Disclosures

We have no relevant disclosures or conflicts to declare

Learning objectives

At the end of the presentation, participants will be able to:
1. Describe in lay language
   • the function of a gene
   • a chromosomal abnormality
2. Identify ways to incorporate principles of genetic literacy into a person-centered approach to patients/families.
3. Apply steps that could be done to enhance or improve genetic/genomic literacy in their nursing practice to promote comprehensive care of patients/families.
Outline

1. Genetic primer for nurses
   • overview & terminology
   • next-generation sequencing (NGS)
   • interprofessional collaboration for genetic healthcare
2. Genetic nursing competencies & genetic literacy
   • nursing competencies for genetic healthcare
   • gaps in genetic literacy
   • incorporating genetics into nursing practice
3. Putting the pieces together
   • case studies
4. Summary

Deoxyribose Nucleic Acid

- Carries the genetic code that determines characteristics of a living thing
- Can be ‘cut up and separated’
  - unique ‘bar code’
- Capacity to replicate itself
- basis of hereditary transmission
- Everyone’s DNA is unique……?

“Identical” twins

- Identical twins come from the same zygote
- DNA is identical
  - Recent research?
- Fingerprints are unique
  - Identical twins come from the same zygote
  - DNA is identical
  - Fingerprints are unique
Genes & chromosomes

Genes
- made up of DNA
- each person has two copies of each gene
- allele = DNA sequence of a gene

Chromosomes
- thread-like structures of DNA inside cell nucleus
- human cells have 46 chromosomes (23 inherited from each parent)
- 22 pairs are autosomes + pair of sex chromosomes

“Reading” chromosomes

Size
- simplest way to differentiate chromosomes

Bandung pattern
- both size & location of the bands are unique

Centromere position
- Centromeres = point of constriction
- Play important role in cell division (mitosis & meiosis)

The X and the Y

Autosomes
- The first 22 pairs of chromosomes (44 autosomes)

Sex chromosomes
- XX = Female
- XY = Male

Karyotype/microarray
- Blood test to examine chromosomes
Karyotypes & diagnosing chromosomal disorders

Chromosomes may be incorrectly distributed in meiosis
- Too many: 3 copies → trisomy
  Trisomy 21 = Down Syndrome
- Too few: 1 copy → monosomy

Autosomal
Most trisomy or monosomy are lethal
- Some babies can be born with missing autosomes

Sex chromosomes
- Usually survive, relatively healthy

Missing pieces?

Chromosomal deletion
Some parts may be lost or rearranged during meiosis

Swapped pieces?

Chromosomal Translocation
Reciprocal = a swap between 2 chromosomes

Balanced
- Individual has all healthy genes

Unbalanced
- Genes are duplicated or deleted
Terminology: genetics vs genomics

Genetics vs. Genomics
The study of single genes & heredity (i.e. how traits/conditions are passed from one generation to the next)
The study of all parts of an organism’s genes

Terminology: genotype vs phenotype

- **Genotype**: genetic composition
- **Phenotype**: physiologic expression

\[
genes + environment = phenotype
\]

Next Generation Sequencing

Then...
- 2003
- 15 years
- 100s of researchers
- $3 billion!

Now...
Parallel sequencing steps:
1. Preparation
   - breaking up DNA
2. Clusters
   - amplifying & copying
3. Sequencing
   - A-T, C-G
4. Analysis
   - alignment (reference)
Interprofessional collaboration: It takes a team!

"front-end"
- nurses
- physicians
- clinical genetics
- genetic counselors

"back-end"
- technicians
- molecular biologists
- bioinformaticians
- geneticists

1. Pop Quiz!

In lay language, what is the function of a gene?
A. Genes are comprised of DNA. They range in size from several hundred to more than 2 million base pairs and are the basic physical and function unit of heredity.
B. Jeans are what I wear on the weekend.
C. A gene is like a recipe for making proteins. Proteins build, control, and maintain your body.
D. Genes are too complicated to understand.
E. Genes are made up of DNA. Though transcription, DNA is copied to RNA that produce proteins through translation.
2. Pop Quiz!

In lay language, what is a chromosomal translocation?
A. When a bit of chromosome is missing
B. When the tip of a chromosome swaps places with the tip of another chromosome
C. When the second X chromosome swaps places with the Y chromosome
D. When the p arm moves to the q arm (and vice versa)
E. When the centromere is located at the chromosome tip

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Relevance of genetics to nursing practice

Genetics in endocrinology

Genetics & Genomics: Responsibilities
Towards genetic competency

Professional practice

- Understand the relationship of G&G to health.
- Ability to elicit a 3-generation family health history using standardized symbols/terminology.
- Consider genetic, environmental, & genomic influences/risks when:
  - collecting health histories
  - conducting physical assessments
  - analyzing findings
- Assess clients’ G&G knowledge & perceptions.
- Develop a plan of care that incorporates G&G.

