Vestibular Rehabilitation Therapy

- Outline:
  - Rationale for the effect of exercises
  - Framework for exercise prescription
  - Exercise progression
  - Preferred prescription patterns
  - Case study
  - General treatment guidelines
  - Summary & conclusion

Vestibular Rehabilitation Therapy (Rationale)

- Vestibular Adaptation:
  - Ability to make long term changes in neuronal response to input
- Substitution:
  - Substitution of other strategies to replace lost function
- Habituation:
  - Reduction in symptoms produced through repetitive exposure to the movement

Adaptation Guidelines

- Stimulus?
- Appropriate time (duration)?
- Adaptation of VOR is context specific (e.g. frequency, head movement directions)
- Appropriate dosage?
  (i.e. Work at the limit of their abilities)

Substitution guidelines

- Synthesize the use of all input from visual, vestibular, and somatosensory system
- Promote the use of vestibular system by removing visual cues and/or altering somatosensory input
  e.g. Standing on foam with eyes closed

Substitution guidelines

- Use different visual input (Eyes open, and Eyes closed)
- Use various positions and various speeds of movements
- Real-life environments (e.g. noisy, crowded)
- Push to the limit

Habituation exercise guidelines

- Perform multiple times daily (2 or 3 sessions)
- Sufficient to induce mild to moderate symptoms (fast, and through full range)
- If no symptoms, exercise should progress
- Appropriate rest between ex’s and sessions
Vestibular Rehabilitation exercises
- In Clinic vs. Home Exercise Program (HEP)

Framework of vestibular exercises
- Consisted of:
  - Main exercise categories / types
  - Exercise modifiers
  - Frequency: Number of times per day
  - Duration (Time): Length of time or number of repetitions.
  - Intensity

Main exercise categories
- Eye – Head Coordination (EH)
- Sitting (SIT)
- Standing Static (SS)
- Standing Dynamic (SD)
- Walking (W)

Eye - Head Coordination
- VORx1
- VORx2
- VOR cancel
- Convergence
- Smooth Pursuit
- Saccade
- Imagined Target
- Anticipatory Gaze shift

VORx2
VORx2

Imaginary Target

Imaginary Target

Imaginary Target

Imaginary Target

Standing Static
(FEET IN PLACE)

- Upright
- Weight Shift
- Single Leg Stance
- Sit To Stand
- Rocker board
- 1 foot on step
Standing Static

Standing Dynamic (feet moving, but not walking),
- march in place
- step level (side or forward/back)
- step multi-level
- turns

Ambulation
- Forward
- Backward
- Walk with turns
- Stairs
- Braiding
- Skip, Jog, Run

Standing Static
- Stand with your back to the wall side to a counter
- Don’t hold on unless you start to fall
- Lift one foot off the floor and hold it up for ___ seconds
- Do this with your eyes: open/closed
- Repeat ___ times each leg, twice a day

Standing Dynamic
- Stepping Forward and Back
  A. Stand near a wall
  B. Step forward with one foot. Return to the center position
  C. Step backward with the same foot. Return to the center position
  D. Repeat the above sequence with the other foot
  E. Do this ___ times a day
  F. Do this with your eyes: open/closed

Exercise Modifiers
- 10 Modifiers were recorded
  - Posture: (Sitting, standing, walking)
  - Surface: (Level, Foam, uneven)
  - Base of Support: (Feet Apart, Feet Together, Semi Tandem and Tandem)
  - Trunk position: (Upright, lean and rotated)
  - Arm position: (In, Out, Juggling, carrying, etc)
  - Head movement: (Still, Yaw, Pitch and Roll)
  - Visual Input: (Eyes Closed, Open and patterns)
  - Direction of body movement: (AP, ML and Multidirectional)
  - Cognitive dual task: (Yes, NA/NS)
VORx1: The patient keeps the eyes fixed on a target placed on a wall 1 m away and moves the head in the yaw or pitch directions.

VORx2: The patient holds a single target and keeps the eyes fixed on it. The patient moves the target in yaw or pitch while moving the head in the opposite direction.
E-H coordination

- VOR cancellation: The patient moves his/her head synchronously in the same direction with a moving target

- Convergence: The patient holds a target (e.g. pencil) at arm’s length in front of face, and then gradually moves it toward the nose until the point where he starts experiencing diplopia or blurred vision. At this point patient holds fixation on the pencil for a few seconds, and then moves the target away.

