Streams of Development and Behavior in XXY

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OBJECTIVES

1. Background of 47,XXY
2. Clinical Features of 47,XXY
3. Developmental and Behavioral profile
4. Syndrome-specific management

Prevalence compared to other syndromes

- 47, XXY 1 in 500
- Down syndrome 1 in 700
- Turner syndrome 1 in 2,500
- Fragile X syndrome 1 in 4,000
Estimated rates of XXY diagnosis (1990-1993)

- Estimated babies born in region: 198,095
- Estimated number of males: 94,547
- Estimated number of 47,XXY males: 118
  - Prenatally: 10%
  - Postnatally: 26%
  - Undiagnosed: 64%

(Abramsky & Chapple, 1997)

Estimated XXY ages diagnosed postnatally

<table>
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<tr>
<th>Diagnosed</th>
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<td>Under 1 year</td>
<td>1-10 years</td>
<td>11-20 years</td>
<td>More than 20 years</td>
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<td>1%</td>
<td>0</td>
<td>7%</td>
<td>19%</td>
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Timing of Diagnosis of 47,XXX and 48,XXXXY: A Survey of Parent Experiences

- 47, XXX (n=89)
  - Developmental Concerns
    - First concern: 5.2 years (range 2 mo-20yr)
    - Age of diagnosis: 10 years (range 2 mo-30yr)
  - Endocrinologic issues
    - First concern: 19.1 yrs (range 3m-40y)
    - Age of diagnosis: 21.1 yrs (range 7m-40y)

AJMG, 2012
XXY Prevalence

- Most common sex chromosomal disorder
- Prevalence of 1 : 581 males
- True incidence may be higher
- Many XXY males remain undiagnosed throughout their lifetimes:
  - No unusual physical features
  - Most with normal range of development
  - Chromosomal study not done routinely

Hallmark of developmental milestones

- Range of developmental milestones
  - Range of normal is wide
    - Average age (e.g., sitting average age 6 months)
    - Average range (e.g., sitting average range 4-9 months)
  - Important to know what is within expected range
  - Make sure progressing appropriately
  - Not just achieving milestones but doing them correctly
    - No wide gait when walking
    - Speech is intelligible and spontaneous

Development of Children with XXY

- The developmental progress for a child with XXY
  - Wide range of individual differences in rates of development, especially in language
- How to help the child progress appropriately
  - Effective therapy and practical teaching strategies
  - Balancing family needs with the needs of the child
Interventional Therapies

- Key Points
  - May not qualify for services if within the “average range”
    - Continue to monitor (every 3-6 months)
    - Ask for home-based program
    - Private therapies
    - Use alternative strategies
      - Swimming instead of physical therapy
      - Joining boys scouts instead of social skills training

- Therapists provide guidance
- Parents make it happen
  - Home practice program
  - Daily practice
  - Do 5 minutes activities throughout the day
  - Incorporate with daily activities
  - Teach the correct way early
- Focus on long-term functional outcome

Principles of Typical Development

4 domains of function
- Gross motor (cephalocaudal progression) = physical therapy
- Fine motor (midline to periphery; proximal to distal) = occupational therapy
- Language = speech therapy
  - Expressive communication
  - Receptive communication
  - Social-adaptive
Gross Motors

HEAD CONTROL > ROLL OVER
TRUNK CONTROL > SIT
HIP CONTROL > CRAWL
LEG CONTROL > WALK

Gross Motor Milestones

• Newborn
  - Reflex activity predominates
  (Moro, stepping, grasp reflexes)

• 0-3 months: Reflex activity predominates. Development of head control
  - Prone
    • Newborn— Touches chin
    • 2 months— Lifts head and chest (45 degrees)
    • 4 months— Extends arms (90 degrees)
**Gross Motor Milestones**

- **Supine**
  - 2 months: Head lag on pull to sit
  - 4 months: Head in plane with body on pull to sit, controlled in sitting
  - 6 months: Head leads in pull to sit

