THE 4th RARE GENETIC DISEASES RESEARCH SUMMIT (REDRESS)

27th - 28th November 2025

Meeting Proceedings

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THE 4th RARE GENETIC DISEASES RESEARCH SUMMIT (REDRESS - 2025)

INAUGURAL SESSION

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Rare Genetic Diseases Research Summit (REDRESS) 2025: Building an Ecosystem for Collaborative Action

What does it take to develop solutions that can ease the hardships faced by the rare disease community? This agenda has been the focal point of the annual Rare Genetic Diseases Research Summit (REDRESS) organized by the Tata Institute for Genetics and Society (TIGS) and the Organization for Rare Diseases India (ORDI). What began as a determined brainstorming initiative has now evolved into a national platform where science, precision medicine, advocacy, and compassion come together to build a robust rare disease ecosystem.

The fourth edition of REDRESS, held on 27th and 28th November 2025, commenced with Dr. Rakesh Mishra, Director, TIGS, defining the mission of REDRESS and expressing heartfelt thanks to the patient advocacy groups for their resilience and clarity of purpose. Dr. Mishra highlighted the creation of the GenTIGS database at TIGS that brings together genes and pathogenic variants associated with rare genetic disorders (RGDs), incorporating data from large-scale genome sequencing projects. It captures RGDs prevalent globally as well as those specifically in India, enabling easy retrieval, cross-referencing and deep genomic analysis. He also described TIGS' selection by the Indian Council of Medical Research (ICMR) to host the Centre for Advanced Research for Neuromuscular Genetic Disorders (CAR-NMGD), which aims to create an integrated ecosystem across premier institutions with patient advocacy partners to ensure alignment with real patient needs. TIGS is developing natural history-based quantitative clinical models, cellular and animal models, diagnostic assays, and mRNA-based therapeutic and gene editing platforms with muscle-targeted non-viral delivery systems. TIGS has been privileged to work through a network of collaborations and via infrastructure support at the Bangalore Life Science Cluster (BLiSC) and our technologies are making rapid progress towards regulatory approval and implementation. India already has the scientific capability, innovation ecosystem, and collective will to lead globally in rare genetic disease research. Inaugurating REDRESS 2025, Dr. Mishra reiterated the need for advancing from discussion to action.

Prof L S Shashidhara, Director of National Centre for Biological Sciences, a Centre of the Tata Institute of Fundamental Research (NCBS-TIFR), championed the sharing of resources and aggregation of capabilities made possible within the BLiSC ecosystem. He reflected on how research in Genetics and Molecular Biology has evolved over the last century and highlighted how the effect of natural genomic diversity on health remains a challenge yet to be unravelled. Researchers must prepare to harness the huge genomic resources and cutting-edge technologies such as CRISPR gene editing, mRNA-based interventions, and the development of novel cells and organoid-based disease models to accelerate drug discovery for rare genetic disorders.

Mr. Prasanna Shirol shared his family's experience of raising a child with a rare disorder and the twin pillars of awareness and hope that a platform such as REDRESS can offer to patients seeking meaningful solutions. He acknowledged the progress in recent years in terms of policies, funding and research, but reminded all stakeholders how afflicted children run out of time waiting for accurate and affordable diagnostics and therapeutics. Mr. Shirol set the tone for REDRESS-2025 by urging collaborations to accelerate the outcomes, reminding us of a patient’s urgent perspective that serves as both strength and inspiration.

SESSION 1
RGD LANDSCAPE AND DIAGNOSTICS IN INDIA

SESSION CHAIR

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Mr. Sunil Ladwa

Founder
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Session 1
Diagnostic Frontiers in Rare Genetic Disorders

The session aimed to explore new technologies and approaches shaping diagnostics for rare diseases in India. It gave an overview of genomic, proteomic and metabolomic technologies at the forefront of molecular diagnosis and emphasized how multiomics is gaining increasing significance in diagnostics.

Next-generation mass spectrometry-based diagnostics for genetic disorders - Dr. Akhilesh Pandey

Dr. Akhilesh Pandey highlighted the growing importance of next-generation mass spectrometry (MS) in diagnosing rare genetic and metabolic disorders, underscoring the limitations of relying solely on genomic sequencing and the urgent need for integrated biochemical, proteomic, and metabolomic approaches that bridge the gaps from genotype to phenotype. MS is a rapid, extremely sensitive, high-throughput, and versatile technology that can analyse proteins, metabolites, lipids, and post-translational modifications, offering deep mechanistic insights into complex rare disorders. Dr.Pandey emphasized that although genomic technologies have advanced dramatically with commendable accessibility, sequencing often yields variants of uncertain significance that require functional validation, making MS an essential complementary platform capable of providing direct biochemical evidence of disease pathways. A major focus of the talk was the critical need to develop clinical-grade, scalable, and affordable MS-based diagnostic assays for countries like India, where the burden of rare diseases is high, diagnostic infrastructure is limited, and many existing tests are outdated or insufficient for current clinical demands.

Dr. Pandey discussed the ongoing initiatives to design simplified, triple-quadrupole MS assays for targeted analytes that can be implemented in routine diagnostic laboratories, including glycopeptide and peptide assays for congenital disorders of glycosylation (CDG) diagnosis based on quantitation of glycosylated and non-glycosylated forms. Mass spectrometry also decodes hereditary haemolytic disorders like RBC membranopathies involving vertical and horizontal interaction defects, causing spherocytosis and cytoskeletal network instability respectively. LC-MS/MS detects compound heterozygosity in hemoglobinopathies, whereas multiplexed LC-MS/MS plays a role in diagnosing sphingolipidoses and detecting LysoGb3, a diagnostic biomarker in Fabry disease. Ceramide metabolism in Niemann-Pick disease (type A/B) and tafazzin defects in Barth syndrome are also detected by LC-MS/MS. Additional diagnostic developments using MS assays include cardiolipin and monolysocardiolipin quantification for mitochondrial disorders, Glycosaminoglycans (GAGs) for mucopolysaccharidoses and coagulation factor peptide analysis improving detection over colour-based assays. He further highlighted that integrating MS data with genomic information can substantially shorten diagnostic odysseys, improve accuracy, and aid interpretation, particularly in populations with high consanguinity and a significant prevalence of genetic disorders.

Looking ahead, he emphazised that the future of rare disease diagnostics lies in multiplexed, high-resolution, multi-omics frameworks with MS at their core, driven by strong collaboration among clinicians, researchers, diagnostic laboratories, and patient advocacy groups. The session concluded with a reminder of the profound human impact of timely and accurate diagnostics, stressing that early detection can dramatically alter patient trajectories and that sustainable progress depends on continuous innovation, shared expertise, and a coordinated global effort.

Rare disease diagnosis beyond NGS - Dr. Alpa J Dherai

The presentation explored the evolving landscape of rare disease diagnosis in India, emphasizing the need to look beyond next-generation sequencing (NGS) to incorporate functional biochemical tools such as metabolomics, epitranscriptomics, proteomics, and transferrin isoform analysis into clinical practice. One such example was development of rapid biochemical screening in NICU using metabolomics to detect inborn errors of metabolism (IEMs) early. Untargeted metabolomics screens broadly for all metabolites, helping discover rare or unexpected disorders, while targeted metabolomics focuses on specific, known biomarkers for rapid and precise diagnosis. In NICU settings, small-molecule targeted assays (such as amino acids or acylcarnitines via MS/MS) provide fast, clinically actionable results for newborns in critical care. While NGS has significantly improved diagnostic yield, often reaching 40–60%, Dr. Dherai highlighted that confirmatory biochemical testing remains indispensable, particularly in a resource-limited setting where many advanced assays are unavailable to frontline clinicians. Congenital disorders of glycosylation (CDG), a genetically diverse group of multisystem disorders involving defects in N- or O-glycosylation pathways, served as the central focus of the discussion. The talk explained the stepwise process of glycosylation and its vulnerabilities, noting that most reported CDG cases worldwide involve N-glycosylation defects.

To address diagnostic gaps, Dr. Dherai's laboratory optimized an accessible high-performance liquid chromatography (HPLC)-based transferrin isoform assay, an easier alternative to traditional isoelectric focusing, to detect abnormal glycosylation patterns. Their experience with over 200 samples revealed a notably high rate of positive screens, with both type I and type II patterns identified, and suggested that the CDG spectrum in India may differ from global trends. Using several case scenarios, Dr. Dherai demonstrated how combining NGS with transferrin isoform analysis and enzyme assays led to accurate diagnoses, clarified variants of uncertain significance, and in one case, enabled early therapeutic intervention for a treatable CDG subtype. The presentation concluded that integrating genomics with metabolomic and proteomics, along with expanding glycan analysis capabilities, will be crucial for improving rare disease diagnosis and patient care in India.

Genomics Made Accessible and Affordable: Development of Low-Cost Genetic Diagnostic Tests - Dr. Prajnya Ranganath

The session delivered by Dr. Prajnya Ranganath focused on making genomics accessible and affordable through the development of low-cost genetic diagnostic tests, emphasizing how accurate diagnosis depends on both detailed phenotyping and thoughtful selection of cost-effective testing strategies. She outlined the range of genetic disorders and corresponding diagnostic tools, including karyotyping for chromosomal abnormalities, FISH, MLPA, and array CGH for detecting copy-number variations, and Sanger sequencing or next-generation sequencing for single-gene disorders, emphazising that choosing the right test hinges on meticulous clinical evaluation. She noted that genetic testing is vital for confirming diagnoses, guiding targeted therapies, anticipating complications, identifying hereditary risks, determining recurrence probabilities, supporting reproductive decision-making, and enabling clinical trial eligibility. A significant part of the talk stressed the indispensable role of detailed phenotyping, which includes comprehensive medical history, dysmorphology assessment, three-generation pedigree charting, systemic examination, and directed investigations; these steps help narrow differential diagnoses, improve the yield and interpretation of genetic tests, and avoid unnecessary expenses.

Dr. Ranganath then elaborated on several strategies for low-cost diagnostics, such as phenotype-driven targeted testing illustrated through examples like, sequencing a single FGFR2 exon for Apert syndrome or focused Sanger sequencing for craniosynostosis syndromes based on OMIM/HPO-guided clinical suspicion. Dr. Ranganath highlighted the value of population-specific mutation profiling, like the MLC1 variant associated with megalencephalic leukodystrophy with cysts and the common variant in the Agarwal community, which allows clinicians to test for common founder mutations, thereby reducing costs further. The development of economical gene panels using long-range PCR and low-cost NGS, such as an affordable lysosomal storage disorder panel were discussed, along with alternative technologies like qPCR for SMA carrier screening that offer full concordance with MLPA at significantly reduced cost.

Broader cost-reduction strategies – high-throughput workflows, laboratory centralisation, multiplexing, automation, and AI-assisted interpretation – are accelerating affordability, supported by declining sequencing costs and improved genomic resources. She acknowledged government initiatives such as DBT-UMMID, which aim to expand access to low-cost genetic testing across India. Dr. Ranganath concluded that precise phenotyping combined with strategic, affordable testing approaches can greatly enhance diagnostic efficiency, accessibility, and patient outcomes.

Genomic Profiling for the Diagnosis of Heterogeneous Inherited Bone Marrow Failure Disorders - Dr. Babu Rao Vundinti

Dr. Babu Rao Vundinti's talk focused on the genetics of hematological disorders, particularly rare anemias and inherited bone marrow failure syndromes, and explained why early diagnosis and genetic counselling are essential for improving patient outcomes. Dr. Rao emphasized that while common hematological conditions such as anemias are frequently recognized, many rare genetic disorders continue to be missed because their symptoms overlap with more common conditions.