- Anticipatory gaze shift: The patient makes a eye saccade to a target on one side, and then rotates the head in the same direction until the target is straight ahead, while maintaining fixation on the target

- Saccades: The patient rapidly shifts gaze to a various targets while keeping the head fixed

- Smooth pursuit: The patient maintains gaze with fixed head on a target that is moving slowly

- Imagined target: The patient focuses on a target straight ahead, then closes his/her eyes and moves the head while trying to keep the eyes stabilized on the target. After moving the head, they open the eyes to see if they have kept their eyes on the target

Exercise progression

- Depends on functional status
- Nearly limitless options
- Therapists demonstrate preferred prescription patterns
- Limits the number of modifiers used

- Aerobic progression increasing the intensity or volume
- Vestibular rehabilitation exercises are often based on subtle variations of the exercise
- Myriad combination of treatment variables makes the reporting of exercises challenging
**VORx1 preferred patterns**

- Usually prescribed both for yaw and pitch directions
- Most often customized by changing:
  - Posture (sitting, standing, walking)
  - BOS (feet apart, together, semi-tandem, tandem)
  - Visual Input (eyes open without and with background textures)

**Standing Upright patterns**

- Most often customized by changing:
  - Surface (foam 37%)
  - BOS
    - Feet together: 46%
    - Tandem: 34%
    - Semi-tandem: 13%
  - Direction of head movement (still and yaw movements)
  - Visual input (eyes open and closed)

**Quantifying exercise prescription**

- Subjects
- 113 patients (66 F/47 M)
- 83 patients received vestibular Rehabilitation Therapy
- Median number of visits: 4 (2-13)
- Median Duration: 33 days (2-181)

**Application of framework**

- In the retrospective study, a customized vestibular rehabilitation home exercise program was designed by the physical therapists, and given to the patients
- Each of the computer-generated exercise handouts was reviewed and classified according to the framework
- The visit number in which the exercise was prescribed was also reported

**Method**

- A frequency count was performed to see what are the most common exercise categories, and the most common exercises (constitutes 95% of each group).

**Results**

- 113 patient charts from Vestibular Rehabilitation Clinic during 2006-2008 were reviewed
- 104 were prescribed a home exercise program (HEP)
  - 5 patients were not appropriate for PT
  - 4 others had diagnosis of BPPV only and did not receive HEP
Results

<table>
<thead>
<tr>
<th>Exercise Category</th>
<th>Rx at least 1x during care</th>
<th>Rx during 1st visit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eye-Head Coord.</td>
<td>95 % of patients</td>
<td>86 %</td>
</tr>
<tr>
<td>Standing Static</td>
<td>88 %</td>
<td>66 %</td>
</tr>
<tr>
<td>Walking</td>
<td>76 %</td>
<td>41 %</td>
</tr>
</tbody>
</table>

Eye-Head Coordination Category

<table>
<thead>
<tr>
<th>Exercise Type</th>
<th>Rx at least 1x during care</th>
<th>Rx during 1st visit</th>
</tr>
</thead>
<tbody>
<tr>
<td>VORx1</td>
<td>88 %</td>
<td>72 %</td>
</tr>
<tr>
<td>VOR Cancel</td>
<td>64 %</td>
<td>30 %</td>
</tr>
<tr>
<td>Convergence</td>
<td>29 %</td>
<td>20 %</td>
</tr>
<tr>
<td>VORx2</td>
<td>9 %</td>
<td>1 %</td>
</tr>
</tbody>
</table>

Standing Static Category

<table>
<thead>
<tr>
<th>Exercise Type</th>
<th>Rx at least 1x during care</th>
<th>Rx during 1st visit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upright</td>
<td>84 %</td>
<td>64 %</td>
</tr>
<tr>
<td>Single leg stance</td>
<td>28 %</td>
<td>7 %</td>
</tr>
<tr>
<td>Weight Shift</td>
<td>14 %</td>
<td>2 %</td>
</tr>
<tr>
<td>Sit To Stand</td>
<td>13 %</td>
<td>11 %</td>
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</table>

Walking Category (Forward Ambulation)