Identification & referral

- Identify clients who may benefit from G&G information/services.
- Identify credible & appropriate information & resources specific to clients’ needs.
- Identify ethical, legal and societal issues (ELSI) related to G&G.
- Define issues that undermine autonomous, informed decisions.
- Facilitate referrals for specialized G&G services as needed.
Education & support

- Provide current, accurate G&G information to facilitate decision-making and improve patient outcomes.
- Interpret selected G&G information/services for clients.
- Use health promotion/disease prevention practices that consider G&G influences & risks.
- Work with insurance/payers to facilitate reimbursement.
- Evaluate effectiveness & outcomes of G&G information, interventions, & treatments.

Key standards for G/G nursing

1. Assess
   Elicit a 3-generation family tree using standardized symbols/terminology.

2. Diagnose
   Identify clients who may benefit from G&G information/services.

3. Plan
   Identify current, accurate & appropriate information specific to client needs. Facilitate referrals for specialized G&G services as needed.

4. Implement
   Provide accurate G&G information to facilitate decision-making.

5. Evaluate
   Measure effectiveness & outcomes of G&G information and interventions.

What is health literacy?

The degree to which individuals have the capacity to:
- Obtain
- Process
- Understand

basic health information & services needed to make health decisions.

(National Academies Press, 2004)
So what is genetic literacy?

- Obtain
- Process
- Understand

- complexity
- rapidly evolving
- unique → family

What the public sees…

The challenge of genetic literacy

- Confusion genetics vs. genomics (Hurst et al, Genet Med, 2013)
- Familiar with terms yet lack underlying knowledge of concepts (Card et al, Genet Med, 2015)
- Unable to translate complicated findings and fully appreciate the meaning & implications of results (Roberts et al, Annu Rev Genomics Hum Genet, 2014)

- 85% of primary care providers felt ‘unprepared’ to discuss genetic test results with patients (Powell et al, J Genet Counsel, 2012)
- 80% of nurses reported needing further training to become ‘competent’ in G&G (Barr & McConkey, Nurse Educ Today, 2007)
- Nurses are not demonstrating competencies needed to provide holistic G&G care (Barr et al, J Adv Nurs, 2012)
Simplifying numbers

“You have a 25% chance of passing this condition to your offspring”

Simplifying texts

Plain Language
- Organizing information so that the most important points come first
- Breaking complex information into understandable chunks
- Using simple language and defining technical terms
- Using active voice (perform vs. receive)

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Incorporating genetics into nursing practice

**Situation**
Patient presents for initial consultation...
Non-emergent issue but potentially complex diagnosis...
For the first time.....
What do you do?
You need a systematic approach!

**“SCREEN” Genetic family history**

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<tr>
<td>Do you have any concerns about conditions that run in the family?</td>
<td>Have there been any problems with pregnancy, infertility, or birth defects?</td>
<td>Have any members of your family died or become sick at an early age?</td>
<td>How would you describe your ethnicity? Where were your parents born?</td>
<td>Are there any other risk factors (or non medical conditions) in your family?</td>
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**Family health history: Red flags**

- Early age of onset → e.g. heart disease at 32yo, breast CA at 28yo
- Gender → e.g. breast CA in a male
- Multiple affecteds → e.g. parent, uncles/aunts, siblings
- Disease combinations → e.g. breast & ovarian CA in family
- Reproduction → e.g. infertility, multiple miscarriages
- Disease with absent risk factors → e.g. hyperlipidemia in a runner
- Abnormal growth → e.g. dysmorphic features, blindness, deafness
- Malformations → e.g. cleft lip/palate, congenital heart defects
- Ethnic disposition → e.g. sickle cell in AA, HBOC in Ashkenazi

*Seibert (2016) Genomic Essentials for Graduate Level Nurses*
Brainstorm the diagnostic process

What do you do in your practice?

What about your practice?
- History taking
- Pearls of wisdom
- Diagnostic workup and karyotyping

Group exercise: You as the expert!

Case 1: Extreme short stature

- presents at 1.8 years
- severe postnatal growth failure
- height SDS: -6.96, BMI SDS 1.6
- syndromic features
- spontaneous hypoglycaemic episodes
- height velocity ~2cm/year (-4.8 SDS)
Case 1: Extreme short stature

History
- Twin pregnancy, born at 35/40 weeks' gestation (Caesarian)
- Birth Wt: 3.3 kg (+1.7 SDS), length: 53 cm (+2.71 SDS)
- Occipitofrontal circumference 35cm (+2 SDS)
- Twin brother's birth weight 2.5kg (-0.05 SDS)