Bone marrow failure, characterized by reduced red blood cells, white blood cells, and platelets, can be either acquired or inherited, with pediatric cases posing especially significant diagnostic challenges. He discussed how clinical monitoring, understanding the severity and stability of cytopenias, and identifying high-risk genotypes guide both treatment decisions and long-term management. Disorders such as Fanconi anemia, Diamond Blackfan anemia, dyskeratosis congenita, and other telomere biology disorders were described, noting their genetic complexity, variable presentation, and increased risk of malignancies later in life.

Dr. Rao stressed the importance of differentiating inherited bone marrow failure syndromes from aplastic anemia, as treatment approaches differ dramatically. Techniques such as chromosomal breakage analysis, targeted sequencing, and telomere length testing by qPCR play critical roles in establishing an accurate diagnosis. The talk also highlighted unique challenges in the Indian population, including founder mutations and under-reported disease prevalence. He emphasized the high prevalence of FANCA gene variants (54%), followed by FANCG gene (18%) and FANCD2 gene (3%) in the Indian population. Misdiagnosis of these disorders can delay care for years, while accurate genetic evaluation can guide appropriate therapy, monitoring, and prenatal counseling. Overall, the presentation underscored that early genetic identification and personalized management are key to improving survival and quality of life in patients with rare hematological disorders.

ICMR Initiatives in Rare Genetic Disorders - Dr. Monika Pahuja

Dr. Monika Pahuja's talk focused on ICMR's growing commitment to rare disease research, while addressing the major challenges that continue to slow progress. Dr. Pahuja emphasized that although ICMR has identified a set of priority rare diseases, the organization remains open to supporting any condition with strong therapeutic or translational potential. Dr. Pahuja showed solidarity with the patient groups and noted that although their anguish is justified, a recurring challenge observed is the widespread lack of accurate and timely knowledge dissemination to patients and caregivers, leading to unrealistic expectations of overnight access to trial commencement and therapeutic relief. The speaker elucidated the role of ICMR in facilitating clinical trials through designated sites following regulatory protocols rather than conducting the trial itself. Another major concern is the limited availability of reliable national data, though government efforts are underway to establish a unified rare disease database.

The presentation also explained the role of the Central Technical Committee for Rare Diseases (CTCRD), which decides the inclusion of conditions under the National Policy for Rare Diseases. On the research front, multiple funding avenues such as small grants, intermediate grants, Centre for Advanced Research (CAR), and First in the World Challenge Program offer significant support, but the quality of submitted proposals remains a bottleneck. Initiatives are underway to strengthen newborn screening programs and optimize site selection for Duchenne Muscular Dystrophy trials. Trial sites are being listed on the portal of CTRI (ctri.nic.in) with expedited development pathways supporting faster progress.

Dr. Pahuja commented that several applications lack clear methodology, realistic milestones, or clinician involvement, all of which are crucial to achieving meaningful progress. She urged researchers to focus on achievable goals, avoid overly broad objectives, and build strong interdisciplinary teams. Overall, the message reinforced that while funding and policy support are increasing, impactful outcomes depend on well-designed research, accurate public communication, and strong collaboration across the rare disease ecosystem.

Building Support Network for Navigating Life with Fibrodysplasia Ossificans Progressiva – Mr. Sunil Ladwa

The talk by Mr. Sunil Ladwa focused on the critical need to build robust support networks for individuals and families navigating life with Fibrodysplasia Ossificans Progressiva (FOP). FOP is a rare genetic disorder characterized by the progressive transformation of skeletal muscle and connective tissues into bone (heterotopic ossification). It follows an autosomal dominant inheritance pattern and typically presents in early childhood with painful soft tissue swellings and great toe malformations. FOP profoundly affects physical movement, daily functioning, emotional well-being, and access to medical care. Mr. Ladwa stressed the importance of creating awareness about rare disorders that often remain poorly understood and frequently misdiagnosed. He further outlined how limited resources, delayed diagnosis, and lack of public awareness severely impact quality of life, reinforcing the need for comprehensive support systems. He highlighted the central role of medical support, noting that early and accurate diagnosis through genetic testing and specialist consultations is essential, along with evidence-based treatments, multidisciplinary care plans, emergency protocols, and the avoidance of misleading, harmful, or unproven therapies.

Equally important is family and emotional support, as families serve as primary caregivers who require guidance, counselling, and structured routines to help patients manage anxiety, frustration, and isolation, with peer groups offering vital community and psychological strength. He also emphasized community-level support through NGOs, social workers, accessible public spaces, transportation assistance, and volunteer networks that help families navigate societal and logistical challenges. Financial and administrative support, including access to government schemes, disability benefits, medical insurance, documentation assistance, and CSIR-funded resources such as mobility aids, remains a major need, especially as many families struggle with costs. Mr. Ladwa commended patient organisations in India for driving awareness, promoting early diagnosis, offering emotional and financial assistance, advocating for policy improvements, and creating community networks that empower families.

Summary of Questions and Discussion

The discussion session highlighted a meaningful exchange between clinicians, researchers, genetic counselors, policymakers, and patient advocacy groups, all focused on strengthening rare disease diagnosis and collaboration in India. The discussion also revolved around how India has a conducive and collaborative ecosystem of clinicians, scientists and policy makers and how it should be used to improve rare disorder diagnosis and management. Questions emphasized the need for better dissemination of genetic testing information. While research findings are published regularly, many clinicians, especially at primary and district levels, do not access these resources.

Genetic counselors described their role in bridging this gap by conveying clear, practical guidance on affordable first-line tests. Participants also cited workshops conducted under the NPRD as effective tools for training paediatricians, obstetricians, and government physicians, but noted that more structured national platforms are still needed to translate research into routine practice.

A key discussion point was the development of standardized clinical guidelines. Representatives from SIAMG shared new statements on cytogenetics and NGS in paediatric, obstetric, and prenatal care, which are being drafted to support consistent diagnostic decision-making mandatory for SMA and thalassemia screening. Attention also turned to drug repurposing, with ICMR explaining its dual strategy of analysing global data for promising candidates while also considering external proposals. Several repurposed drug trials are already underway following rigorous review.

A strong message came from the patient advocacy community, which raised concerns about limited communication between researchers and patient groups. Despite ongoing research in disorders like Niemann-Pick, families often lack information or pathways for collaboration. ICMR acknowledged these gaps and encouraged direct outreach while explaining ethical constraints in publicly listing labs or NGOs. The session closed with a call for unified efforts across government and private sectors, reaffirming that progress in rare diseases depends on transparent, collaborative, and patient-centered engagement.

From left: Dr. Alpa J. Dherai, Dr. Annie Q. Hasan, Dr. Babu Rao Vundinti, Dr. Akhilesh Pandey, Dr. Prajnya Ranganath, Mr. Sunil Ladwa, Dr. Monika Pahuja

Dr. Monika Pahuja

PANEL DISCUSSION 1
COLLABORATIVE ECOSYSTEM FOR RGD DIAGNOSIS, TREATMENT & SUPPORT

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Panel Discussion 1
Collaborative Ecosystem for RGD Diagnosis, Treatment, and Support

Incorporating Newborn Screening (NBS) in Indian Rural Settings - Dr. Priyanshu Mathur

Dr. Priyanshu Mathur's talk focused on a phased and cost-effective national strategy to address the urgent need for newborn screening in India's rural community settings. He began the discussion by emphasizing the importance of starting with simple panel tests for common hemoglobinopathies such as sickle cell disease, thalassemia, and G6PD deficiency and gradually incorporating more complex panels. In resource-limited settings, this phased approach was presented as a feasible method for newborn screening. He highlighted the necessity of sustained community-level awareness and establishing a centralized policy framework that states can easily adopt. He pointed out the necessity for a unified policy that would ensure standardized protocols, uniform quality guidelines, and proper data systems.

He also emphasized establishing centralized laboratory networks capable of supporting large-scale genetic screening, thereby improving cost efficiency. Public private partnerships (PPP) have been identified as a promising model for widespread implementation. Despite these advancements, limited government support has been available for individuals with rare or group 3 genetic disorders, many of whom require long-term expensive care.

Additionally, he discussed the successful implementation of the Rajasthan Mukhya Mantri Aayushman Aarogya Yojana, which operates on a centralized insurance premium of ₹950 per family and is supported by a dedicated fund of ₹3,000 crore. Efforts are currently underway to integrate provisions for rare diseases within this scheme. Finally, Dr. Mathur cited the importance of strengthening the ICMR Registry, enforcing standardized guidelines, and utilizing NHM platforms to develop a centralized, searchable genetic database for equitable service delivery across the country.

Importance of Genetic Counselors in Clinical Practice in the Indian Scenario - Dr. Annie Q Hassan

Dr. Annie Hassan's talk addressed the growing importance of genetic counseling in the Indian healthcare system. She emphasized that clinicians often lack specialized skills to identify patients who need further genetic evaluation or referral, which results in delayed diagnosis and treatment.

She pointed out a key challenge, which was the absence of electronic patient record systems, limiting the clinician's capability to track family histories and genetic patterns. She highlighted the role of genetic counselors, who can effectively bridge the gap. The shorter, scalable and cost-effective training modules make it a feasible adoption in Indian settings. Dr. Hassan pointed out that to improve preventive counseling, enhance awareness of hereditary risks, and promote timely genetic screening, integrating genetic counselors into both public and private health systems is essential.

She noted that in India, genetic counseling in private hospitals is largely limited to post-testing, resulting in missed opportunities for early screening. She emphasized the need for a unified national policy that integrates genetic testing and counseling into rare disease care. She highlighted the example of the Philippines model where mothers receive genetic education during antenatal visits. She further recommended integrating genetic counseling training in postgraduate programs to build a skilled genetic counseling workforce and strengthen India's rare genetic diseases healthcare infrastructure. Dr. Hassan concluded that it is important to integrate genetic counseling into the Indian health care system for improving patient care, strengthening preventive care, and ensuring that patients with rare diseases receive timely diagnosis and treatments.

During the discussion, Dr. Hassan highlighted that while a national policy exists for screening specific disorders, its implementation is ultimately driven by state governments, which vary widely across states. She noted that schemes like Karnataka's Arogya Shree provide up to ₹8 lakh for hearing implants, yet no dedicated state funding exists for screening itself. This gap reflects broader challenges at the national level, where it remains difficult to prescribe a uniform screening panel because the prevalence of rare diseases differs significantly across region.

Regional Differences and the MPS Mutations – Dr. Sudha Srinivasan

Dr. Sudha Srinivasan discussed regional differences in mucopolysaccharidoses (MPS) mutation patterns across India. She highlighted significant regional differences in mutation patterns across India, though large-scale continental data availability was limited. She emphasized that most available samples originate from Tamil Nadu, Karnataka, and Puducherry, making it difficult to determine whether observed variations are truly regional. Notably, nearly 40% of reported MPS 4A cases are from South India, with one mutation occurring frequently among patients in Tamil Nadu. In contrast, MPS I and II appear more common in North India. Dr. Srinivasan pointed out that severity varies widely, and participants emphasized that quality of life is an important indicator of disease burden. International expert groups have also released statements linking clinical severity to treatment prioritization. Comparing regional samples, patients from Gujarat exhibited severe disease and a distinct C7 mutation, differing from the profiles in Tamil Nadu and West Bengal. She explained a nonsense mutation identified in another MPS cohort. Enzyme replacement therapy (ERT) was noted to be effective in a non-severe MPS case treated by Dr. Sujata, where a child with a mild MPS phenotype responded well to treatment. During the talk, Mr. Akhilesh Pandey highlighted the MGenome resource holds a large volume of relevant genomic data. When questioned about national datasets, Dr. Srinivasan confirmed that ICMR currently holds only anecdotal information, underscoring the need for stronger national registries.