<table>
<thead>
<tr>
<th>Exercise Type</th>
<th>Rx at least 1x during care</th>
<th>Rx during 1st visit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward Ambulation</td>
<td>73 %</td>
<td>40 %</td>
</tr>
<tr>
<td>Feet Apart, Yaw</td>
<td>62 %</td>
<td>30 %</td>
</tr>
<tr>
<td>Feet Apart, Pitch</td>
<td>27 %</td>
<td>12 %</td>
</tr>
<tr>
<td>Tandem, head still</td>
<td>32%</td>
<td>9 %</td>
</tr>
</tbody>
</table>

Walking Category (Backward Ambulation)

<table>
<thead>
<tr>
<th>Exercise Type</th>
<th>Rx at least 1x during care</th>
<th>Rx during 1st visit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Backward Ambulation</td>
<td>24 %</td>
<td>9 %</td>
</tr>
<tr>
<td>Feet Apart, head still</td>
<td>17 %</td>
<td>8 %</td>
</tr>
<tr>
<td>Feet Apart, Yaw head turns</td>
<td>13 %</td>
<td>0 %</td>
</tr>
<tr>
<td>Tandem, head still</td>
<td>20 %</td>
<td>3 %</td>
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</table>

Preferred prescription patterns

- Therapists demonstrated preferred prescription patterns
- Limit the number of modifiers used
VORx1 preferred patterns

• Usually prescribed both for yaw and pitch directions
• Most often customized by changing:
  – Posture (sitting, standing, walking)
  – BOS (feet apart, together, semi-tandem, tandem)
  – Visual Input (eyes open without and with background textures)

Standing Upright patterns

• Most often customized by changing:
  • Surface (foam 37%)
  • BOS
    ✓ Feet together: 46%
    ✓ Tandem: 34 %
    ✓ Semi-tandem: 13%
  • Direction of head movement (still and yaw movements)
  • Visual input (eyes open and closed)

Progression of exercises during care

• Framework can be used to detail progression of exercise
• Example: VORx1

Progression of VORx1

<table>
<thead>
<tr>
<th>Posture and BOS</th>
<th>Initial prescription</th>
<th>Final prescription</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sitting</td>
<td>21</td>
<td>4</td>
</tr>
<tr>
<td>Standing feet apart</td>
<td>40</td>
<td>19</td>
</tr>
<tr>
<td>Standing feet together</td>
<td>29</td>
<td>30</td>
</tr>
<tr>
<td>Standing semi-tandem</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Standing tandem</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Walking</td>
<td>1</td>
<td>31</td>
</tr>
</tbody>
</table>

Progression of VORx1 from sitting posture

• 23 patients were prescribed VORx1 in sitting position, sometime during duration of care
  – Progress to feet apart: 11
  – Progress to feet together: 6
  – Walking with complex visual background: 2
  – Final posture: 4

Progression (Feet Apart)

• 52 patients were prescribed VORx1 in standing with feet apart sometime during duration of care
  – Progress to standing feet together: 19
  – Walking(complex visual background): 10
  – Semi Tandem: 2
  – Feet Apart (Complex visual background): 1
  – Feet Apart with increased time : 1
  – Final posture: 19
Progression (Feet together)

- 54 patients were prescribed VORx1 in standing with feet apart sometime during duration of care
  - Progression to Walking: 17
  - Standing tandem: 4
  - Semi-tandem: 3
  - FT with complex visual background: 1
  - FT with increased time: 1
  - Sitting: 1
  - Final posture: 30

Common exercise volumes

<table>
<thead>
<tr>
<th>Exercise Type</th>
<th>Frequency</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>VORx1</td>
<td>3x / day</td>
<td>60 seconds</td>
</tr>
<tr>
<td>VOR Cancel</td>
<td>2x / day</td>
<td>10 repetitions</td>
</tr>
<tr>
<td>Convergence</td>
<td>2x / day</td>
<td>10 repetitions</td>
</tr>
<tr>
<td>VORx2</td>
<td>1x / day</td>
<td>30 seconds</td>
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Common exercise volumes

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<tr>
<td>Standing Upright</td>
<td>2x / day</td>
<td>30 seconds</td>
</tr>
<tr>
<td>Single leg stance</td>
<td>4x / day</td>
<td>30 seconds</td>
</tr>
<tr>
<td>Weight Shift</td>
<td>1x / day</td>
<td>10 repetitions</td>
</tr>
<tr>
<td>Sit To Stand</td>
<td>1x / day</td>
<td>10 repetitions</td>
</tr>
<tr>
<td>Standing Upright</td>
<td>2x / day</td>
<td>30 seconds</td>
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Common exercise volumes

