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The Role of Genetic Counselling in the Prevention and Management of Inborn Errors of Metabolism: A Review

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***Abstract*—** Inborn errors of metabolism (IEMs) are a heterogenous set of inherited illnesses that occur due to abnormalities in enzymes, transport proteins, cofactors or other components of metabolic pathways. Rare separately, together IEMs contribute substantially to infant morbidity, developmental disability, neurological dysfunction, metabolic crises, organ damage and early mortality. Many IEMs are curable and early detection and immediate care can avert irreparable sequelae. Genetic counselling is a major component of the continuum of care for IEM, from preconception risk assessment and carrier discovery to newborn screening, molecular diagnosis, prenatal diagnosis, reproductive decision-making, therapeutic education, cascade testing and psychosocial support. Improvements in tandem mass spectrometry, next-generation sequencing, whole-exome sequencing, whole-genome sequencing, and metabolomics have promoted early detection and diagnosis. However, these technologies also pose issues in the interpretation of variants of unknown importance, informed consent, privacy, incidental results, affordability and equal access. These difficulties are especially pertinent in low- and middle-income countries, such as Nigeria, where newborn screening programs, specialised metabolic laboratories, genetic counselling services and access to treatment are still limited. Recent research from throughout Africa points to considerable variation in newborn screening and the need for integrated systems that link screening to confirmatory diagnosis, treatment, counselling and follow-up. The study highlights the significance of genetic counselling in the prevention and management of IEMs and methods for strengthening genetic and metabolic services in Nigeria and other resource-limited settings.

Keywords: inherited metabolic diseases; genetic counselling; neonatal screening; carrier screening; genetic testing; prenatal diagnosis; inherited metabolic disorders; Nigeria; Africa.

INTRODUCTION

Inborn errors of metabolism (IEMs), commonly referred to as inherited metabolic diseases, encompass a vast group of hereditary conditions caused by abnormalities in metabolic enzymes, transporters, co-factors or cellular pathways. Such errors may cause buildup of harmful metabolites, shortage of vital products, aberrant storage of substrates, or reduced energy generation. More than 1,000 IEMs have been reported and they represent a significant cause of illness and mortality, especially in infancy and childhood [1].

The clinical presentation of IEMs is extremely heterogeneous. The newborn may be normal at birth but thereafter develop poor feeding, vomiting, lethargy, seizures, hypoglycaemia, hyperammonaemia, metabolic acidosis, jaundice, hepatomegaly, cardiomyopathy or neurological degeneration. Others may eventually have developmental delay, recurring unexplained sickness, intellectual incapacity, muscle weakness, renal dysfunction or progressive neurological disease. The diagnosis may be delayed2 as these signs coincide with common childhood illnesses. Early diagnosis is particularly critical as many of the IEMs are curable. Metabolic crises and irreversible organ damage may be prevented by dietary adjustment, vitamin or cofactor supplementation, pharmaceutical therapy, enzyme replacement, substrate reduction, and other measures. So newborn screening has become an important technique to identify certain illnesses in the pre-clinical state. Tandem mass spectrometry can be used to screen for many amino acid, organic acid and fatty-acid oxidation problems simultaneously from a dried blood spot [3]

Genetic counselling provides information to individuals and families to enable them to comprehend heredity, risks of recurrence, testing alternatives, therapy, prognosis, reproductive choices and psychological ramifications and so supports biochemical and molecular diagnosis. This review

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discusses the function of genetic counselling in the prevention and management of IEMs with special focus on newborn screening and the situation in Nigeria and Africa[4].

GENETIC COUNSELLING AND IEM PREVENTION

Essentially primary prevention is genetic counselling, which gives individuals and couples an opportunity to appreciate their genetic risks before conception. A comprehensive family history and pedigree can reveal past unexplained infant deaths, recurrent miscarriages, developmental impairments, metabolic disorders, consanguinity, and known hereditary conditions. If the pathogenic variation is hereditary, the carrier test can detect whether an apparently healthy individual carries the illness [5]. Autosomal recessive inheritance is seen in many IEMs . If both parents carry pathogenic variations in the same gene, then each pregnancy has a 25% chance of an affected child, a 50% chance of a carrier child and a 25% chance of a child who inherits neither harmful variant. Accurate communication of these hazards can inform the reproductive choices of families without instilling undue fear[6]. Carrier screening and cascade testing are also significant. After diagnosis of an afflicted kid, testing may be offered to parents, siblings, and selected relatives. Cascade testing can discover carriers and previously undetected afflicted persons and give relatives with information essential to reproductive planning. Testing is voluntary, confidential and correctly interpreted with genetic counselling[7].