During the discussion phase, the critical importance of informed consent in genomic research was highlighted. Dr. Srinivasan emphasized that all samples must be anonymized to protect participants' identities. She further noted that the current ICMR ethical guidelines need to be updated, particularly for work emerging from discovery genomics or population-level genomics to ensure stronger requirements for anonymization.

Importance of Multi-Sectoral Collaborations with Pharma Companies – Dr. Arkasubhra Ghosh

Dr. Arkasubhra Ghosh emphasized the importance of establishing cost-effective genetic therapies by strategically collaborating with pharmaceutical companies. He noted that large-scale upscaling is only possible when strong partnerships with the pharmaceutical industry are built, but such collaborations require a clear proof of concept—something many current programs lack, especially those without human data. He highlighted that although India can produce therapies at significantly lower cost than Western countries, gene therapy will remain expensive due to its complex production processes, and he mentioned it is on par with other high-cost medical interventions such as bone marrow transplantation. Using muscular dystrophy as an example, he explained that gene therapy alone is insufficient and must be accompanied by comprehensive clinical management. He also discussed pharmacogenomic therapy, stressing that it is not a standalone solution but can extend therapeutic windows when used alongside small-molecule drugs. Ultimately, he emphasized that all curative approaches should be evaluated both with and without gene therapy, reinforcing that these modalities must function in tandem rather than as isolated solutions.

Point of Care Technologies in India - Dr. Phani Nagaraj

Dr. Phani Nagaraj's presentation focused on the current limitations and future potential of point-of-care (PoC) technologies in genetic testing within India. He noted that despite significant scientific progress, most PoC innovations remain at the proof-of-concept stage, with very few reaching clinical use as diagnostic tools. Dr. Nagaraj highlighted that although sensitivity and specificity have improved substantially, these advancements have not translated into widespread access. India continues to have a limited number of functional genetic testing centers, underscoring the gap between research output and real-world application.

Dr. Nagaraj emphasized the urgent need to develop PoC technologies that balance accuracy with affordability, particularly for use in diverse field settings. He stressed that meaningful progress would require stronger collaboration among researchers, clinicians, industry partners, and technology developers to ensure that promising prototypes can evolve into reliable diagnostic solutions.

He further noted that scaling genetic testing across the population will depend heavily on supportive policy frameworks. Integrating genetic testing into national health programs would help standardize access and improve equity. During the discussion, an audience member highlighted the role of insurance coverage in reducing financial barriers, noting that expanded reimbursement for genetic tests could significantly increase uptake among middle and low-income groups. Dr. Nagaraj concluded that addressing technological, policy, and financial challenges is essential for advancing India's genetic testing ecosystem.

Accessibility of Genetic Testing - Mr. Shaiket Deb

Mr. Shaiket Deb's discussion addressed the current challenges and opportunities in improving accessibility of genetic testing in India. He observed that access remains limited, particularly in tier 2 and tier 3 cities where most of the population resides. High costs, insufficient infrastructure, and clinicians' apprehension about managing positive results have hindered widespread adoption. Mr. Deb emphasized the critical role of genetic counseling, targeted awareness programs, and clinician training in identifying patients who would benefit from testing. He noted that even basic screenings, such as the double marker test for Down syndrome, are not routinely performed across many regions. He proposed that smaller, focused awareness initiatives, public-private partnerships (PPPs), and integration with national programs like NAS could expand access while encouraging private sector participation in genetic health services.

He further highlighted the transformative potential of artificial intelligence (AI) in diagnostics and therapeutics. Many laboratories have adopted AI-driven bioinformatics pipelines, reducing processing times and improving accuracy. Despite these advances, genetic data management remains fragmented, with regional government databases lacking standardization and integration. Mr. Deb stressed that establishing centralized, standardized genetic data systems is essential to fully leverage AI for research, diagnostics, and patient care. He concluded that coordinated efforts in capacity building, awareness generation, and technological integration are critical to making genetic testing more equitable and effective, ultimately supporting improved preventive care and health outcomes across socio-economic groups.

During the discussion phase, it was noted that, from an infrastructure perspective, some states have made significant progress. However, newborn screening (NBS), which ideally needs to be completed within 72 hours to one week of birth, faces significant logistical challenges in government hospitals. Mr. Deb highlighted the need for strengthened public–private partnerships to streamline logistics within the government system. He also pointed out that extreme summer temperatures can increase the risk of false positives, underscoring the importance of robust quality control measures.

Advocacy on Drug Development and Patient Access in Low-Resource Settings - Dr. Nisha Venugopal

Dr. Nisha Venugopal focused on advocacy at the intersection of data privacy and drug development in India. She emphasized the urgent need for a robust data protection framework, citing models such as NCPI, to govern the collection, storage, and use of health and clinical data. Dr. Venugopal highlighted the critical challenge of preventing commercial exploitation of sensitive patient data by IT companies, while ensuring that anonymized datasets remain accessible for public health research and drug discovery.

A central component of her work is the advocacy organization Every Voice, which drives outcome-focused efforts to reform policy and strengthen ethical standards in data use. She stressed that building trust with patients is essential to promote informed participation in large-scale initiatives such as the 10,000 Genome Project. Dr. Venugopal underscored that ensuring transparent access, informed consent, and strict anonymization protocols are key to creating a patient-centered research ecosystem. Her advocacy aims to balance privacy, ethical oversight, and scientific advancement, ultimately accelerating the discovery of new therapies while safeguarding individual rights.

Photographs from Panel Discussion 1 - Collaborative Ecosystem for RGD Diagnosis, Treatment, and Support

From left: Prof. Sudha Bhattacharya, Dr. Phani Nagaraj, Dr. Annie Q. Hasan, Dr. Arkasubhra Ghosh, Mr. Shaiket Deb, Dr. Sudha Srinivasan, Dr. Nisha Venugopal

Online: Dr. Priyanshu Mathur
From left: Prof. Sudha Bhattacharya, Dr. Phani Nagaraj, Dr. Annie Q. Hasan, Dr. Arkasubhra Ghosh, Mr. Shaiket Deb, Dr. Sudha Srinivasan, Dr. Nisha Venugopal

SESSION 2
FRONTIERS IN RGD THERAPEUTICS AND MANAGEMENT

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Session 2
Frontiers in RGD Therapeutics and Management

The therapeutic landscape of RGDs is distinct compared with other diseases and faces several challenges. These include small market size, delayed or improper diagnosis, population-specific symptom presentation, and lack of availability or access to drugs.

Trying to Solve the VUS Puzzle: The Ideal Approach - Dr. Veronica Arora

Dr. Veronica Arora addressed the challenges involved in analyzing VUS (Variants of Uncertain Significance) within genetics and the impact these analyses have on diagnosis and treatment choices, particularly concerning rare genetic conditions. Despite advances in sequencing, VUS occurrences persist, mainly due to limited population data and incomplete gene-disease knowledge. Dr. Arora stressed that a VUS represents uncertainty, rather than illness, and should not guide critical decisions like those involving reproduction. Employing the ACMG 5-tier system, she pointed out that VUS classification is uncertain, as it covers a broad probability spectrum (5-90%). The discussion presented the "hot, warm, and cold VUS sub-categories", aiding clinicians in assessing the potential for reclassification. Assessing a VUS requires integrating information from databases, population frequency data like gnomAD, structural modeling, and computational predictions, with the understanding that these methods offer supplementary support. Functional assays, enzyme analyses, Magnetic Resonance (MR) spectroscopy, and linking phenotype to genotype are necessary to determine whether a variant explains the clinical presentation. Dr. Arora concluded that VUS interpretation must be cautious, phenotype-driven, and evidence-based, and that improved databases and functional evaluation will continue to reduce uncertainty in variant classification.

Advancing Genome Editing Therapies for Resource-Limited Settings - Dr. Debojyoti Chakraborty

Dr. Debojyoti Chakraborty works on CRISPR-based gene therapies for rare diseases and other diseases. In his talk, he detailed the intricate process behind creating India's inaugural, entirely homegrown CRISPR-based treatment platform emphasizing the scientific, logistical, regulatory and socio-economic obstacles faced. While CRISPR treatments have successfully battled diseases such as sickle cell disease globally, commercial availability is scarce because of the costs driven by patent monopolies, costly licensing, and significant clinical development expenditures. This makes such therapies inaccessible for countries like India, where sickle cell disease predominantly affects marginalized tribal communities. To overcome these barriers, he and his colleagues identified and engineered a highly specific and clinically usable Cas9 enzyme, enFnCas9, which shows higher accuracy and minimal off-target cuts. Through extensive protein engineering and validation, this system became the foundation for India's first CRISPR patent, enabling freedom to operate without reliance on foreign IP.

The team then built an end-to-end national ecosystem for gene therapy development, securing funding from the Ministry of Tribal Affairs, coordinating with regulatory bodies like ICMR, DBT, CDSCO, AIIMS, and NITI Aayog, and establishing a full GMP-grade manufacturing facility for genome-editing reagents, including domestic production of Cas9 in partnership with industry. A dedicated clinical infrastructure and outreach program were set up at AIIMS to prepare sickle cell patients for participation in clinical trials. This work culminated in Birsa-10, India's first indigenous CRISPR clinical trial, named in honor of Birsa Munda. The long-term goal is to reduce treatment costs dramatically, so therapies can be covered under national health schemes and made accessible to underserved populations. The platform is now expanding toward DMD, retinal disorders, and *in vivo* editing applications. Dr. Chakraborty spoke about many real-life examples of patients and their families, acknowledging that failures can be crushing, but that it is the courage and trust of those families that drive him to keep improving his work.

Repurposing and Re-exploring Drugs for Cost-Effective Rare Disease Management - Dr. Sumita Danda

Dr. Sumita Danda emphasized the requirement for affordable rare disease treatment in India and highlighted drug repurposing as an effective, realistic approach to bridge this deficiency. Rare diseases, while impacting populations worldwide, occur more frequently in India because of genetic variability, consanguineous marriages, and endogamous communities. Conventional drug development is lengthy, costly and unsuitable for these disorders, making repurposing (employing authorized drugs for different uses) a quicker and more cost-efficient solution. Since safety and toxicity information is already available, initial-phase trials can frequently be skipped, cutting timelines and expenses. A significant segment of the discussion revolved around an achievement from CMC Vellore related to the uncommon condition of Alkaptonuria (AKU). Clinical interest by Dr. Isaac in the tribal populations of Tamil Nadu uncovered a trend of early, intense back discomfort and joint rigidity , ultimately linked to a newly identified splice mutation causing AKU.

This lack of enzyme activity results in the buildup of homogentisic acid and advancing ochronotic arthropathy. Nitisinone, first employed for Tyrosinemia Type 1, demonstrated potential in lowering HGA levels. CMC Vellore carried out community prevalence surveys, functional assessments and an ICMR-supported randomized controlled trial comparing 2 mg and 5 mg dosages in subjects. Preliminary results indicate an over 95% decrease in HGA levels in both cohorts, with clinical improvements observed at 5 mg and few adverse effects. Dr. Danda emphasized that the future of rare disease care lies in collaboration across academia, patient advocacy, regulators, and data-sharing networks. Drug repurposing, supported by indigenous manufacturing and advanced genomic tools, offers hope and meaningful improvement in patients' lives.