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<th>Frequency</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feet Apart, Yaw head turns</td>
<td>1x / day</td>
<td>20 head turns</td>
</tr>
<tr>
<td>Feet Apart, Pitch head turns</td>
<td>1x / day</td>
<td>20 head turns</td>
</tr>
<tr>
<td>Tandem, head still</td>
<td>1x / day</td>
<td>20 feet</td>
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<td>1x / day</td>
<td>20 feet</td>
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<td>1x / day</td>
<td>20 head turns</td>
</tr>
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<td>Tandem, head still</td>
<td>1x / day</td>
<td>20 feet</td>
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Conclusion

Therapists addressed the E-H coordination first, before the Standing Static and ambulation. Therapists demonstrated preferred prescription and progression patterns. Therapists used preferred exercise volume.
Case study
• 15 year old female student had concussion 4 months ago after hitting head on school locker
• Initial symptoms of “spinning”, nausea, headache
• Soccer and softball player
• Chorus member

Current Presentation
• Spinning and nausea have ceased
• Complains of “lightheadedness, imbalance”, rated 0-40/100
• Frequent headaches with cognitive effort, rated 0/10 now, but 4-7/10 in past week

Past Medical History
• PMH significant for multiple concussions
  – May 2007: Soccer ball to R temple (had seizure)
  – May 2008: Snowboarding accident (blow to head, but doesn’t remember details)
  – Aug 2008: decelerated quickly on ATV, no impact
• Headaches: Does not have personal history of migraine, but “uncle has terrible migraine headaches”

Concussion Management
• Before hitting head on locker:
  – ImPACT scores average to high average, with symptom score of 0
  – No Headaches
  – Tapered off amantadine (neurostimulant), feeling well
  – Sleeping well with trazadone
  – Going to school without accommodations, no symptoms

Concussion Management
• After hitting head on locker:
  – Brief symptoms initially
  – Slow, continuous increase in symptoms then ensued.
  – Drop in grades, significant increase in effort with lower results.

Concussion Management
• After hitting head on locker:
  – Significant decrease in all ImPACT domains.
  – Restarted on amantadine, homeschooling one hour/day, 4 days/week.
Initial PT Evaluation (1/12)

“What makes symptoms worse?”
• Sit to & from supine, bending over, sit to stand, quick head movements, being in dark or with eyes closed, headaches after 5 pages of reading but “not harder to read”

“What makes it better?”
• “Not moving.”

Self-Report

• Activities-Specific Balance Confidence Scale (ABC)
  - Score: 68%
  - Biggest issues were...
    - “Walking in a crowded mall where people rapidly walk by.” (50%)
    - “Being bumped by people as you walk through a mall” (50%)
    - “Bending over to pick up a slipper,” “walking outside house to car,” “walking across mall parking lot,” “stepping on/off escalator while holding onto a railing,” “…while holding parcels” (all 60%)

Self-Report

• Dizziness Handicap Inventory (DHI)
  - Score: 58
  - Has difficulty with quick head motion, heights, darkness.
  - Sometimes has difficulty with looking up, bending over, getting out of bed, reading, sports/dancing/chores

• Falls
  - Multiple falls in past six months. Says these are due to “hurrying.”

Examination

• Hearing
  - Within Normal Limits (WNL) at conversation level.
  - No new c/o tinnitus or fullness in ears

• Vision
  - Denies blurring or trouble focusing. Wears contacts. Just had WNL eye exam.

Examination

• Oculomotor exam
  - Smooth pursuit and saccades normal
    - Dizziness increased from baseline of 0/100 to 10/100. “Head feels like it’s filling with air.”
    - Cover/uncover (latent ocular misalignment) normal
  - Convergence spasm
    - Fixation blocked, with vertical gaze and in primary position
    - Also drift-to-midline with lateral gaze
  - Convergence insufficiency noted
    - 23 cm near point
    - no symptoms during “pencil pushup”
Examination

• Vestibulo-ocular exam
  – Gaze stabilization
    • VOR and VOR-Cancellation normal (no saccades, stayed on target, no report of blurring).
    • But, symptoms now climbed to 20/100
  – Head Thrust Negative