NEWBORN SCREENING & GENETIC OUNSELLING

Newborn screening is one of the most important public health uses of genetic and metabolic medicine. A newborn may have a significant metabolic disease with no clinical signs in the first days of life. Screening can thus detect disease before irreparable neurological or organ damage occurs[8]. Tandem mass spectrometry has transformed the field of newborn screening, now enabling detection of several metabolic abnormalities from a single blood samples. But screening is not the same as diagnosis. An aberrant screening result requires confirmation by a biochemical and/or molecular test in a timely manner[9]. Genetic counselling is important at all stages of the screening route. Before screening, parents should be informed of the goal, extent, restrictions, and likelihood of false-positive or false-negative results. Counselling after an abnormal result helps lessen parental concern and explain the need for confirmatory testing. On diagnosis, counselling should cover inheritance, prognosis, treatment, recurrence risk, family testing and reproductive alternatives. Therefore, a good screening program has to stretch further than laboratory analysis. It includes a complete pathway from sample collection and screening to recall, confirmation diagnosis, counselling, treatment, follow-up and family support. Recent African research suggests that there are still considerable gaps in this continuum [10]

Genomic Medicine and Molecular Diagnostics

The diagnosis of IEMs has been revolutionised by the emergence of next-generation sequencing (NGS), whole-exome sequencing (WES), whole-genome sequencing (WGS) and metabolomics. Many IEMs are not easily detected by normal newborn screening, and conventional biochemical screening continues to be important. NGS can detect harmful variations in patients with unexplained clinical or biochemical characteristics and can uncover illnesses that otherwise would remain undetected until clinical symptoms appear [11].

The combination of molecular and biological methods is especially promising. Genetic testing may be used to confirm suspected diagnoses, clarify inheritance, facilitate cascade testing and support prenatal diagnosis. But genetic testing can generate complex results, such as variations of dubious importance and accidental findings. Genetic counsellors are therefore key to clarify what genomic results signify and crucially what they do not mean[10].

In addition, genomic newborn screening is emerging as a potential complement to standard biochemical screening. Recent study has found a large number of curable hereditary metabolic illnesses that can perhaps be considered for DNA-first screening, while issues of treatability, penetrance, cost, consent and interpretation remain [3]. Genomic technologies should therefore be used to complement, not replace, clinical assessment, biochemical testing and professional genetic counselling.

GENETIC COUNSELLING IN PRENATAL AND REPRODUCTIVE MEDICINE

A prenatal diagnostic might be informative for families with a previously affected child or known pathogenic variation regarding the genetic status of a pregnancy. Diagnostic modalities may involve chorionic villus sampling, amniocentesis, targeted molecular testing, enzyme assays or biochemical analysis depending on the disorder[14]. The pretest genetic counselling should address the aim and limitations of testing, potential hazards, probable results, and reproductive consequences. Counselling should be non-directive and uphold the values, beliefs and autonomy of the family.

Preimplantation genetic testing for monogenic disorders (PGT-M) is another reproductive option for some couples with recognised risk for the transmission of an IEM. Embryos generated by in-vitro fertilisation can be screened for the familial pathogenic mutation before to implantation. While PGT-M may lessen the probability of an impacted pregnancy, the availability, price, technical requirements and ethical acceptability of PGT-M vary widely between settings[5].

Genetic Counselling in the Management of IEMs

After diagnosis, genetic counselling is also important. Many IEMs require lifelong management including special diets, medical foods, vitamin or cofactor therapy, enzyme

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replacement, pharmaceutical therapy or avoidance of metabolic triggers. Families should be made aware of the association between adherence and metabolic control[10] Dietary treatment is especially crucial for illnesses such as phenylketonuria, maple syrup urine disease, urea-cycle abnormalities, and some organic acidemias. Genetic counsellors should work with nutritionists, paediatricians, chemists, nurses, laboratory scientists and other specialists to share knowledge with families about what is required for treatment[11].