Gene Therapy Development - Dr. Suresh Poda

The fourth talk of the session was delivered by Dr. Suresh Poda, President of Laurus Labs, Hyderabad, who discussed the lab's mission to bring affordable genetic medicines to the Indian market. Laurus Labs is constructing an advanced biologics GMP facility for gene therapy and drug manufacturing, including R&D capabilities. Globally, about 7,000 rare diseases affect 350 million people, but treatments exist for only around 400, and the options are mostly symptomatic. Rare disease therapies currently focus on small molecules, Antibody-Drug Conjugates (ADCs), antibodies, and emerging gene therapies, which constitute 9% of treatments. Gene therapy includes technologies such as CRISPR, gene replacement, antisense oligonucleotides (ASOs), and microRNA, with over 1,000 clinical trials ongoing in the US. High costs, especially for AAV-based therapies like ZolgenSMA costing USD 2.69 million, limit accessibility in India, where ASO therapies may range from ₹20 to ₹30 lakhs. First-generation gene therapies face challenges including expensive manufacturing, complex purification of large AAV vectors, limited tissue targeting, short durability, limited specificity, and immunogenicity due to pre-existing AAV antibodies. Second-generation therapies, like those for Dravet syndrome, use novel gene regulation targeting inhibitory neurons via intracerebroventricular administration, avoiding systemic delivery issues. Preclinical results show significant seizure reduction and protection from sudden death. Development demands extensive, costly preclinical safety testing and multi-country clinical trials. The FDA has granted RMAT designation to promising therapies. Second-generation gene therapies improve safety and tissue specificity, representing advances in treating rare genetic diseases with targeted, safer approaches. Some of the rare genetic disease therapies can be manufactured at Laurus Labs in India and the costs can be brought down.

Rare Disease Advocacy and LAMA2 Muscular Dystrophy - Shruti Gupta and Raghav Gupta

The last talk of this session was delivered by Shruti Gupta and Raghav Gupta, co-founders of Lama2 India, Delhi. The talk focused on rare disease advocacy and LAMA2 Muscular Dystrophy (LMD). LMD has a very low prevalence of around 1 in 100,000. Shruti shared her personal journey as the parent of Ishika, diagnosed with LMD. Lama2 India was established to find a cure for Ishika and support other affected families.

The organization advocates strongly for the children who suffer from LMD. Families face numerous challenges, including a lack of awareness among doctors, delayed diagnosis requiring multiple consultations over months, and limited treatment options focusing on supportive care like physiotherapy. Parents struggle with inconsistent access to physiotherapy and financial barriers that complicate genetic testing. Social challenges, such as maintaining respiratory health, are critical. Since August 2024, Lama2 India has expanded from one patient to supporting 63 individuals, aged 1 to 24 years. The group dispels myths about LMD prognosis and connects families with resources, including affordable supportive devices sourced through personal networks.

Advocating for the first human CRISPR clinical trial in India, Lama2 India has engaged biotech companies and government bodies like ICMR, with a confidential disclosure agreement signed to facilitate this effort. Globally, Lama2 India is part of an international network that meets regularly to monitor research progress. However, regulatory hurdles prevent clinical trials in India, prompting efforts to secure a waiver. Simultaneously, the group calls for greater awareness and researcher support, stressing that rare diseases remain obscure without public discourse. Despite challenges, parents remain hopeful as government collaboration improves.

Summary of Questions and Discussion

The post-discussion session underscored the urgent need to advance gene therapy development in India, highlighting funding, regulatory, and advocacy challenges. Participants agreed that high costs of gene therapy are unsustainable and cannot be borne by industry alone. Government-led, long-term programs spanning five to ten years are essential to drive innovation, as current short-term grant cycles are inadequate. Agencies like ICMR are beginning to fund clinical trial components, but organizations such as CSIR, DBT, DST, and ANRF must support foundational R&D efforts for sustainable solutions.

The regulatory landscape offers cost-saving pathways by leveraging approvals from FDA or EMA, allowing India's cell and gene therapy (CGT) regulations to waive redundant toxicology studies. Laurus Labs' successful approval collaboration with ImmunoACT within three years demonstrates a functioning and supportive system. ICMR supports first-time trials in India, contingent on marketed drug availability post-trial, aligning with its goal to lower drug costs through local trials.

R&D funding exists but must be focused and long-term; small grants are insufficient for gene therapy development, which needs dedicated financial support beyond basic research. There is a need for focused programs that support translational research. Parent groups like Lama2 India actively facilitate patient registries and engagement with biotech firms and government, despite policy barriers forbidding molecular testing domestically. They are pursuing waivers to conduct India's first human trial for LAMA2 muscular dystrophy. The session emphasized collaboration between scientists, clinicians, pharma, and advocacy groups to define endpoints and leverage natural history studies to ensure sustainable therapeutic progress. This meeting was pivotal in uniting stakeholders, fostering accountability, and amplifying parental voices driving rare disease advancement.

From left: Dr. Indumathi Mariappan, Dr. Sumita Danda, Dr. Veronica Arora, Dr. Debojyoti Chakraborts, Dr. Suresh Poda, MS. Shruti Gupta, Mr. Raghav Gupta

Dr. Debojyoti Chakraborty

SESSION 3
POPULATION AND NEWBORN SCREENING FOR RGDs

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Session 3
Population and Newborn Screening for RGDs

Carrier screening for rare diseases in India - Dr. Ashwin Dalal

Dr. Ashwin Dalal's presentation focused on addressing population-level strategies for the prevention of autosomal-recessive and X-linked rare diseases through carrier screening. He emphasized that although all individuals carry a few mutations in genes for autosomal recessive disorders, disease manifests when both partners are carriers, conferring a 25% recurrence risk. For India, hemoglobinopathies (β-thalassemia, sickle cell anemia) and spinal muscular atrophy (SMA) represent the highest-priority targets, supported by recent national recommendations from the IAMG (Indian Academy of Medical Genetics), SFM (Society for Fetal Medicine), and FOGSI (Federation of Obstetric and Gynaecological Societies of India) advocating universal antenatal carrier screening for these conditions. He spoke on various screening strategies, including cord blood/newborn, pre-pregnancy (preconception), antenatal, community-based, and screening in educational institutions, with antenatal screening identified as the most operationally feasible. A few diagnostic approaches described by him include NESTROFT (Naked eye single tube red cell osmotic fragility test), red-cell indices, HbA_2 and mutation analysis.

Dr. Dalal presented findings from the DBT-UMMID Aspirational District Program in Yadgir and Raichur districts of Karnataka, which screened 27,730 pregnant women, identifying 752 carriers for β-thalassemia and 29 carriers for sickle cell anemia. 40 at-risk couples were identified, leading to 17 prenatal diagnoses along with detection and termination of 4 affected fetuses. Implementation challenges included low awareness, late first antenatal visits, inadequate district-level laboratory capacity, sample-transport difficulties, and reluctance toward prenatal diagnosis. The talk underscored the need for strong logistics, counselling frameworks, culturally adapted communication, and robust India-specific genomic databases to guide future national carrier-screening policy and scale-up.

During the discussion phase, Dr. Dalal explained that in antenatal carrier screening, both parents need to be tested, and a prenatal test is done only if both are carriers. He added that these programs work like other public-health services, where consent is understood, as long as proper counseling is given; detailed consent is needed only if the samples are used for research. He also shared that once large genomic datasets are combined, India will be able to estimate how common any rare disease might be, although access to this data is currently limited to the project team.

Expanding the Frontiers of Public Health: Population and Community Screening for Rare Genetic Disease - Dr. Dipanjana Datta

Dr. Dipanjana Datta presented a public-health oriented framework for integrating rare disease screening into primary healthcare systems. Emphasizing the distinction between population health and individual clinical care, she highlighted the need for both population-based and community-based screening approaches to generate reliable databases and enable early identification of at-risk families. Drawing parallels with successful national programs such as under-five mortality reduction programs, tuberculosis control, and the national sickle-cell anemia elimination mission, she positioned rare diseases within the same preventive public-health approach. Her presentation described global models, including Australia's Mackenzie Mission and the WHO's recent call for improved rare-disease surveillance, and reviewed India's initial challenges: low public awareness, cost barriers, fragmented logistics, and lack of structured referral pathways.

Dr. Datta then outlined the West Bengal rare disease screening initiative named Kalyan Nirupam Yojana, built entirely within existing NHM infrastructure using ASHA workers, medical officers, and genetic counselors. Through a multilingual, questionnaire-based screening program operating across 166 wards, more than 11,267 individuals were screened. The initiative identified 72 at-risk families, 46 high-risk families, 11 confirmed cases, and an additional 15 suspected cases. Complementary pilots for glaucoma and kidney health screening further demonstrated feasibility. Dr. Datta concluded that low-cost, pre-symptomatic screening integrated into public-health systems can significantly reduce diagnostic delays and improve outcomes for rare-disease families.

During the discussion phase, Dr. Datta explained that family-wide cascade screening is difficult because of stigma, financial challenges, and families living far apart; so uptake remains low despite counseling. When asked how their group grew from three to 50 families, she said it happened organically through clinicians sharing contacts, parent-to-parent referrals, ORDI connections, and word-of-mouth, especially in rural areas. On involving medical colleges, she noted that government programs have strict geographic limits, and private colleges seldom participate in public-health work without dedicated funding.

Newborn Screening in India: the Need, the Path, and the Players - Prof. B K Thelma

Prof. Thelma addressed the audience on the need, path, and challenges of implementing extensive NBS programs. She highlighted prevention as the true priority of medical biology, emphasizing how early screening can truly shift healthcare from reactive to preventive care. She started by highlighting the growing burden of genetic and complex disorders in India. She noted that many disorders considered rare worldwide are relatively common in India due to lack of systematic screening, founder effects, consanguineous marriages, and sociocultural patterns. Considering national statistics, she described how neonatal and under-five mortality rates remain high, underscoring the urgency for systematic data collection.

Her talk focused on the large-scale study of NBS conducted in Delhi, funded by DBT. They screened 200,000 newborn babies across 21 public and private hospitals, focusing on five treatable disorders (CAH, G6PD and Biotinidase deficiency, CH, and Galactosemia) and collected epidemiological data for 34 additional metabolic conditions. The project demonstrated high parental acceptance, efficient sample collection logistics, good clinician engagement and reliable reporting within 24–48 hours. G6PD deficiency emerged as the most frequent condition (1 in 215). The project saved around one newborn per day through early diagnosis and treatment.

Key outcomes included the establishment of mutation data, the creation of India-specific normative metabolic reference ranges, SOP development, diagnostic algorithms, and strengthened public–private collaboration. The initiative of this project influenced Delhi government to launch Mission NEEV (Neonatal Early Evaluation Vision). She concluded that India has the scientific and economic capacity to mandate NBS across the country. She stressed that coordinated policy action and state-wise data remain essential for national implementation.

When Answers are Rare: The Silent Struggle from Symptoms to Support - Ms. Navintara Kamath

Ms. Navintara Kamath, founder of the NiemannPick India Charitable Trust and mother of a child with Niemann-Pick disease, shared her own experience and the struggles of families in India affected by this rare disorder. She highlighted about the severe delays in diagnosis through two real patient stories: one family with a 3-year-old child showing hepatosplenomegaly received a confirmed diagnosis only after 13 years of inconclusive tests. The second family, from a rural part of Odisha, had their first son showing epilepsy followed by developmental delays. The mother had to travel to Bengaluru for two years; meanwhile, her second son also began showing the same symptoms. Later, she discovered that both of her sons are affected with Niemann-Pick C and now they are bedridden. These cases depict the financial, emotional, and social isolation faced by rare-disease families. They often lack caregiving assistance and community support.

Navintara mentioned her non-scientific understanding on Niemann-Pick disease as a lysosomal storage disorder affecting major organs, with types ASMD (A, A/B, B) and NPC (NPC1 and NPC2), the latter being the most aggressive. She started a non-profit organization in 2023, NiemannPick India Charitable Trust, to support families through workshops, awareness programs, parent meetings, and collaborations with international alliances and AIIMS. In 2025, the trust initiated its first NPC clinical trial, starting in India. However, unaddressed needs remain notable—National Rare Disease Policy didn't include treatment for ASMD, approved NPC drugs are inaccessible in India, and due to a lack of awareness, diagnostic delays persist. In response to the audience's question on what India lacks in comparison to countries where screening is established, Navintara requested policymakers, researchers, clinicians, advocacy groups, and pharma partners to unite, improve treatment access, accelerate diagnosis and support families with dignity and compassion. She emphasized the need for sustainable access to enzyme replacement therapy and described global models (Turkey, Singapore, Brazil) that could inspire Indian frameworks.

