Nephrogenic diabetes insipidus

Nephrogenic diabetes insipidus is a disorder of water balance. The body normally balances fluid intake with the excretion of fluid in urine. However, people with nephrogenic diabetes insipidus produce too much urine (polyuria), which causes them to be excessively thirsty (polydipsia). Affected individuals can quickly become dehydrated if they do not drink enough water, especially in hot weather or when they are sick.

Nephrogenic diabetes insipidus can be either acquired or hereditary. The acquired form is brought on by certain drugs and chronic diseases and can occur at any time during life. The hereditary form is caused by genetic mutations, and its signs and symptoms usually become apparent within the first few months of life.

Infants with hereditary nephrogenic diabetes insipidus may eat poorly and fail to gain weight and grow at the expected rate (failure to thrive). They may also be irritable and experience fevers, diarrhea, and vomiting. Recurrent episodes of dehydration can lead to slow growth and delayed development. If the condition is not well-managed, over time it can damage the bladder and kidneys leading to pain, infections, and kidney failure. With appropriate treatment, affected individuals usually have few complications and a normal lifespan.

Nephrogenic diabetes insipidus should not be confused with diabetes mellitus, which is much more common. Diabetes mellitus is characterized by high blood sugar levels resulting from a shortage of the hormone insulin or an insensitivity to this hormone. Although nephrogenic diabetes insipidus and diabetes mellitus have some features in common, they are separate disorders with different causes.

Frequency

The prevalence of nephrogenic diabetes insipidus is unknown, although the condition is thought to be rare. The acquired form occurs more frequently than the hereditary form.

Causes

The hereditary form of nephrogenic diabetes insipidus can be caused by mutations in at least two genes. About 90 percent of all cases of hereditary nephrogenic diabetes insipidus result from mutations in the AVPR2 gene. Most of the remaining 10 percent of cases are caused by mutations in the AQP2 gene. Both of these genes provide instructions for making proteins that help determine how much water is excreted in urine.

The acquired form of nephrogenic diabetes insipidus can result from chronic kidney disease, certain medications (such as lithium), low levels of potassium in the blood
(hypokalemia), high levels of calcium in the blood (hypercalcemia), or an obstruction of
the urinary tract.

The kidneys filter the blood to remove waste and excess fluid, which are stored in the
bladder as urine. The balance between fluid intake and urine excretion is controlled by
a hormone called vasopressin or antidiuretic hormone (ADH). ADH directs the kidneys
to concentrate urine by reabsorbing some of the water into the bloodstream. Normally,
when a person's fluid intake is low or when a lot of fluid is lost (for example, through
sweating), increased levels of ADH in the blood tell the kidneys to make less urine.
When fluid intake is adequate, lower levels of ADH tell the kidneys to make more urine.

Mutations in the AVPR2 or AQP2 genes prevent the kidneys from responding to signals
from ADH. Chronic kidney disease, certain drugs, and other factors can also impair the
kidneys' ability to respond to this hormone. As a result, the kidneys do not reabsorb
water as they should, and the body makes excessive amounts of urine. These problems
with water balance are characteristic of nephrogenic diabetes insipidus.

Inheritance Pattern

When nephrogenic diabetes insipidus results from mutations in the AVPR2 gene, the
condition has an X-linked recessive pattern of inheritance. The AVPR2 gene is located
on the X chromosome, which is one of the two sex chromosomes. In males (who have
only one X chromosome), one altered copy of the gene in each cell is sufficient to
cause the condition. In females (who have two X chromosomes), a mutation usually has
to occur in both copies of the gene to cause the disorder. However, some females who
carry a single mutated copy of the AVPR2 gene have features of nephrogenic diabetes
insipidus, including polyuria and polydipsia. A characteristic of X-linked inheritance is
that fathers cannot pass X-linked traits to their sons.

When nephrogenic diabetes insipidus is caused by mutations in the AQP2 gene, it can
have either an autosomal recessive or, less commonly, an autosomal dominant pattern
of inheritance. In autosomal recessive inheritance, both copies of the gene in each cell
have mutations. The parents of an individual with an autosomal recessive condition
each carry one copy of the mutated gene, but they typically do not show signs and
symptoms of the condition. In autosomal dominant inheritance, one mutated copy of the
AQP2 gene in each cell is sufficient to cause the disorder.