- **0-3 months:** Development of head control
  - Ventral suspension
    - 1 month: Lifts head to plane of body
    - 3 months: Lifts head above body, extends legs

- **1-8 months:** sitting
  - 1-2 months
    - No trunk control
    - Head unsteady
  - 2-3 months
    - Raises head and shoulders
    - No thoracolumbar control
Gross Motor Milestones

• 4 - 8 months: Rolling and sitting
  - 4 months
    • Rolls front to back
    • Sits with support (head steady)
    • Lumbar area control
    • Good head control
  - 5 months
    • Rolls back to front (supine to prone)

• 4 - 8 months: Rolling and sitting
  - 6 months
    • Sits alone, props on hands
  - 8 months
    • Gets into sitting position

• 9-12 months: Creeping and walking
  - 9 months
    • Crawls
    • Pulls to stand
Gross Motor Milestones

• 9-12 months: Creeping and walking
  - 10 months
    • Cruises
    • Walks with two hands held
  - 12 months
    • May walk alone
      (9-17 months)

• 18-24 months: Running and climbing stairs
  - 18 months
    • Runs clumsily, walks pull/push toys
    • Walks up/down stairs with one hand held
  - 24 months
    • Runs well (wide-based gait)
    • Walks up/down stairs alone

• 3-4 years: Alternating leg movement
  - 3 years
    • Peddles tricycles
    • Balance on one foot for 1 sec
  - 48 months
    • Walks on tiptoes
**Gross Motor Milestones**

- **2-6 years: Balance and Coordination**
  - 2 years
    - Kicks ball forward
  - 3 years
    - Hops 2-3 times
  - 4 years
    - Skips
  - 5 years
    - Jumps rope

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**XXY : Gross Motor Development**

- Spectrum of development and behavior
  - Some boys may not have gross motor delays
  - Some boys more affected than others
  - Possibly influenced by age of diagnosis, therapies, etc...
- Delayed and/or uncoordinated motor skills
- Decreased tone, strength, and coordination

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**Gross Motor and Growth**

- **Infancy**
  - Hypotonia, especially upper trunk
    - Late walking (most walk by 12 mo with tx; 18 mo without tx)
  - Normal height
- **Childhood**
  - Increasing height, usually between ages 5-8 years
- **Adolescence**
  - Decreased upper to lower body segment ratio
  - Increased armspan
  - Narrow shoulder (2cm decrease) and wide hips (1 cm increase)
**47, XXY: Physical Features**

- Tall stature
  - Increase in height significant between ages 5 and 8
  - Mean final height
    - XXY: 6 feet
    - XYY: 6 ft 3 in
    - 5 inches taller than father

**Bones and Joints**

- Flat Feet
  - Pes Planus
  - Treatment controversial in mild cases
    - Arch supports vs. no arch supports
  - Moderate to severe cases
    - Orthopedic Evaluation
    - Orthotics

**Increase likelihood for...**

- Delayed gross motor development
  - Physical Therapy

- Poor tone, coordination, and strength
  - Extracurricular activities (e.g., swimming, horseback riding, running, hiking, walking up/down hill)

- Unable to keep up with peers in sport activities
  - Seek other non-sport activities your son may be interested (e.g., art, music, computers, hiking)
Fine Motor (Visual Motor) Milestones

0-3 months: Gross movements dominate. Development of tracking

- 0-2 months
  - Primitive grasp
  - Keeps hands fisted
  - Emergence of Asymmetric tonic neck reflex (ATNR): fencing posture
    - Appears at 2 weeks
    - Disappears at 2-3 months

- 3 months
  - Hands open, regards hands

4-6 months: Emergence of hand use

- 4 months
  - Midline hand play
  - Reaches for objects
  - Grasps rattle
  - Brings objects to mouth
Fine Motor (Visual Motor) Milestones

- 4-6 months: Emergence of hand use
  - 6 months
    - Reaches with either hand
    - Rakes objects, palmar grasp
    - Transfers objects
    - Plays with toes