Some IEMs may deteriorate rapidly with infection, fasting, dehydration, vomiting, surgery or exposure to certain drugs. Therefore, families should be provided with emergency management plans and information to give to healthcare professionals during severe illness[8].

Genetic counselling also facilitates long-term psychosocial adjustment. Parents may experience shame, anxiety, grief, fear about future pregnancies, stigma and financial difficulty. Open discussion regarding the hereditary origin of the disorder helps address misconceptions and lessen unwarranted feelings of parental responsibility[12].

ETHICAL AND CULTURAL ISSUES

Genetic counselling involves significant ethical difficulties, including informed consent, confidentiality, non-directiveness, genetic prejudice, reproductive autonomy, and the management of unclear or inadvertent findings. Testing should be done with proper consent and families should be informed of the possible consequences before testing[13]. Cultural competency is very relevant in genetic counselling. Different communities hold different beliefs about heredity, marriage, reproduction, handicap, and origin of disease. Counselling should consequently be culturally sensitive, intelligible and non-coercive.

Genetic counselling may also be subject to stigma and myths regarding inherited disease in African contexts. Improved understanding and early health care seeking may be promoted with adequate community education[14].

GENETIC COUNSELLING IN NIGERIA AND AFRICA

Major gaps in newborn screening and genetic services persist in Africa. A 2025 situation analysis showed large disparities in newborn screening capacity among African countries, noting the need for better laboratory infrastructure, specialist training, referral systems and sustainable national programs [2] Nigeria has similar challenges, with a lack of specialised metabolic laboratories, limited access to molecular diagnostics, a deficit of trained genetic professionals, low public awareness and financial constraints to testing and treatment. However, Nigerian researchers have shown that pragmatic methodologies can be used to diagnose IEM even with modest laboratory facilities, contradicting the notion that sophisticated equipment is a prerequisite for the study of metabolic disorders [15]

A workshop on integrated newborn screening in Nigeria in 2026 further highlighted the need to build coordinated nationwide screening systems. Such programs should include screening with confirming diagnosis, treatment, genetic counselling, follow-up and family support [16] A practical Nigerian approach should therefore involve phased newborn screening for selected treatable disorders, development of regional metabolic reference laboratories, training of genetic counsellors and other health professionals, access to biochemical and molecular testing, establishment of referral pathways, development of IEM registries and integration of genetic counselling into maternal, newborn, paediatric and reproductive health services.

Multidisciplinary Approach

The care of IEMs effectively involves a multidisciplinary team that includes paediatricians, clinical geneticists, chemical pathologists, medical laboratory scientists, nurses, nutritionists, chemists, genetic counsellors, psychologists, social workers and public health specialists. Medical laboratory scientists play a particularly essential role in biochemical screening, tandem mass spectrometry, enzyme assays, molecular testing, and monitoring. Genetic counsellors take the results from laboratories and genomics and make them into knowledge families can comprehend and use to make decisions. This comprehensive strategy guarantees successful treatment and prevention after diagnosis[17].

Future IEM prevention will increasingly rely on the integration of biochemical screening, genomic technologies, genetic counselling and multidisciplinary therapy. Research should determine the prevalence and spectrum of IEMs in African populations, analyse the cost-effectiveness of newborn screening, identify pathogenic variations relevant to the local community, and evaluate the psychological and reproductive results of genetic counseling[18]. Nigeria should prioritise illnesses on the basis of prevalence, severity, treatability, feasibility of screening, availability of confirming diagnosis and potential for prevention of irreversible damage. Regional laboratories and referral centers are potentially more cost-effective and could improve access and improve expertise.

CONCLUSION

Genetic counselling is an important part of the prevention and management of inborn errors of metabolism. It is useful for preconception risk assessment and carrier detection, newborn screening, molecular diagnosis, prenatal diagnosis, reproductive planning, cascade testing, treatment education, emergency readiness, and psychosocial support. The rapid growth of tandem mass spectrometry, NGS, WES, WGS and metabolomics is an unparalleled opportunity for early diagnosis. But technology alone cannot alleviate the impact of IEMs. Effective outcomes can be achieved thru

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integrated systems linking screening to confirmed diagnosis, genetic counselling, accessible therapy, family testing and long-term follow-up.