Family History
- Caucasian, non-consanguineous:
  - Mum Bahamian, Ht: 175.3 cm (+2.21 SDS)
  - Dad British, Ht: 177.8 cm (+0.47 SDS)
- Mid-parental height +1.1 SDS
- Patient's twin brother & older sister healthy and growing well

Laron Syndrome

Clinical Characteristics
- Severe short stature
- Normal to high GH, Low IGF-1
- Unresponsive to GH treatment

Genetic characteristics
- GHR gene (5p13-p12)
- Mutations → GH resistance (receptor) (interferes with the ability to bind GH)
- Autosomal recessive inheritance
  - Homozygous → Both copies have same harmful mutation
  - Compound heterozygous → Each copy of the gene has a different harmful mutation

Management & Treatment
- Combination IGF-1 / IGFBP3
- Clinical trial 2005
- Inrelax (Mecasermin) 2007
- GnRH analogue when 13 yo
Pregnancy & birth history

- Parental heritage – Bahamas
- Laron Syndrome - region / ethnicity
  - Ashkenazi Jewish ancestry
  - Sephardic Jewish ancestry
  - Ecuador, Florida, Bahamas (Baumbach, 1997)

Genetic counselling

- Parental genetics
- future pregnancies?
- Sibling genetics
- Consent?
- Results?

What does this have to do with nursing?

History & clues for inheritance pattern

**Autosomal Recessive (AR)**
- affected person has mutation in BOTH copies of the gene in each cell
- parents = unaffected carriers → each child has 25% risk
- example: Laron syndrome

**Autosomal Dominant (AD)**
- affected person has a mutation in ONE copy of the gene
- transmitted parent to child → each child has 50% risk
- example: Huntington disease, neurofibromatosis, polycystic kidney disease

**X-Linked**
- female carriers, males affected (skips generations via carriers)
- example: Hemophilia, Kallmann syndrome due to mutations in KAL1 (ANOS1)

Case 2: Absent puberty

Pierre: 16½ yo♂ presents for evaluation
- normal full-term delivery
- bilateral cryptorchidism (corrected @ 4 & 7yo)
- healthy child, met developmental milestones on time
- normal linear growth
- no spontaneous puberty (TV = 2-3 mL, bilat.)
- normal sense of smell
Could this family benefit from genetic healthcare?

Genetics: Diagnosis & Intervention

Differential diagnosis
- delayed puberty vs permanent HH

Evaluation
- initial labs & DNA → "trial" treatment: 50mg IM Q 4wks X 3M
- genetic results + repeat labs → Dx = HH

Interventions
- genetic counseling
- discuss treatment options → induce 2° sex characteristics
- anticipatory guidance
- Transition planning: peds → adult

Case 3: Short stature

Louise presents at 11 yo for evaluation of short stature
- Only child, normal delivery (7lbs 8oz / 3.4Kg)
- Mother has been concerned about growth from 7yo
- Doing well in school
- Otherwise healthy but a "picky eater"

Pediatrion: "I suspect that this girl's short stature is constitutional and that many of her eating problems are behavioral rather than anything more serious"
Family history & differential diagnoses

Family History
Parents from Columbia, both alive & well
- Father 163 cm
- Mother 141 cm
Mother had menarche at 16yo
Hard time conceiving (35yo at Louise’s birth)
“Difficult pregnancy”
OB considered Caesarian section r/t short stature

Differentials
Constitutional short stature, malabsorption, undernutrition, genetics?

Diagnosis: Turner syndrome (46X)

Karyotype  46X (del) X (p.22.1)-Xpter
(deletion of short arm of one X chromosome)

Growth
- No SHOX short stature (mesomelic bone dysplasia)
- Middle parts of limbs are disproportionately short

Sexual development
Abnormal ovarian development

Familial Turner Syndrome?
- No gonadal dysgenesis, normal menses
- Genetic counseling
- Prenatal screening (futura pregnancies)
- 45X foetus 1 in 200; 1% are miscarried

Care & Response to treatment

- Rule out other problems
- Cardiovascular system – NL
- Thyroid function – NL
- GH treatment initiated
- Transitional care planning (seen in adult clinic)
- Spontaneous menarche at age 15
- Regular cysts – no treatment
- Finished GH age 15 – final height 145.2 cm
- Studying childcare in college
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Take-home points

- Genetic-genomic era is here opportunities & challenges
- Nurses can help overcome barriers to genetic literacy
- Genetic competencies are relevant for pediatric endocrine nursing
- Key genetic nursing competencies:
  - 3-generation family history is the cheapest genetic test
  - Identify, refer, support & collaborate
- Integrating genetics into nursing practice is part of person-
  & family-centered care

Thank you!

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International Society of Nurses in Genetics
(www.isong.org)

Vision: Caring for people’s genetic & genomic health
throughout the lifespan & across the continuum-of
health & disease
Mission: To serve the nursing profession & the public