Fine Motor (Visual Motor) Milestones

- Grasp Development/voluntary release
  - 6 months
    - Rake, takes one cube only
  - 7 months
    - Radial-palmer grasp
  - 8 months
    - Scissor grasp, takes 2 cubes (one in each hand, bangs cubes together)

Fine Motor (Visual Motor) Milestones

- Grasp Development/voluntary release
  - 9 months
    - Inferior-pincer grasp (immature pincer)
  - 12 months
    - Fine-pincer grasp using fingertips
**Fine Motor (Visual Motor) Milestones**

- Tower and complex control
  - 15 months
    - Tower of 2 blocks (vertical before horizontal)
  - 18 months
    - Tower of 3-4 blocks
    - Turns pages 2-3 at a time
    - Scribble
    - Uses Spoon for solids

- 3-6 years - Copying and building skills
  - 3 years
    - Copies circle
    - Uses scissors
    - Uses spoon/fork
    - Draws head without a body
  - 4 years
    - Copies cross
    - Draws person with 3-4 body parts
  - 5 years
    - Ties shoelace, print letters

**Bones and Joints**

- Elbows
  - Radioulnar synostosis
  - Inability to pronate and supinate forearm
  - Limited range of motion can interfere with fine motor skills (e.g., handwriting, posture, school successes)
  - X-ray if limited range of motion
  - But, usually no treatment...
Therapies Considerations for Fine Motor

- Occupational Therapy
- Handwriting program
  - Handwriting without tears
    - www.hwtears.com
- Computers
- Musical instrument
- Practical practice strategies
  - Tie shoes, button, color, draw
- Inform school
  - Extra time to complete task

Handwriting

- Handwriting Without Tears
  http://www.hwtears.com/

Pencils for little hands

www.hwtears.com
## Language Milestones

### 1 month
- **Receptive**
  - Alerts to sound and voice
  - Shows social interest in faces and people
- **Expressive**
  - Cries

### 2 months
- **Receptive**
  - Smiles in response to being talked to
  - Shows social interest
- **Expressive**
  - Coos (musical sounds), single vowel

### 4 months
- **Expressive**
  - Reciprocal cooing and turn-taking

### 6 months
- **Expressive**
  - Babbling (uses repetitive consonant/vowel sounds)
  - Imitate speech sounds like coughing, tongue clicking

### 9 months
- **Receptive**
  - Understands approx 10 words
- **Expressive**
  - Says "dada" and "mama" nonspecifically
  - Sing-song jabbering of babbling sounds

### 12 months
- **Expressive**
  - Says "dada" and "mama" specifically
  - Produces single words (9 - 12 months)
  - Points for needs and for interesting objects or actions
  - Gestures
  - Creates complicated babbling called jargon which sounds like sentences
Language Progression

**Expressive**
- 15 months
  - 4-6 words
- 18 months
  - 7-25 words

2-6 years: Word combination

**Expressive**
- 24 months
  - 50+ words
  - combine 2 words together
- 36 months
  - 250+ words
  - 3+ word sentences
  - Pronouns, plurals, future tenses
  - Count 3 items

2-6 years: Word combination

**Expressive**
- 4 years
  - 5-6 word sentences
  - Name 3-4 colors
  - Count 5-10
  - Past tenses
  - Ask questions
- 5 years
  - Uses all parts of speech
  - Knows past, present, future
  - Count to 10
### Speech Intelligibility to Strangers

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<th>Age</th>
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<td>-2 years</td>
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<tr>
<td>-3 years</td>
<td>75%</td>
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<td>-4 years</td>
<td>100%</td>
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### Language Milestones

**4-9 months**
- **Receptive**
  - Deliberately turns head toward sound
  - Responds appropriately to tone of voice
  - Responds to name

**9-12 months**
- **Receptive**
  - Comprehends verbal routines, such as “wave bye-bye”
  - Responds appropriately to “no”
  - Understands pointing
  - By 12 month, obeys commands with gestures with rapid growth in receptive language