Photographs from Session 3 - Population and Newborn Screening for RGDs

From left: Dr. Ashwin Dalal, Dr. Dipanjana Datta, Ms. Navintara Kamath, Prof. B K Thelma, Dr. K Thangaraj

Dr. Dipanjana Datta

PANEL DISCUSSION 2
ROLE OF INDIGENOUS STARTUPS DRIVING INNOVATIVE SOLUTIONS FOR RGDs

MODERATOR

Prof. Vijay Chandru

Co-founder & CEO
CrisprBits Pvt. Ltd.
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Dr. Dheeraj Reddy Bobbili

Founder & CEO
Wellytics
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Ms. Niby Jacob

Founder & CEO
Bluegene Healthtech
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Dr. Nikhil Phadke

Founder & CSO
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Prof. (Dr.) Sharan Srinivasan

Chairman & MD
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Dr. Rahila Sardar

Co-founder & CEO
VGenomics
Noida

Panel Discussion 2
Role of Indigenous Startups Driving Innovative Solutions for RGDs

The panel explored how indigenous Indian startups are addressing critical gaps in rare genetic disease (RGD) diagnostics, data systems, precision medicine, accessibility, and sustainability. With rare diseases affecting millions of Indians, the discussion highlighted the need for India-specific innovation, robust genomic resources, and clinically deployable solutions. The conversation addressed the critical challenges, opportunities, and pathways for indigenous startups to thrive in this space. The conversation revealed a sector brimming with innovation but constrained by systemic gaps that demand urgent attention from policymakers, investors, and the academic-industry ecosystem.

Bluegene Healthtech: The Case for Neutral Genetic Counseling - Ms. Niby Jacob

With 15 years of experience in the genetic diagnostics ecosystem, Ms. Niby Jacob has witnessed firsthand the disconnect between laboratory analysis and clinical utility. Her journey from genetic counselor at Strand Genomics to founder of Bluegene Healthtech was driven by a fundamental observation: genetic counseling—once considered peripheral to diagnostics—is actually integral to the entire value chain. Ms. Jacob observed a significant disconnect and gap in the system, noting that clinicians historically distrusted laboratory-based genetic counselors, fearing they might order unnecessary tests for patients. The innovation at Bluegene lies in positioning genetic counseling as a neutral, independent service. By creating a buffer between laboratories and clinicians, the startup has built trust where skepticism previously existed. Ms. Jacob emphasized that genetic counseling extends beyond clinical consultation to encompassing the creation of disease-specific panels, proper variant interpretation, and training the next generation of genetic counselors—a gap that has plagued the Indian diagnostics sector. Her approach underscores a critical insight: sustainable RGD solutions require placing emphasis on the human element of interpretation and patient engagement, not just the technological sophistication of testing platforms.

VGenomics: Translational Science as Mission-Driven Innovation - Dr. Rahila Sardar

Dr. Rahila Sardar's journey into rare genetic diseases is rooted in personal motivation. After completing her PhD in Bioinformatics from ICGEB, she realized the void in translational science within India. When she became a mother and discovered the enormous burden of RGDs in India alongside the paucity of diagnostic and therapeutic solutions, she made the decision to start VGenomics. She described this decision as a mission, emphasizing that her company is driven by the desire to address a societal need rather than purely commercial objectives. VGenomics' strategy combines multi-omics and artificial intelligence to accelerate both diagnostics and drug discovery. The company has developed a clinically compliant genomics platform (launching soon after comprehensive validation) and is advancing into drug discovery. Within just two and a half years, VGenomics has secured collaborations with major institutions like AIIMS Delhi and has worked across hundreds of samples. Dr. Sardar highlighted a crucial point about startup sustainability: the need for strong commercialization models alongside social contribution. She underscored that by leveraging partnerships with philanthropies and government grants, startups can run free testing programs while building sustainable revenue streams from commercial applications —demonstrating that social impact and business viability need not be mutually exclusive.

Wellytics: Integrating Clinical and Genomic Data at Scale - Dr. Dheeraj Reddy Bobbili

Dr. Dheeraj Bobbili transitioned from researcher to entrepreneur after identifying a fundamental problem: while genomic sequencing had become tractable, the bottleneck lies in capturing and structuring clinical data. He observed that collating medical information into a structured format poses a greater challenge than conducting genetic tests, having witnessed months-long delays in genomic research attributable to unstructured phenotype data.

Wellytics addresses this problem with an AI-powered platform that integrates clinical and genomic data, enabling faster and more accurate diagnostic decision-making. The platform is fully compliant with DPDP (Digital Personal Data Protection) regulations and designed to bridge the fragmentation of health records across systems. Dr. Bobbili's perspective is particularly relevant to the Indian context, where data privacy regulations differ from Western standards. He emphasized that while the challenges of consent, data sharing, and multilingual interfaces are complex, emerging AI models, particularly those developed for Indian languages, offer pragmatic solutions. The platform even supports automated generation of patient clinical histories from scanned documents in multiple regional languages, addressing a real-world barrier to adoption across India's diverse regions.

GenePath Diagnostics: Translating Global Expertise into Indian Solutions - Dr. Nikhil Phadke

Dr. Nikhil Phadke brings a unique perspective. He co-founded a company in the United States and developed technology that achieved significant commercial success (eventually acquired by BD), worked internationally on large-scale screening programs (including 26 million newborns across multiple countries), and then deliberately chose to restart in India. His experience in Turkey, where public-private partnerships enabled screening of millions of newborns for spinal muscular atrophy (SMA) and other genetic disorders, illustrates the potential of collaborative models.

GenePath's story in India is instructive about both opportunity and constraint. The company has successfully developed tests for complex genomic regions (such as congenital adrenal hypoplasia and atypical hemolytic uremic syndrome) where technical challenges require specialized expertise. Their collaboration model integrates with CSR funding and has been transformative in context of conducting 38,000 HPV tests for free using government funding while validating proprietary test development. Similar models can be used in context of rare genetic disorders by focusing on the priority diseases with identified population cohorts. However, Dr. Phadke acknowledged that RGD space for industries in India needs more support from a more global diversification approach-where the loss-making operations in India can be balanced by business in other countries. This insight underscores a fundamental challenge: the RGD diagnostics market in India, while important, cannot yet sustain standalone commercial operations. Startups must develop global diversification strategies or be embedded in broader ecosystems like public-private partnerships.

PRS Neurosciences and Mechatronics Research Institute: Patient-Centered Innovation from the Ground Up - Prof. Dr. Sharan Srinivasan

Prof. Sharan Srinivasan represents a distinct innovation model: the clinician-scientist-entrepreneur, entirely self-funded with no institutional backing. A stereotactic and functional neurosurgeon with 25 years of practice, Prof. Srinivasan has pioneered approaches to rare movement disorders, including Huntington's chorea, dystonia, and focal dystonias through neuromodulation and precision surgery. His innovation transcends genetics. It spans functional neuroscience (mapping brain circuits), hardware-software development, and neurotechnology.

Prof. Srinivasan's perspective on startups and rare diseases centers on the importance of keeping the patient at the core and maintaining a sense of purpose when developing tools for rare genetic disorders. He also emphasized that 90% of startups fail within five years, a statistical reality globally and not unique to India. His observations are that passion is a prerequisite for a successful startup model in RGD space. He stated the startups that endure are those driven by a different motivation, grounded in passion for the work rather than an emphasis on exit strategies or valuation outcomes.

Crucially, Prof. Srinivasan also articulated an often-unspoken reality about medical innovation in India: resources and priorities must reflect ground-level needs, emphasizing that startups must design solutions appropriate to the Indian context, not simply import models from advanced economies. However, he also highlighted a critical gap: the medical profession is still struggling with basic acute emergency care (like stroke-ready hospitals and standardized stroke protocols). Genetics, in his view, sits lower in the hierarchy of immediate clinical needs. This raises a profound question: how do rare genetic disease initiatives position themselves when much of the healthcare system is still managing acute and common chronic conditions?

Navigating Complexity Through Collaboration - Prof. Vijay Chandru

Prof. Chandru's role as moderator and co-founder of Strand Life Sciences and CrisprBits (a company focused on translating genetic discoveries into clinical solutions) allowed him to synthesize themes across the panel while offering institutional perspectives. Central to his analysis were ecosystem-level challenges: how to build sustainable companies focused on diagnostics, how to establish robust variant databases relevant to Indian populations, how to foster genuine academic-industry-public partnerships, and how to manage data sharing and privacy in ways that balance innovation with patient protection.

A recurring theme discussed was the need for academic-industry partnerships, data sharing frameworks, and ecosystem development. Translating these into ground-level action remains difficult. This highlights the need for models that have demonstrated that large-scale, socially impactful programs are achievable when structured appropriately, with clear roles for public funding, institutional anchors, and appropriate incentive structures.

Critical Challenges Facing India's RGD Startups

The Sustainability Paradox

The most candid insight from the REDRESS 2025 discussion: building a sustainable company solely around rare genetic disease (RGD) diagnostics in India is nearly impossible. The market is small, economics are unfavorable, and willingness to pay, whether by patients, insurers, or government, is minimal. Viable models either serve global markets or operate within subsidized frameworks such as public–private partnerships, philanthropic programs, or cross-subsidization from broader diagnostic portfolios.

Startups in this space juggle dual missions: addressing critical unmet needs while staying financially viable. Those that survive balance social impact with commercial pragmatism—leveraging export markets, grant funding, and institutional collaborations to fund long-term R&D and clinical validation.

Data Challenges: From Variants to Interoperability

Variant interpretation remains a bottleneck. The prevalence of variants of uncertain significance (VUS) limits the clinical utility of sequencing. India relies heavily on international databases like ClinVar, now itself under funding pressure, leaving the ecosystem exposed. Emerging local efforts—such as TIGS' variant repository (GenTIGS)—need sustained funding, transparent governance, and clinician participation to capture India-specific genomic data.

Fragmentation of patient records compounds the problem. With testing spread across institutions and states, the lack of interoperable electronic medical records (EMRs) prevents longitudinal data use.

Consent, Privacy, and Governance

Informed consent in the genomic era faces conceptual strain. Dense legal documents rarely translate to genuine understanding—especially when non-genetic clinicians are mediators. Beyond procedural compliance, real consent demands personal interaction and comprehension. Technology may simplify forms, but deeper questions remain: should patients merely "consent," or should they share data under fiduciary models ensuring value returns to them and their communities?

The Human Element: Integrating Clinical Genetics

Genetic counseling emerged as a critical missing link. Effective diagnostics require clinical context, proper interpretation, and follow-up. Yet India faces a severe shortage of genetic counselors, and medical curricula still marginalize genetics education. As Ms. Niby Jacob emphasized, without trained intermediaries, even the best technology remains underused or misused.

Pathways Toward a Viable Ecosystem

1. Leverage public-private partnerships. Collaborations with institutes such as TIGS demonstrate how philanthropic funding can de-risk innovation while creating access to diverse patient cohorts. Such partnerships work best when startups pursue complementary revenue from global markets.

2. Build for global scale. Rare diseases transcend borders. An Indian condition affecting ten patients may correspond to hundreds globally. Startups should design for international relevance while leveraging India's genetic diversity and cost-efficient R&D environment.