The development of sustainable genetic counselling and newborn screening programs for Nigeria and other African countries is an important opportunity to reduce unnecessary children illness, disability and mortality. Genetic counselling should therefore be acknowledged not as an optional addition to metabolic medicine, but as a core element of modern inherited-disease prevention and family-centered health care.

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REFERENCES

[1.]Zhang H, Tian H, Dai W, (2025). Expanded newborn screening for inborn errors of metabolism and genetic variants in Xinjiang, China. *Frontiers in Genetics*. 16:1617418.

[2.]Diagnosis of inborn errors of metabolism through massive DNA sequencing: Benefits and limitations, (2025). *[Journal details not provided]*.

[3.]Famuyiwa MK, (2020). Congenital disorders and community genetic services in Nigeria: A systematic review. *African Journal of Reproductive Health*. 24(3):161–175.

[4.]Berry SA, (2021). Newborn screening and inherited metabolic disorders: Current perspectives. *International Journal of Neonatal Screening*. 7(4):72.

[5.]Ferreira CR, (2021). The burden of inherited metabolic diseases and advances in diagnosis. *Journal of Inherited Metabolic Disease*. 44(5):987–999.

[6.]Saudubray JM, Baumgartner MR, Walter JH, (2022). *Inborn Metabolic Diseases: Diagnosis and Treatment*. 7th ed. Springer.

[7.]Levy HL, (2020). Phenylketonuria: From newborn screening to lifelong management. *Molecular Genetics and Metabolism*. 131(1–2):1–8.

[8.]Anetor JI, Orimadegun BE, Anetor GO, (2023). A pragmatic approach to the diagnosis of inborn errors of metabolism in developing countries. *African Journal of Laboratory Medicine*. 12(1):1946.

[9.]Beck MM, Applegate CD, (2020). Genetic counseling and inherited metabolic disorders: Current practice and future directions. *Journal of Genetic Counseling*. 29(6):1025–1036.

[10.]Mak CM, Lee HC, Chan AY, Lam CW, (2013). Inborn errors of metabolism and expanded newborn screening: Review and update. *Critical Reviews in Clinical Laboratory Sciences*. 50(6):142–162.

[11.]Satekge T, Okesina A, Anetor J, Erasmus R, (2025). The status of newborn screening in Africa: Situation analysis, future plans and call to action. *African Journal of Laboratory Medicine*. 14(1):2973.

[12.]Folayan OS, Orimadegun BE, Ayede AI, Inusa BP, Kase MK, Anetor JI, (2026). Integrated newborn screening in Nigeria: The way forward, a workshop report. *International Journal of Neonatal Screening*. 12(1):5.

[13.]Vernon HJ, (2015). Inborn errors of metabolism: Advances in diagnosis and therapy. *JAMA Pediatrics*. 169(8):778–782.

[14.]van Rijt WJ, Koolhaas GD, Bekhof J, (2016). Inborn errors of metabolism that cause sudden infant death: A systematic review with implications for population neonatal screening programmes. *Neonatology*. 109(4):297–302.

[15.]Vockley J, Burton B, Berry GT, Longo N, Phillips J, Schiff M, (2021). Clinical management of inherited metabolic disorders. *Molecular Genetics and Metabolism*. 132(2):67–81.

[16.]Elmonem MA, van den Heuvel LP, (2021). Newborn screening for inborn errors of metabolism: Is it time for a globalized perspective based on genetic screening? *Frontiers in Genetics*. 12:758142.

[17.]Veldman A, Sikkema-Raddatz B, Derks TGJ,., (2025). Newborn screening by DNA-first: Systematic evaluation of the eligibility of inherited metabolic disorders based on treatability. *International Journal of Neonatal Screening*. 11(1).

[18.]Uppal K, (2024). Advances in reproductive genetics and preimplantation genetic testing for monogenic disorders. *Human Reproduction Update*. 30(1):45–67.