**15 months**
- **Receptive**
  - Follows one step command without gestures
  - Finds 1 body part

**18 months**
- **Receptive**
  - Understands at least 50 words
  - Find 5 body parts
  - Points to 1-2 pictures
Language Milestones

- **24 months**
  - **Receptive**
  - Follows 2 step commands
  - Points to named pictures

- **36 months**
  - **Receptive**
  - Understands 2 prepositions
  - Knows first/last name

- **48 months**
  - **Receptive**
  - Understands opposites (big/small)
  - Tells stories

47, XXY: Linguistic function

- Speech delay evident by 12 month of age
  - Delayed vocal plays / ability to produce sounds
  - First words spoken at 18-24 months

- 24 months of age: expressive language worse than receptive language = verbal apraxia

- Pre-school years
  - Shy when language demands high
  - “Tip of the tongue” phenomenon
  - Speech on command difficult
  - Difficulty formulating sentences and expressing thoughts

47, XXY: Linguistic function

Consequences of language deficits:

- Lower verbal IQ than performance IQ
  - Denver study: VIQ 94 and PIQ 99
  - Boston study: VIQ 95 and PIQ 110

- 50% with dyslexia

- Increased risk for reading and spelling impairment

- Inability to cope with social situations--passive, social withdrawal, frustrations, outbursts
Consequences of language deficits

AT RISK FOR:
• Short attention span
• Impulsivity
• Social Skills problems
• Sensory Integration Problems
• Anxiety, Depression, Mood Disorders

47, XXY: Linguistic function

• Deficits in verbal skills may persist into adulthood
  • 10 to 20 points reduction in verbal skills in adolescence (Ratcliffe and Paul, 1986) and adulthood (Netley, 1986)
  • Cases of older males with verbal skills better than performance skills (Boone-Brawer, 2006)
  • 50 males with XXY (4.1-17.8 years), impairment in both verbal and non-verbal cognition (Ross, 2008)
    • Older group- impaired language/motor function
    • Younger group- attention problems

Action Plan

• Speech therapy (focus on pragmatics)
• Social skills training
• School accommodations
  – Small group settings within classroom
  – Prompt answers
  – Praises

• Practical strategies
  – Sitting in front of class
  – Play date with peers
Language Development

- Pre-speech: movement of muscle of face (i.e., lip, jaw) and oral area (i.e., tongue)
- Best practices: tone, strength, coordination
  - Blowing bubbles, horns
  - Mirror work
  - Sipping from straw
- www.talktools.net

Language Development

- Total communication: Speech therapy
- Non-verbal
  - www.signingtime.com
    - Signs do not replace speech, but encourage its development
    - Hand over hand teaching of these signs to learn how to use them
  - Gestures, pointing, etc.
  - Pictures
- Verbal: focus on pragmatics
  - Reading books, singing
  - Play group

Picture Communication

- Pictures can promote language development
- Pictures can be traded for an object or pointed to as a request
- Pictures can be low tech (paper) or high tech (on a device)
- Works better with two people in the beginning
Social-Adaptive Milestones

- 0-3 months: Bonding
  - Newborn - recognizes mother's face
  - 6 weeks - social smile
  - 2 months - regards face

Social-Adaptive Milestones

- 4-8 months:
  - 4 months - laughs
  - 6-8 months - prefers primary caretaker, stranger anxiety, holds bottle, finger feeds
9-15 months: Social Interactions

• 9 months
  - Plays peek-a-boo, pat-a-cake
  - Uncovers hidden object
  - Waves bye-bye
  - Separation anxiety

12 months
Plays simple games
Interest in books

2-4 years: Play

• 2 years
  - Terrible two’s
  - Parallel play

• 3 years
  - Cooperative play, takes turns, shares
  - Knows name, asks why, sense of humor

• 4 years
  - Prefers peer play
  - Tell stories

Aquatic Therapy

www.koolkidzfoundation.org
The water/pool is a great natural environment

• Indications
  • Trunk and extremity weakness
  • Decreased cardiovascular endurance/stamina
  • Decreased weight bearing status
  • Decreased motor control
  • Decreased attention to task