3. Treat data infrastructure as a public good. Variant databases, registries, and EMR interoperability must operate on open, sustainable models—supported by government funding, philanthropy, and moderated open-access frameworks similar to India's Biodiversity Portal.

4. Redefine success metrics. Profit and valuation alone cannot measure success in this sector. True success lies in scientific progress, clinical utility, and social impact. Investors must embrace longer horizons and patient-centric priorities.

5. Embed patient and clinician voices. Startups originating within patient advocacy groups display sharper mission alignment and urgency. The KJ Baby case—where a therapy materialized within nine months through a united effort—illustrates the power of collaborative purpose.

6. Enable interdisciplinary fluency. Clinicians, engineers, and scientists often speak incompatible languages. Translational roles bridging these domains are essential from the outset, not retrofitted after communication breakdowns.

7. Reform medical education. Genetics must move from elective to essential in India's MBBS curriculum. Frontline physicians need baseline literacy to identify potential RGD cases early and refer appropriately.

A Sector at an Inflection Point

India's RGD ecosystem faces fundamental challenges: market economics that make standalone businesses unviable, data infrastructure gaps, workforce shortages (genetic counselors, trained clinicians), and policy environments that have not yet fully internalized the importance of rare genetic disease diagnostics. The solutions are not mysterious—they are evident from examples both within and outside India. What is required is coordinated action: commitment to data sharing and variant database development as public goods, venture capital willing to support longer timelines and mission-driven companies, medical education reform, and institutional partnerships that transcend transactional relationships.

The patients counting days—as one clinician eloquently put it—deserve nothing less than a full ecosystem mobilized to serve them. The entrepreneurs, clinicians, and scientists assembled at REDRESS 2025 have demonstrated both the will and the capability to build that ecosystem. The question for the broader system is whether it will provide the structural support required to translate that will into scaled impact.

Photographs from Panel Discussion 2 - Role of Indigenous Startups Driving Innovative Solutions for RGDs

From left: Prof. Vijay Chandru, Dr. Nikhil Phadke, Ms. Niby Jacob, Dr. Rahila Sardar, Prof. (Dr.) Sharan Srinivasan, Dr. Dheeraj Reddy Bobbili

From left: Dr. Nikhil Phadke, Ms. Niby Jacob, Dr. Rahila Sardar

SESSION 4
CLINICAL RESEARCH: BENCH TO BEDSIDE AND BACK

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Session 4
Clinical Research: Bench to Bedside and Back

The session highlighted the translational journey from laboratory discoveries to clinical implementation and the feedback loop that drives new scientific insights. Through diverse talks covering regulatory science, molecular neurology, precision therapeutics, stem-cell therapies, and patient advocacy.

Rare Disease Clinical Trials: Ethical & Regulatory Considerations, Challenges & Opportunities - Dr. Mala Srivastava

Dr. Mala Srivastava offered a clear and insightful walkthrough of the evolving regulatory landscape shaping rare-disease clinical trials in India. She began by framing how policies such as the New Drugs and Clinical Trials Rules (NDCTR) 2019 and the National Policy for Rare Diseases (NPRD) 2021, along with international regulatory frameworks, have created a more supportive environment for innovation. These reforms now enable fee waivers, expedited reviews, accelerated approvals, and dedicated pathways for Orphan Medicinal Products (OMPs), a major shift for conditions that historically lack structured guidance. She highlighted that rare-disease patients often face unique ethical vulnerabilities: limited treatment choices, high dependence on clinicians, and difficulty navigating complex consent processes. For this reason, she emphasized the importance of ensuring free ancillary medical care, safeguarding post-trial access to therapies, strengthening Serious Adverse Event (SAE) reporting, and ensuring vigilant oversight from Institutional Ethics Committees (IECs) and Data Safety Monitoring Boards (DSMBs). Dr. Srivastava gave an overview of the key regulatory steps required for initiating rare-disease trials such as pre-submission consultations with the Central Drugs Standard Control Organization (CDSCO), securing Orphan Drug Designation (ODD), filing an Investigational New Drug (IND) application, meeting Chemistry Manufacturing and Controls (CMC) standards, obtaining import or test licenses, and registering studies on the Clinical Trials Registry India (CTRI). She emphasized that early regulatory dialogue could prevent delays.

Moving to study design, she explained that traditional large trials often aren't feasible for small patient populations. Instead, innovative approaches such as N-of-1 designs, decentralized trials, real-world evidence (RWE), and adaptive monitoring allow meaningful data generation even with very few participants. However, she also noted several challenges, including the manufacturing complexity of Advanced Therapy Medicinal Products, the limited number of trial-ready sites, gaps in documentation, uncertainty around reimbursement, and the need for stronger investigator training.

She concluded by emphasizing that India can play a much larger role in global rare-disease research if early regulatory engagement becomes routine, if Centre's of Excellence (CoEs) align their processes, and if clinicians receive sustained capacity-building support. These steps she noted, are essential to ensuring that promising therapies can reach patients faster, safely, and equitably.

Movement Disorders: From Bench to Bedside and Back - Dr. Meera Purushottam

Dr. Meera Purushottam shared insights from more than two decades of dedicated translational research in adult-onset movement disorders. She began by describing how NIMHANS progressively built one of India's most robust diagnostic and research programs for spinocerebellar ataxias (SCAs), hereditary ataxias, dystonia's, and Huntington's disease (HD). This effort has not only expanded genetic-testing capacity but also created a large, well-characterized clinical cohort that continues to guide research questions. She discussed her team's significant work on SCAR-12 and SCAR-27D, particularly FGF14-related repeat-expansion disorders, and presented striking evidence of tissue-specific allelic instability. Using postmortem brain samples, she illustrated how repeat lengths vary across regions such as the frontal cortex, cerebellum, and occipital areas. These findings highlight how instability across different tissues can shape symptom severity and progression. She also shared rare molecular signatures uncovered in these studies, including variations in repeat purity, somatic mosaicism, and mutation behavior across tissues, offering a deeper understanding of disease mechanisms. In juvenile-onset Huntington's disease, Dr. Purushottam described dramatic and disproportionate expansions in organs such as the liver, kidney, and brain, explaining why these children present unusually early and severe symptoms. She also highlighted cases involving de novo repeat expansions, where individuals develop HD despite no family history. This observation carries important implications for genetic counselling, screening strategies, and long-term surveillance.

A cornerstone of her group's ongoing efforts is the Indian Huntington's Disease Registry, which systematically integrates genetic data with psychiatric profiles, cognitive assessments, and demographic variables. The registry helps to map the true national burden of HD, understand regional variation, document longitudinal progression, and prepare well-characterized cohorts for future clinical trials. Throughout her talk, Dr. Purushottam emphasized the powerful feedback loop between clinical observations and laboratory investigations. Insights from patients inform molecular research, which then refines diagnostic pipelines, gene panels, and the identification of atypical or early-stage presentations. Her work strongly reflects India's growing leadership in understanding dynamic mutations and their clinical impact, an area that will shape the next generation of neurogenetic diagnostics and therapies.

Molecular Insights & Precision Therapeutics for Autism in Rare Genetic Disorders - Dr. Sheffali Gulati

Dr. Sheffali Gulati delivered an engaging overview of the molecular and clinical diversity that characterizes autism spectrum disorder (ASD). She highlighted how research has moved beyond behavioral descriptions toward recognizing rare monogenic syndromes such as Rett syndrome, Fragile X syndrome, Tuberous Sclerosis Complex (TSC), PTEN-associated conditions, and SHANK3-related disorders as key models for understanding ASD biology. These syndromes, she noted, offer powerful insights into the cellular pathways that shape neurodevelopment.

Drawing from her extensive cohort at AIIMS, Dr. Gulati emphasized the high prevalence of comorbidities in autistic children, including epilepsy, Attention-Deficit/Hyperactivity Disorder (ADHD), sleep problems, gastrointestinal disturbances, neuropsychiatric symptoms, and sensory-processing issues. This clinical complexity underscores the need for multidisciplinary care.

She reviewed several core molecular pathways implicated in ASD, such as disruptions in synaptic scaffolding proteins (SHANK3, NRXN1), chromatin-remodeling abnormalities in the CHD8 gene, immune dysregulation, mitochondrial dysfunction, oxidative stress, and gut-brain axis alterations. These insights have opened new avenues for targeted therapies. emerging interventions include MECP2 and CDKL5 gene therapies, mTOR inhibitors for TSC-related autism, folinic acid supplementation for folate receptor autoantibodies (FRAA)-positive children, antisense oligonucleotides (ASOs), and early CRISPR-based research efforts.

Dr. Gulati also highlighted the growing importance of biomarkers such as functional MRI (fMRI), diffusion tensor imaging (DTI), quantitative EEG (qEEG), metabolomics, and genomic profiling, which are helping tonstratify ASD into more biologically meaningful subgroups. She stressed the impact of modifiable environmental and perinatal factors including air pollution, maternal infections, micronutrient deficiencies, and endocrine disruptors.

She concluded by advocating for precision-medicine models that integrate genomics, neuromodulation techniques such as transcranial magnetic stimulation (TMS), early behavioral therapies, and artificial intelligence (AI) enabled early-detection tools. Her talk underscored the rapidly growing intersection of molecular neuroscience and real-world pediatric neurology.

Cell-Based Therapeutic Strategies: Intraosseous and Intravenous Fetal MSCs for Bone Fragility in Severe Osteogenesis Imperfecta - Dr. Vrisha Madhuri

Dr. Vrisha Madhuri presented pioneering work on mesenchymal stem cell (MSC) therapy for severe Osteogenesis Imperfecta (OI), focusing on the unique regenerative potential of fetal liver-derived MSCs. She explained that these early-stage cells have strong osteogenic capacity and low immunogenicity, making them especially suitable for bone-fragility disorders. Her team designed the BOOST-to-B clinical trial to maximize therapeutic benefit by delivering MSCs through two routes: intravenously to support systemic effects and intraosseously to directly target weakened bones. This combined approach was developed to enhance engraftment in areas where bone formation is critical.

Dr. Madhuri shared encouraging safety data, noting that no infusion-related adverse reactions were observed. She highlighted significant clinical improvements among participating children, including increases in bone mineral density (BMD) of up to 25 percent and a remarkable reduction in annual fractures from an average of seventeen to around three. Gains in motor functioning, reduced pain, and better overall mobility contributed to meaningful improvements in quality of life. Many children also showed accelerated growth velocities that exceeded expected centiles, reflecting the systemic impact of MSC-based therapy.

She then discussed her group's work on developing scalable alternatives, such as induced pluripotent stem cell (iPSC)-derived MSCs and MSC-derived exosomes. Early preclinical studies demonstrate that these exosomes can restore bone microarchitecture in severe mouse models, suggesting future possibilities for cell-free regenerative therapies.

While the results are promising, Dr. Madhuri also addressed key challenges, including the limited availability of donor cells, regulatory barriers for advanced cellular products, and the need for Good Manufacturing Practice (GMP)-compliant production systems. She concluded that MSC-based interventions represent an emerging therapeutic frontier for OI, with the potential to significantly expand treatment options beyond traditional bisphosphonate therapy.

Tuberous Sclerosis Complex Care in India: A Patient Advocacy Perspective - Mr. Rahul Vipparthi

Mr. Rahul Vipparthi described TSC as a multisystem disorder affecting the brain, heart, kidneys, skin, lungs, and behavior. He presented international consensus guidelines for surveillance, including MRI, EEG, renal US/MRI, dermatological assessment, and behavioral/neuropsychiatric evaluations. He highlighted several India-specific challenges: the absence of multidisciplinary clinics, fragmented diagnostic pathways, limited clinician awareness outside metropolitan areas, the burden of sedation for imaging in sensory-sensitive children, and the high cost of surveillance. He discussed the progression of TSC manifestations by age-cardiac rhabdomyomas antenatally, seizures in infancy, behavioral disorders in childhood, renal and pulmonary manifestations emerging later. mTOR inhibitors are disease-modifying but costly. TSC Alliance India runs peer-support groups, regional WhatsApp communities, caregiver education programs, podcasts, webinars, and advocacy campaigns for dedicated TSC clinics. They also facilitate knowledge exchange between Indian experts and global TSC networks. His talk highlighted the central role of patient groups in bridging systemic gaps.