Examination

• BPPV? (dizziness with sit to supine, bending over).
  – Dix-Hallpike and Roll tests, negative bilaterally
  – However, convergence spasm noted throughout

Examination

• Gait
  – Feels increase of symptoms and decreased balance during gait with horizontal and vertical head turns.
  – No obvious deviations

• Standing Balance
  – Feet together: Eyes Open 17 s, Eyes closed 30 s
  – Feet tandem: Eyes Open 30 s, Eyes closed 10 s
  – Feet on foam: Eyes Open 30 s, Eyes closed 30 s

Home Exercise Program (HEP)

• Don’t want to give patient too much (increase of symptoms with minor activity, but pt. minimizes complaints).
  – VORx1, VOR-Cx
  – pencil-pushups
  – Standing on level surface and on foam with EO/EC
  – gait with head turns
• Follow up once per week to assess HEP progress, evolution of symptoms

Visit 2 (1/19 – 1 week later)

• Additional testing:
  – Dynamic Visual Acuity
    • Loss of 4 lines on Snellen Eye chart
    • Increase of symptoms from 0 to 20/100
  – Dynamic Gait Index (DGI) 19/24
  – Functional Gait Assessment (FGA) 22/30

Visit 2 (1/19 – 1 week later)

• HEP?
  – Noncompliance? (couldn’t demonstrate well)
  – Again advised to “spread through the day”
• Reviewed HEP with patient, demonstrating rest and technique.
Visit 3 (1/26)

- Update: “80-85% better”
  - Dizziness with quick head motion, blurred vision with VORx1
  - 5-10 minutes of reading before sx increase.
  - “Just a few stumbles,”
  - 1 Headache previous week (with reading, math)…
  - Progressed to “checkerboard background” and “line on page”

- Sensory Organization Test
  - Slightly below normal in conditions 1, 2, 3, and 4, above normal in conditions 5 and 6.

5th visit, re-eval (2/9)

- Convergence spasm and insufficiency…
  - Spasm unchanged (vertical and 1’ position with fixation blocked)
  - But near-point decreased to 13 cm (was 23)
- Significant improvement with decreased BOS and on foam (increased sway, but no LOB).
- Reading still causes headaches (cognition: “could read a magazine all day”)
- Plan: continue to address vestibulo-ocular sx, balance, convergence.

Re-eval on 7th visit (3/16)

- Problems: horizontal head turns, change in gait speed.
- Near-point of convergence 7cm, convergence spasm mild, but present in each position. Reading reported “improved.”
- Complicated visual surround still an issue with VOR and VOR-Cx.

Re-eval on 7th visit (3/16)

- Able to attend on-stage choral performance in Boston with peers (one headache, managed with medication).
- Exertional training: three minutes of jogging and balance exercises.
Neuropsych Update

- Increased to 4 hours/day at school (two classes).
- "Mild degree of improvement" in ImPACT
  - Verbal memory 6th percentile (low)
  - Visual memory 13th percentile (low avg)
  - Visual motor speed 79th percentile (high avg)
  - Reaction time 12th percentile (low avg)
  - Symptom scale is 11.

Most recent visit (3/30)

- Had severe migraine headache, hospital admission for 3 days
- School decreased to one hour/day (one class) due to headaches (2-10/10)
- Complicated visual surround still difficult with VORx1, but ready for VORx2 since sx decreased; instructed to increase time on gaze stabilization
- Convergence spasm mild but still present
  - Referred to neuro-ophthalmology at Children’s

Case 2

- 15 y.o female student volleyball player
- Presented with "lightheadedness" and "Off balance"
- No oculomotor abnormalities
- Dizziness rating between 40 - 80 (current 75)
- 0 falls over the last week

Initial Clinical outcome measures

<table>
<thead>
<tr>
<th>Outcome measure</th>
<th>Score</th>
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</thead>
<tbody>
<tr>
<td>ABC</td>
<td>70</td>
</tr>
<tr>
<td>DHI</td>
<td>22</td>
</tr>
<tr>
<td>DGI</td>
<td>21</td>
</tr>
<tr>
<td>FGA</td>
<td>24</td>
</tr>
<tr>
<td>GS (m/sec)</td>
<td>1.1</td>
</tr>
<tr>
<td>TUG (sec)</td>
<td>7.6</td>
</tr>
<tr>
<td>FTSTS(sec)</td>
<td>6.7</td>
</tr>
<tr>
<td>SOT</td>
<td>55</td>
</tr>
</tbody>
</table>