Other Names for This Condition

• ADH-resistant diabetes insipidus
• congenital nephrogenic diabetes insipidus
• diabetes insipidus renalis
• diabetes insipidus, nephrogenic
• NDI
• vasopressin-resistant diabetes insipidus
Diagnosis & Management

Genetic Testing Information

• What is genetic testing? 
  https://primer/testing/genetictesting

• Genetic Testing Registry: Nephrogenic diabetes insipidus

• Genetic Testing Registry: Nephrogenic diabetes insipidus, autosomal

• Genetic Testing Registry: Nephrogenic diabetes insipidus, X-linked

Research Studies from ClinicalTrials.gov

• ClinicalTrials.gov
  https://clinicaltrials.gov/ct2/results?cond=%22nephrogenic+diabetes+insipidus%22

Other Diagnosis and Management Resources

• GeneReview: Hereditary Nephrogenic Diabetes Insipidus
  https://www.ncbi.nlm.nih.gov/books/NBK1177

• MedlinePlus Encyclopedia: ADH
  https://medlineplus.gov/ency/article/003702.htm

• MedlinePlus Encyclopedia: Diabetes Insipidus - Nephrogenic
  https://medlineplus.gov/ency/article/000511.htm

Additional Information & Resources

Health Information from MedlinePlus

• Encyclopedia: ADH
  https://medlineplus.gov/ency/article/003702.htm

• Encyclopedia: Diabetes Insipidus
  https://medlineplus.gov/ency/article/000377.htm

• Encyclopedia: Diabetes Insipidus - Nephrogenic
  https://medlineplus.gov/ency/article/000511.htm

• Health Topic: Diabetes Insipidus
  https://medlineplus.gov/diabetesinsipidus.html

Genetic and Rare Diseases Information Center

• Nephrogenic diabetes insipidus
Additional NIH Resources

- National Institute of Diabetes and Digestive and Kidney Diseases: Diabetes Insipidus
  https://www.niddk.nih.gov/health-information/kidney-disease/diabetes-insipidus
- National Institute of Diabetes and Digestive and Kidney Diseases: The Kidneys and How They Work
  https://www.niddk.nih.gov/health-information/kidney-disease/kidneys-how-they-work

Educational Resources

- Boston Children's Hospital
  http://www.childrenshospital.org/conditions-and-treatments/conditions/d/diabetes-insipidus
- MalaCards: diabetes insipidus, nephrogenic, autosomal
  https://www.malacards.org/card/diabetes_insipidus_nephrogenic_autosomal
- MalaCards: diabetes insipidus, nephrogenic, x-linked
  https://www.malacards.org/card/diabetes_insipidus_nephrogenic_x_linked
- Merck Manual Consumer Version
- Orphanet: Nephrogenic diabetes insipidus
  https://www.orpha.net/consor/cgi-bin/OC_Exp.php?Lng=EN&Expert=223

Patient Support and Advocacy Resources

- National Organization for Rare Disorders (NORD)
  https://rarediseases.org/rare-diseases/nephrogenic-diabetes-insipidus/
- Resource list from the University of Kansas Medical Center
  http://www.kumc.edu/gec/support/diabetes.html

Clinical Information from GeneReviews

- Hereditary Nephrogenic Diabetes Insipidus
  https://www.ncbi.nlm.nih.gov/books/NBK1177

Scientific Articles on PubMed

- PubMed
  https://www.ncbi.nlm.nih.gov/pubmed?term=%28Diabetes+Insipidus,+Nephrogenic%5BMAJR%5D%29+AND+%28nephrogenic+diabetes+insipidus%5BTIAB%5D%29+AND+english%5Bla%5D+AND+human%5Bmh%5D+AND+%22last+1800+days%22%5Bdp%5D+AND+%22last+1800+days%22%5Bdp%5D
Catalog of Genes and Diseases from OMIM

- DIABETES INSIPIDUS, NEPHROGENIC, AUTOSOMAL
  http://omim.org/entry/125800

- DIABETES INSIPIDUS, NEPHROGENIC, X-LINKED
  http://omim.org/entry/304800

Medical Genetics Database from MedGen

- Hereditary nephrogenic diabetes insipidus

- Nephrogenic diabetes insipidus, autosomal

- Nephrogenic diabetes insipidus, X-linked

Sources for This Summary

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/16580609

  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/16093448

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  Citation on PubMed: https://www.ncbi.nlm.nih.gov/pubmed/20301356

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