Photographs from Session 4 - Clinical Research: Bench to Bedside and Back

From left: Prof. Sanjeev Jain, Mr. Rahul Vipparthi, Dr. Vrisha Madhuri, Dr. Mala Srivastava, Dr. Meera Purushottam, Dr. Sheffali Gulati

Mr. Rahul Vipparthi

Rare Genetic Diseases Research Summit (REDRESS) 2025: Key Takeaways to Plan a Way Forward

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Rare Genetic Diseases Research Summit (REDRESS) 2025: Key Takeaways to Plan a Way Forward

The Way Forward Session at REDRESS-2025 focused on approaches for advancing our capabilities in rare disease research, diagnosis, and therapeutics. The objective was to bring together leaders from science, medicine, industry, and patient advocacy to identify national priorities and outline practical steps for strengthening India's rare disease ecosystem. The discussion covered a wide range of topics, including population-specific genetic databases, national registries, newborn screening, translational research, affordable therapies, and the need for unified regulatory frameworks. The panelists highlighted actionable solutions that can support evidence-based policymaking, accelerate therapeutic development, and thereby improve care for individuals living with rare genetic disorders in India.

Actioning the Intent to Cure Rare Genetic Diseases

Prof. Vijay Chandru set the tone for the final panel discussion at REDRESS-2025 with his talk on "Actioning the intent to cure rare genetic diseases". Outlining the path from analysis that leads to advocacy which then results in action, he walked the audience through the origins of the National Policy for Rare Diseases (NPRD). He highlighted how the first step of diagnostics can be democratized with advances in genomics, and genetic screening can lead to a confirmatory diagnosis for most diseases. With the cost associated with molecular and next-generation sequencing reducing drastically, technological advances have reached the stage where the challenges of the diagnostic odyssey for patients can truly be overcome.

Addressing the next key step, Prof. Chandru discussed the potential for CRISPR-based technologies to lead the way in therapeutics. Preclinical models and stem-cell-based therapeutics afford the n=1 model that rare patients need clinical trials to become meaningful and accessible. Consolidation and automation will be the key drivers of successful implementation of these technologies.

Panel Discussion

Dr. Rakesh Mishra moderated the discussion with a focus on a masterplan for policy and implementation. He emphasized the need for translational research and frameworks that connect basic science to real-world health solutions, and he solicited expert views across the following key areas:

Strengthening India's Genetic Registries for Better Rare Disease Management

Prof. Vijay Chandru emphasized the need for India to develop its own genetic variant database to accurately capture the country's unique population diversity and the rare disorders that are comparatively more prevalent here. Current national registries for rare and genetic diseases were identified as insufficient, making their expansion an urgent national priority. Further, the potential of AI-enabled models to strengthen population-level early screening was highlighted, demonstrating that early diagnosis and timely interventions are now feasible.

In terms of registry development, a bottom-up approach was strongly recommended, beginning at primary health centers and extending through ASHA workers and community-level health systems. Reliance solely on large hospitals and tertiary centers can provide an incomplete picture of the actual rare disease cases across the country, while academic institutions are often not equipped to build adequate registries for practical implementation

Dr. Rakesh Mishra stressed that comprehensive registries form the foundation of clinical trial design, research planning, and national health strategies. Recent discussions at the Indian National Science Academy (INSA) underlined how regulations need to be people-friendly and feasible at the grassroots level. Ongoing collaborations with multiple groups are contributing to the strengthening of India's registry systems.

Advancing Genomic and Stem Cell Research Landscape

Prof. Maneesha Inamdar emphasized the urgent need to define population-specific "normal" genetic baselines for India, as most existing global reference standards are derived from Caucasian datasets. This limitation often results in misinterpretation of genetic variants and inaccurate disease-risk predictions for Indian patients. An immediate solution is to harness the power of stem cell–based models, particularly their ability to reveal early human developmental processes and disease mechanisms that originate before birth. However, global research continues to depend on a narrow set of stem cell lines that fail to represent India's genetic diversity. Consequently, the development of Indian-origin stem cell lines should be a key national priority.

Addressing this gap, the Institute for Stem Cell Science and Regenerative Medicine (inStem) has established India's first stem cell biobank to provide high-quality, well-characterized stem cell resources and ensure stringent quality controls for the research community. Furthermore, national capacity-building efforts are being strengthened through the DBT-supported ESCORT platform (Enabling Stem Cell and Organoid Research and Training), which offers training and resources in stem cell and organoid technologies. Complementing these efforts, the CReATE (Centre for Research, Application and Training in Embryology) facility enables advanced research in early human embryology and 3D differentiation models, supporting scientific questions that cannot be addressed using traditional animal models.

Strengthening Newborn Screening, Therapeutic Development, and Industry Collaboration for Rare Diseases

Prof. B K Thelma emphasized that prevention must remain a national priority, necessitating the rapid expansion of newborn screening programs across India. Expanded metabolic screening technologies are a major enabler, allowing the detection of 80–120 conditions from a single blood spot, thereby making nationwide adoption both feasible and impactful. With early detection, targeted carrier testing for parents becomes possible, reducing the likelihood of recurrence in future pregnancies. The panelists underlined the importance of coupling genomic screening with effective follow-up, ensuring that identified families are counseled for prevention and disease management.

Many children diagnosed with rare disorders are awaiting the development of effective therapeutics. However, to enable therapeutic progress, the availability of accurate and reliable patient numbers is essential, allowing targeted resource allocation by the government and clarity for industry partners regarding the documented patient numbers and outcomes. Researchers and clinicians can help generate high-quality data to estimate these numbers across various states and build capacity for implementation-ready technologies for the states to take over screening programs. Strong government support is necessary, particularly through mandating newborn screening guidelines at the state level to ensure uniform and systematic programs across India.

The importance of academia-industry collaboration was stressed, recognizing that academic institutions alone cannot translate biological insights into on-ground impact. Dr. Rakesh Mishra expanded on this theme that meaningful improvements in patient care depend heavily on strong industry participation for translation into practical, scalable solutions. Early engagement of industry partners was highlighted as the most promising approach to ensure that development strategies align with real-world needs, economic feasibility is addressed, and long-term implementation becomes achievable.

Advancing Rare Disease Research and Clinical Capacity

Prof. Sanjeev Jain highlighted how common diseases often arise from the combined effect of numerous rare variants. Rare diseases offer a powerful lens for understanding complex disorders, where a single gene mutation can manifest as a broad spectrum of clinical symptoms. This distinction underscores the scientific value of rare disease research in uncovering core biological mechanisms that can serve as a model for understanding widespread conditions such as diabetes, hypertension, and arthritis.

The discussion reiterated how progress in rare disease care depends on strong integration between academia, industry, and the medical community. Within this framework, medical professionals play a pivotal role in implementing genetics-based diagnostics and overseeing long-term patient management. Without well-trained clinicians who understand genetics, genomics, and chronic care pathways, even the most advanced technologies and therapies cannot reach their full impact. The need for the hour is to link the medical system with biotechnology and diagnostic innovation and to ensure active participation from patient advocacy groups for a cohesive research ecosystem.

India has the world's largest pool of doctors that can be brought together via visionary programs. For example, Prof. Jain highlighted the impact of preimplantation genetic testing programs for conditions such as Huntington disease, which provided valuable insights into how disease genes function during the earliest stages of human development.

Making Advanced Precision Therapies Affordable Through Indigenization

Dr. Suresh Poda noted that achieving affordability for advanced therapies, such as gene therapy, immunotherapy, enzyme replacement and CAR-T therapy, requires strategies beyond government funding. Globally, affordability remains a challenge; even high-income countries struggle with high treatment costs despite established insurance and reimbursement systems.

For India, the reliance on imported drugs is financially unsustainable and needs to be replaced with commercially viable projects for precision care. The recent approval of indigenous CAR-T therapy has allowed treatment at a much lower cost compared with international prices. Adenovirus-based gene therapies are similarly being explored and can be expedited by academic grants that partner with industry for moving beyond the exploratory phase to early clinical stage.

Strengthening the infrastructure for gene therapy and precision medicine is crucial for producing next-generation genetic therapies locally, at scale, and at costs aligned with national healthcare needs.

Strengthening Governance and Regulatory Systems

Mr. Prasanna Shirol emphasized that India's rare-disease ecosystem requires a greater sense of urgency, comparable to the rapid regulatory responses implemented during the COVID-19 pandemic and the roll-out of nationwide vaccination systems. Accelerating therapy development and its approval depends on removing regulatory hurdles, which continue to be a major bottleneck in delivering rare disease care, particularly because health is a state subject and implementation varies widely across India. Unclear divisions of responsibilities between central and state authorities have resulted in inconsistent execution of national programs, such as with the first National Policy for Rare Diseases (2017), where limited engagement from many states prevented its nationwide impact.

There is a lack of clarity between judicial judgments and the rare-disease cell created at the MOHFW for providing uniform guidelines resulting in isolated or uneven outcomes. This also leads to uncertainty regarding regulatory pathways. Finally, the high cost of developing and providing therapies and the fragmented funding streams complicate innovation and impact patient access.

A unified national framework can integrate policy development, regulatory pathways, streamlined funding approaches, and clinical and research strategies that are essential for effective and equitable management for rare diseases.

Photographs from Way Forward session

From left: Dr. Rakesh Mishra, Dr. Suresh Poda, Mr. Prasanna Shirol, Prof. Maneesha Inamdar, Prof. Sanjeev Jain, Prof. B. K. Thelma, Prof. Vijay Chandru

From left: Dr. Suresh Poda, Mr. Prasanna Shirol, Prof. Maneesha Inamdar, Prof. Sanjeev Jain

Conclusion

REDRESS-2025 concluded with the acknowledgement that addressing rare diseases requires a holistic and collaborative ecosystem. From strengthened governance to unified registries and clinician-researcher-industry partnerships, every step must align toward a patient-focused, affordable, and evidence-based system. The panel emphasized that the future of rare disease care lies in breaking silos, building integrated frameworks, and ensuring that innovation translates into accessible and meaningful outcomes for patients. Following are the key single-point takeaways gathered from each of the panelists:

- Research in rare diseases needs to account for economic viability; as the cost of technologies is brought down, industry-led optimization for personalized therapies will increase.
- Disorders should be prioritized based on established registries while simultaneously engaging industry to develop solutions, rather than solely relying on state-level government screening programs.
- Critical mass needs to be achieved to address the challenges surrounding rare disorders, with a prioritization of diseases and approaches that can help multiply our efforts rather than spreading them too thin.
- Addressing rare diseases requires reducing the current fragmentation through consolidation at both policy and data levels, advocating for unified government guidelines across diseases and creating accessible databases for patients, researchers, and clinicians.
- The framework for rare disease care needs to shift from being labeled as a burden to an opportunity. With genetic variations being natural and inherited, government policies should not be created solely from a financial perspective, but with a focus on the scientific understanding that can be gained and the care that can be provided. India's large and genetically diverse population offers a unique advantage, providing access to substantial patient numbers, expanding technological capacity, and opportunities to generate large, meaningful datasets that can accelerate our understanding of disease biology.
- A unified narrative needs to be developed and presented unambiguously across patients and stakeholders. Currently, even low-cost treatments remain unnoticed due to the absence of a cohesive narrative and advocacy.
- Strategic planning, collective effort, and government collaboration will go a long way for rare disease initiatives to be implemented effectively. There is an urgent need for disease-agnostic approaches and shared responsibility among all stakeholders to make a meaningful impact.

