. National Institute of Health 2014. Available from: https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/national-institutes-of-health. [Last accessed on 2022 Jan 30].
3. Taruscio D, Vittozzi L, Choquet R, Heimdal K, Iskrov G, Kodra Y, *et al*. National registries of rare diseases in Europe: An overview of the current situation and experiences. Public Health Genomics 2015;18:20–5.
4. Rubinstein YR, Groft SC, Bartek R, Brown K, Christensen RA, Collier E, *et al*. Creating a global rare disease patient registry linked to a rare diseases biorepository database: Rare Disease-HUB (RD-HUB). Contemp Clin Trials 2010;31:394–404.
5. Mazzucato M, Visonà Dalla Pozza L, Manea S, Minichiello C, Facchin P. A population-based registry as a source of health indicators for rare diseases: The ten-year experience of the Veneto Region's rare diseases registry. Orphanet J Rare Dis 2014;9:37.
6. Elliott AF, Davidson A, Lum F, Chiang MF, Saaddine JB, Zhang X, *et al*. Use of electronic health records and administrative data for public health surveillance of eye health and vision-related conditions in the United States. Am J Ophthalmol 2012;154 (6 Suppl):S63-70.
7. Li J, Heinz C, Finger RP. [Registry-based research in ophthalmology]. Ophthalmologe 2018;115:826–31.
8. Orphanet Report Series. Rare eye disease registries in Europe. September 2020. Available from: https://www.orpha.net/orphacom/cahiers/docs/GB/Registries.pdf. [Last accessed on 2022 Jan 30].
9. Sburlan EA, Voinea L-M, Alexandrescu C, Istrate S, Iancu R, Pirvulescu R, *et al*. Rare ophthalmology diseases. Roman J Ophthalmol 2019;63:10–4.

10. Orphanet. Rare Eye Disease registries in Europe. Available from: www.orphanet/consor/cgibin/ResearchTrials_RegistriesMaterials.php?lng=EN&data_id=110870&RegistryMaterialName=Patientenregister-fur-Blauzapfen Monochromasie&title=Patientenregister%20f%FCr %20Blauzapfen] Monochromasie&search=ResearchTrials_RegistriesMaterials_Simple. [Last accesed on 2022 Jan 23].
11. Roth M, Daas L, Renner-Wilde A, Cvetkova-Fischer N, Saeger M, Herwig-Carl M, *et al*. [The German keratomycosis registry : Initial results of a multicenter survey]. Ophthalmologe 2019;116:957–66.
12. Retina International. Available from: https://retina-international.org/members/pro-retina-deutschland-e-v/. [Last accessed on 2022 Jan 23].
13. Wissinger Lab. Molecular genetics laboratory. Availabe from: http://www.eye-tuebingen.de/wissingerlab/. [Last accessed on 2022 Jan 23].
14. The Finnish Register of Visual Impairment. Available from: https://cms.nkl.fi/sites/default/files/2020-03/The%20Finnish%20Register%20of%20Visual%20Impairment%2C%20Annual%20Statistics%202018.pdf. [Last accesed on 2022 Jan 23].
15. European commision. REDgistry. Available from: https://webgate.ec.europa.eu/chafea_pdb/health/projects/947444/summary. [Last accessed on 2022 Jan 23].
16. Acquaviva A, Ciccolallo L, Rondelli R, Balistreri A, Ancarola R, Cozza R, *et al*. Mortality from second tumour among long-term survivors of retinoblastoma: A retrospective analysis of the Italian retinoblastoma registry. Oncogene 2006;25:5350–7.
17. Rodríguez-Carballeira M, Alba MA, Solans-Laqué R, Castillo MJ, Ríos-Fernández R, Larrañaga JR, *et al*. Registry of the Spanish network of Behcet's disease: A descriptive analysis of 496 patients. Clin Exp Rheumatol 2014;32 (4 suppl 84):S33-9.
18. Myasthenia Gravis patient registry. Available from: https://myasthenia.org/Research/MG-Patient-Registry. [Last accessed on 2022 Jan 23].
19. European Reference Networks. ERN-EYE. Available from: https://www.ern-eye.eu/. [Last accessed on 2022 Jan 23].
20. Curing Retinal Blindness Foundation. CRBS. Available from: https://crb1.org/. [Last accessed on 2022 Jan 23].
21. Fighting Blindness Canada Patient Registry. Patient registry. Available from: https://www.fightingblindness.ca/patient-registry/. [Last accessed on 2022 Jan 23].
22. BCM Families Foundation. Available from: blueconemonochromacy.org/patient-registry. [Last accessed on 2022 Jan 23].
23. Jamalia Rahmat, J Alagaratnam, Pik PIN Goh, R Sunder. Retinoblastoma Registry Report- Hospital Kuala Lumpur Experience. Med J Malaysia 2010;65(Suppl A): 128-30.
24. Fighting Blindness Foundation. Available from: https://www.fightingblindness.org/research/patient-registries-help-advance-research-for-rare-diseases-2530. [Last accessed on 2022 Jan 23].
25. Jeon JP. Human lymphoblastoid cell lines in pharmacogenomics. In: Handbook of Pharmacogenomics and Stratified Medicine. Chapter 6. 2014. p. 89-110.