Hippotherapy

www.chastainhorsepark.org

Music therapy

www.mtsogfga.com
“Therapy Moments”

- Getting dressed
- Snack
- Playing with the dog, cat
- Going to run an errand
- At the beach
- Playing sports
- Bathtub time
- Book reading
- Going to the bathroom/washing hands
- Watching TV

Key Points

a Play

- All children learn through play from the time they are born
- Help child learn what toys do and how to play with them
- Show children how to get into imaginative play by joining in with activities
- Imaginative games in second year of life are valuable learning opportunities

Key Points

a Structured Teaching

- Try to provide the extra learning experiences within regular daily activities
- Examples: reading books, drinking from a cup
- Prompt child at each steps as necessary, so that they successfully complete the task
- Child learn by imitation and practice rather than by trial and error
Key Points

Practice
- Increase the skill and efficiency of learned tasks
- Examples: using a spoon/fork, dressing, dancing
- As children progress year by year, improvement is influenced by amount of practice
- Practice in different environment

Key Points

Empower the child
- Verbally praise your child (e.g. "you are so smart")

"Try again"
- Using "try again" instead of "no" when the child does not do something correctly
- Teach the correct ways early

Sensory Integration Dysfunction

- Difficulty processing information from the senses (touch, movement, smell, taste, vision, and hearing) and responding appropriately to that information.
- One or more senses that either over- or underreact to stimulation.
- Sensory processing disorder can cause problems with a child's development and behavior
  - Withdraw when touched.
  - Refuse to eat certain foods because of how the foods feel when chewed.
  - Over-sensitive to odors.
  - Hypersensitive to certain clothes.
  - Dislike getting his or her hands dirty.
XXY: Behavioral Features

- **Personalities variable**
  - Friendly, helpful, relate well to people
    (Leonard, 1991)
  - Timid, immature, reserved, poor peer relationship
    (Robinson, 1991; Ratcliff, 1982; Bancroft, 1982)
  - Risk of psychiatric disorders – anxiety, depression, substance abuse
    (Bender, 1995)

XXY: Social Development

- Prospective studies:
  - Not delinquents, criminals, arsonists, etc.
  - Shyness, social withdrawal common behavioral traits

- New studies: Netherlands
  - Social Cognitive deficits in adults
    - Van Rijn, 2006 & 2008
    - Distress is social interactions
    - Less engagement in social behaviors and activities
    - Higher ratings on autism rating scales
  - Autism spectrum disorders
    - Bruining, Pediatrics, May 2009
    - Age 6-19, n=53, recruited through Dutch Klinefelter Assoc.
    - 27% with autism spectrum disorders

47, XXY Behavioral Features

- Social deficits may persist into adulthood
  - Males with XXY (mean age 39.2 years) compared to XY males (mean age 35.7 years)
  - Males with XXY reported less often engage in social behaviors associated with negative emotions
    - Refusing a request or standing up for one’s rights
  - Adults with XXY have deficits in social-emotional cues with increased levels of emotional arousal
    - Less able to identify and verbalize their emotion

(see Roj, 2006 and see Roj, 2008)
Study Results

- Psychosocial factors: well-being, self-esteem, body image, mental health, general health
- XXY participants lower compared to general male population
- Age of diagnosis not a major predictor of psychosocial outcomes in adulthood
- Better psychosocial outcomes: employment status, social support, physical features
Key Points for Social Development

- Goal: Enhance self-esteem
- Social skills training
- Social Stories
- Hobby and interest
- A few trusted close friends
- Play dates
- Teach socially age-appropriate behavior early
  - A 10 y/o should not sit on parents lap in social setting
- Teach appropriate behavior for private vs. public setting

Medication Consideration

- Medications for psychological or behavioral problems
- Not everyone will need medications
- Medication treatment should always accompany behavioral therapies
- Criteria for medications: (Only 1 needed)
  - Child expresses distress
  - Interferes with learning, academics progress
  - Interferes with social development
  - Interferes with overall home life/general functioning

Questions?