ANNEXURES

At REDRESS 2025, a total of 95 abstracts were submitted towards poster presentation. The submissions were across eight thematic categories, to reflect the breadth of ongoing work in the Rare Genetic Diseases field, the categories were: Basic Research, Clinical Research, Translational Research, Diagnostics & Screening, DigiHealth/MedTech/AI, Regulatory/IP, Newborn Screening/Population Screening, and Policy Research.

Following a review process, 60 abstracts were selected for presentation. The submissions represented a diverse research community, with contributions from 45 institutes, companies and startups across the country.

Name	Title
Radhika Kawathe	When RASopathies Collide: A Rare Case highlighting the Continuum between Noonan Syndrome 1 and LEOPARD Syndrome 1
Lakshmi K	From Molecular Signatures to Predictive Models: Advancing Biomarker Discovery in Duchenne Muscular Dystrophy
Deepika Maru	Outcome of Whole Exome Sequencing in Newborns Diagnosed with Rare Disease
Sripathi Chandragupthan	Treatment for Rare Genetic Diseases: New Ray of Light
Gowrang K M	Rare disease genomics data analysis pipeline
Sneha Kar	Novel HSPB8 Variant Identified in an Indian Cohort Links to Protein Aggregate Pathology
Renu Kumari	Autosomal Recessive Cerebellar Ataxias in India: Systematic Literature-Based Molecular Profiling of Common Subtypes
Mohana Indira Reddy	Coding Blind Spots: Rare-Disease Visibility in India's Transition from ICD-10 to ICD-11

Name	Title
Prachi Sandeep Oza	Cytogenomic analysis in patients with Conotruncal Heart Defects
Rukhsana Hassan	Telomere Shortening Correlates with Disease Severity in Spinal Muscular Atrophy: Insights from Northern, India
Rukhsana Hassan	Interplay between Telomere Attrition and SMN Gene Variability in Northern Indian Patients with Spinal Muscular Atrophy
Andhela Leela Sairam	Targeted multiplexed LC–MS/MS-based assay for early detection and monitoring of Organic Acidemias: A clinical application
Kuthambakam Baby Rani	Community awareness on Fragile X syndrome: A collaborative survey with fragile x syndrome
Karthik Ravi	Exploring Organisational Preparedness and Impediments for Patient Advocacy in the Genomics Era
Sarvesh Galgale	Application of DNA Language Models for Rare Disease Gene and Variant Interpretation
Apurba Das	Correction of Mitf Dysregulation by Small Molecules Reduces Neurodegeneration in Mucopolysaccharidosis Type VII
Surupa Basu	Safety, Pharmacokinetics and Preliminary Molecular Efficacy of Exon 51 Antisense Oligonucleotide PRO051 in Indian Boys with Duchenne Muscular Dystrophy: A Phase-1, Open-Label Study
Nilufar Yasmin	Genetic Shadows: Unveiling a Masked α-Thalassemia Variant in HPFH”

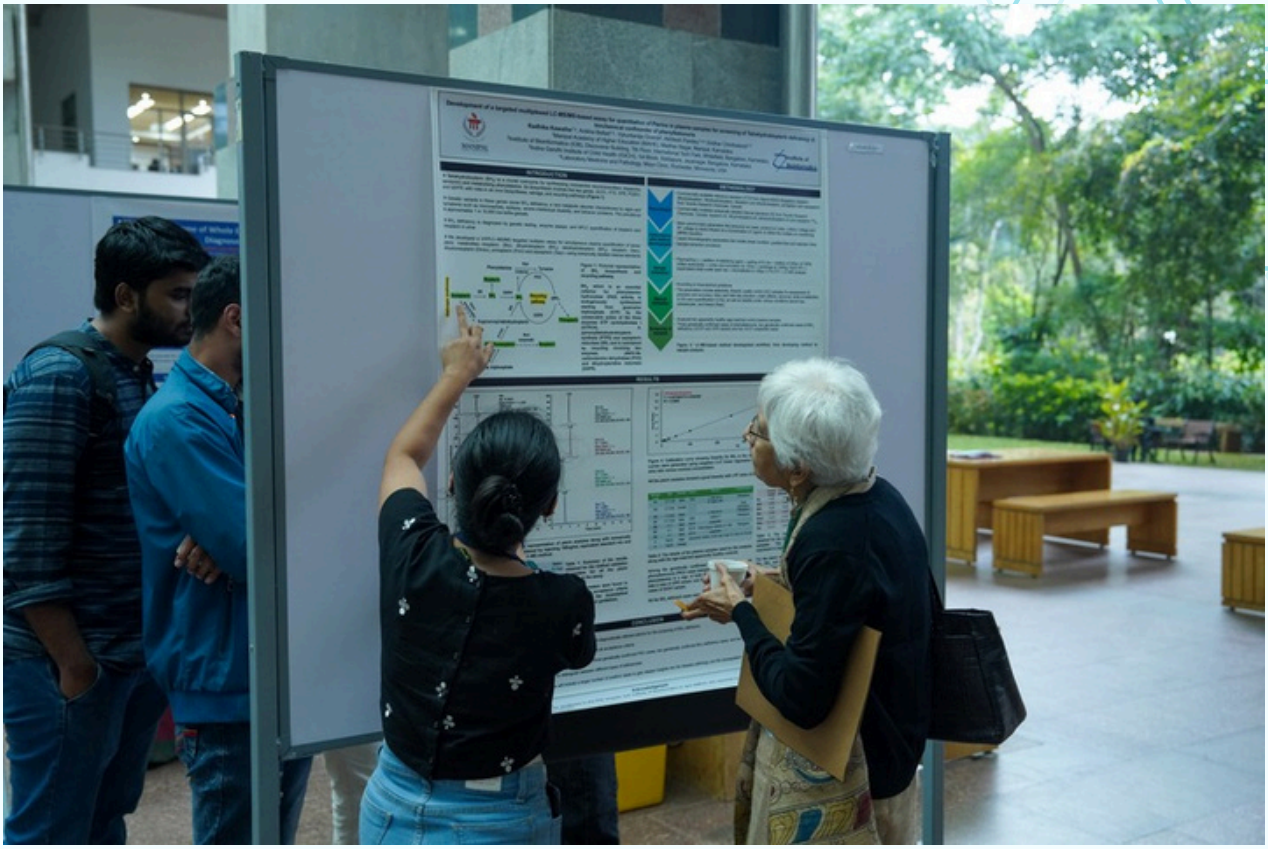
Name	Title
Jeyarish V	Targeting Pathogenic Variants in Niemann-Pick Type C Disease: A Variant- Driven Drug Repurposing Approach Leveraging Genomic and Chemical Databases
Satwik Kuppili	A Rare Case of Complete Cryptophthalmos with Suspected Fraser's Syndrome in a Female Neonate
Vaishnavi Tiwari	Deciphering DUX4-driven gene regulatory networks in FSHD through Integrated Single-cell and Single-nucleus RNA sequencing analysis
Prasanth Vudala	Clinical Presentation of a Novel PCDH12 Mutation Causing Global Developmental Delay: A Case Report.
Prasanth Vudala	A successful treatment with hematopoietic stem cell transplantion in a child with Griscelli syndrome type II
Sathya Swetha	Nanopore Sequencing Based Diagnostic Panel For Spinocerebellar Ataxias
Dr. Sivaraj Mohana Sundaram	Temporal regulation of neural progenitor fate and maturation during early postnatal development
Swetha J	Identification and Computational Analysis of Rare Variants in Non-syndromic Hearing patients of South Indian consanguineous offspring
Kiran Bharat Gaikwad	Dysregulation of TRP Channels and EMT-Related Genes in Fuchs Endothelial Corneal Dystrophy: A Bioinformatics Approach
Omkar Surendra Khade	Comparative lipidomic analysis identifies common metabolic signatures in neuronal ceroid lipofuscinoses

Name	Title
Umesh G	When RASopathies Collide: A Rare Case highlighting the Continuum between Noonan Syndrome 1 and LEOPARD Syndrome 1
Annes Siji	PathCrisp-SickleDetect: A CRISPR-Based Point-of-Care Assay for Accurate Sickle Cell Screening
Nancy Deep	Towards Personalized Therapies: CRISPR-Based Correction of RDH12 Mutation in Leber Congenital Amaurosis
Vishnu N Radhakrishnan	Targeted acylcarnitine profiling using LC-MS/MS for detection of metabolic signatures in inborn errors of metabolism
Arpita Kharat	Virtual Screening and ADMET-Based Profiling of Small Molecule Modulators for Spinal Muscular Atrophy via SMN2 Splicing Enhancement.
Sandhya S M	Stress and coping strategies among parents of children with rare genetic disorders: An exploratory qualitative study in urban Bengaluru
Rajguru Mangesh Sudhakar	SERPINA7 Deficiency: Mutational, Structural, and Clinical Implications of Rare Thyroxine-Binding Globulin Disorder
Juwariah Fazal	Phenotypic Variability in Lowe Syndrome
Kamakshi Tomar	Effect of Timing of Feeding on the phenotypes associated with Huntington’s disease.
Joseline Dias	Market incentives and policy approaches for orphan drugs: a global review with strategic recommendations for India

Name	Title
Vivekanandan V S	Real World Insights into Hypokalemic Periodic Paralysis - Molecular Basis of Bartter Syndrome
Nandha Kumar S	Comparing Classical and CRISPR-based Approaches for Repeat Expansion Analysis
Sangeetha A	Integrating Genetic Counselling into Rare Disease Clinics: Lessons from Multidisciplinary Models in India
Narendra Chirmule	Manav Mandir - A therapy center for muscular dystrophy - that 3-decade story
Asha Subramanian	SemGenome – Democratizing access to cutting edge variant analysis and interpretation for clinical diagnosis of germline disorders
Sangam Shivanna	Alligator boy
G Arun Kumar	Solar Chronicles
Pooja S	GenTIGS v2.0- a comprehensive resource for rare genetic disorders and care services in India
Athika Firdous	In silico knockout analysis and expression signature-based drug repurposing for Wolman disease
Josna Wilson	Application of DNA Language Models for Rare Disease Gene and Variant Interpretation
Saniya Mehraj	Digital PCR based assay for non-invasive diagnosis and screening of SMA

Name	Title
Nimisha Goswami	Generation of Patient-Derived and Isogenic Gene-Corrected iPSC Models of Gaucher Disease Carrying the GBA1 c.1448T>C Variant
Harshatha Reddy	Pharmacogenomic Analysis of Imprinting Disorders
Lloyd Tauro	Clinical validation of developed LC-MS/MS Based Diagnostic Method for Monoamine Neurometabolic Disorders
Kusuma C G	LC-MS/MS analysis of dried blood spots (DBS) for the diagnosis of rare genetic monoamine neurometabolic disorders.
Gayatri Saberwal	Policy inputs to improve the ecosystem for managing rare diseases
Usha Manjunath	Variant Classifier-A tool for variant interpretation according to ACMG guidelines
Anupama Anil	NMPhenoscore: A Symptom-Driven Prioritization Tool for Rare Neuromuscular Disorders
Venkatesh Rajendran	High-Throughput End to End Automated pipeline for scRNA-sequencing data
Lisha James	Monoallelic PMS2 Variant in a Consanguineous Family: A Hidden Case of Constitutional Mismatch Repair Deficiency
Aswin S	Genetic Literacy Initiative by TIGS
TIGS mRNA lab	mRNA biotherapeutics platform for rare genetic disorders

SNAPSHOTS: POSTER PRESENTATIONS



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