Visit one

- Did not start E-H coordination (high symptoms)
- Low level standing static ex’s: (E.O)
  - Sit to Stand
  - Standing upright and weight shift
- Low level ambulation exercises:
  - Forward ambulation on level surface with yaw and pitch head movement (Feet Apart)

Visit 2

- Dizziness 40-65. Current 60
- Did not perform any E-H coordination
- Standing Static Ex’s: (E.C)
  - Sit to Stand
  - Standing upright and weight shift
- Ambulation exercises:
  - Forward ambulation on level surface with yaw and pitch head movement (Feet together)
Visit 3
• Dizziness 40-50, current 40
• Eye –Head Coordination
  – VORx1, while standing on a level surface with feet apart
• Standing Static Ex’s:
  – Standing upright ([E.O, pattern head movement])
  – Weight shift ([E.O, pattern head movement])
• Ambulation exercises:
  – Forward ambulation on level surface with yaw and pitch head movement (Semi –tandem and tandem)

Visit 4
• Dizziness 30-50 (50 when performing the ex’s)
• Do we progress exercise or not?

Visit 5
• Dizziness 30-40, current 30
• Eye –Head Coordination
  – VORx1, while standing on a level surface with feet together
• Standing Static Ex’s:
  – Standing upright (E.C)
  – Weight shift (E.C)
• Ambulation exercises:
  – Forward ambulation on uneven surface with yaw and pitch head movement (Feet Apart)

Visit 6
• Dizziness 20 -40, current 20
• Eye –Head Coordination
  – VORx1, while walking on a level surface with feet Apart
• Standing Static Ex’s:
  – Single leg stance (E.O)
  – Rocker board (E.O), 30 sec
• Ambulation exercises:
  – Forward ambulation on uneven surface with yaw and pitch head movement (tandem)
  – Backward ambulation, level surface, with yaw and pitch head movement

Visit 7
• Eye –Head Coordination
  – VORx2, while standing on level surface
• Standing Static Ex’s:
  – Single leg stance, foam surface
  – Rocker board (E.O), (60 sec)
• Ambulation exercises:
  – Forward ambulation on uneven surface with yaw and pitch head movement (tandem)
  – Backward ambulation, level surface, with yaw and pitch head movement

Visit 8

<table>
<thead>
<tr>
<th>Outcome measure</th>
<th>Initial score</th>
<th>Current score</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABC</td>
<td>70</td>
<td>83</td>
</tr>
<tr>
<td>DHI</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>DGI</td>
<td>21</td>
<td>24</td>
</tr>
<tr>
<td>FGA</td>
<td>24</td>
<td>30</td>
</tr>
<tr>
<td>GS (m/sec)</td>
<td>1.1</td>
<td>1.5</td>
</tr>
<tr>
<td>TUG (sec)</td>
<td>7.6</td>
<td>5.4</td>
</tr>
<tr>
<td>FTSTS(sec)</td>
<td>6.7</td>
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</tr>
<tr>
<td>SOT</td>
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<td>77</td>
</tr>
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</table>
Discharge summary

- Continue current home exercise program
- Refer to exertion program
- Contact ATC to discuss RTP criteria

Future Research

- Address the concerns about measures
- Improve documentation practices and quantify the exercise prescription parameters

Future Research

- Many of the concussion patients are children (i.e. <18 y.o)
- Many of the outcomes measure used in vestibular rehabilitation are developed for middle and older adults

Future Research

- Are the measures sensitive enough (ceiling effect)?
- What are the normal scores for children in functional gait and balance measures?

Recommendations For Concussion Management

- Incorporate the three domains of testing in the clinical decision making
- Do not depend solely on the symptom resolution for RTP especially in children
- Incorporate balance measures to assess the dual task performance and sensory integration function
- Discharge to exertion program after vestibular rehabilitation

Conclusion

- Vestibular rehabilitation can contribute to a multidisciplinary management of individuals with post concussion symptoms
- Vestibular rehabilitation is helpful in reducing the dizziness and improving the balance disorders for patients post concussion
- Vestibular therapist should take into account the effect of adjunct interventions
Questions