

## Appendix A: ZINC Evaluation and Treatment Protocol

Upon initial evaluation and final discharge:

- Subjects will complete validated questionnaires: Post Concussion Symptom Survey (PCSS), Brain Injury Vision Symptom Survey (BIVSS), and Dizziness Handicap Index (DHI).
- Balance assessments will be completed with the Neuro-com – Modified Clinical Test of Sensory Interaction in Balance (mCTSIB) test (visit #2 and final visit).
- The novel Primitive Reflex Screening Tool will be used to screen for reflexes. This tool is in the initial stages of development and will need to be validated in future studies.

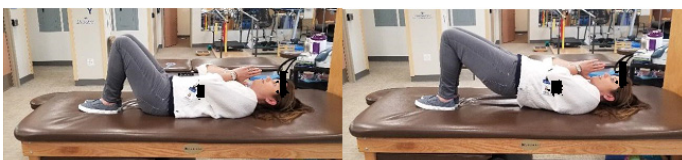
### Module 1

Patient history intake and early education (pacing strategies, blue light filters, early symptom-guided exercise, supplements for healing, return to work and learn guidance). Screen patients via symptom report for BPPV assessment and intervention and cervical spine referral. Complete Primitive Reflex Screening Tool with home program instructions based on positive findings.

#### Home program instruction:

Brain-Body Integration (BBI) Exercises: (Level 1)

- Moro Bridge** – goal 2x10 symptom free, perfect form
- Feet, knees, hands together at midline. Slow movements - 3 seconds up, 3 seconds down. Without lateral sway in the torso.



- Snow Angel** – goal 2x10 symptom free, perfect form
- Emphasis on reaching the apex and returning simultaneously with the arms and legs. Slow movement with 5 seconds up and 5 seconds down, without cognitive effort required.



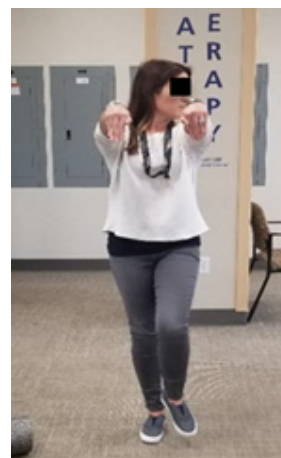
- Superman** – goal 2x10 symptom free, perfect form
- Head flexed as the arms and legs extend. Hold for 5 seconds. Focus on elbows and knees locked in extension without bounce or fidgeting.



- Swimmer** – goal 2x10 symptom free, perfect form
- Head flexed position as the opposite arm and leg extends. Hold for 3 seconds. Focus on elbows and knees locked in extension. Avoid rotation in the torso or a counter push on contralateral extremities.



- Zombie** – goal 60 seconds head turned to each side, symptom free, perfect form
- Arms stiff, straight, and still without the legs crossing midline.



- Bird dog** – goal 2x10 symptom free, perfect form
- Moving purposefully with a brief pause at the top of the movement. Focus on level pelvis and even weight distribution between arm and leg.



**Typical progression** – should a subject not achieve a goal from a particular subset – these modules in each visit will need to be repeated until goals are achieved.

## Module 2

Subjective report from the week.

Vision and vestibular evaluation (“VOMS-Plus”) including the King Devick (repeated on final examination and discharge).

- Vision evaluation includes: assessment of smooth pursuits, saccades, near point convergence, stereopsis, Brock string, cover/uncover and alternate cover tests.

- Vestibular testing includes: VORx1 at 1 cycle per second yaw, pitch, VOR cancellation at 1 cycle per second yaw, pitch identifying impaired fixation, symptom provocation, and oscillopsia.

Modified CTSIB testing on force plate via Neuro-com.

### Exercises and HEP Progression:

- Vision:

- o Novel Binocular Vision Screening Tool – repeat Module #4 and #6

- Goal exercise - 60 seconds each OD, OS

- Subject to find all letters of alphabet sequentially A-Z with right eye (OD) and all numbers sequentially 1-26 with left eye (OS)

King Devick – repeat Module #4 and #6

Timed saccadic eye movement exercise with 3 pages which increase in difficulty. The fastest of 2 trials without errors is recorded.

- Brain-Body Integration (BBI) Exercises: (Level 1)

- o Bridge – goal 2x10 symptom free, perfect form

- o Snow Angel – goal 2x10 symptom free, perfect form

- o Superman – goal 2x10 symptom free, perfect form

- o Swimmer – goal 2x10 symptom free, perfect form

- o Zombie – goal 60 seconds each side, symptom free, perfect form

- o Bird dog – goal 2x10 symptom free, perfect form

- Add/progress BBI exercises for HEP as indicated:

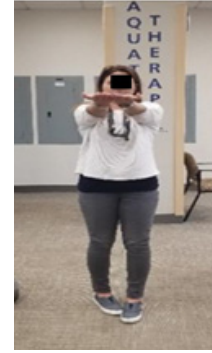
- o **Duck on a bike** – goal 20 feet symptom free, perfect form



- o Externally rotated lower extremities walking heel to arch. Hands in fists with elbows extended.

- o **Pigeon carrying a pizza** – goal 20 feet symptom free, perfect form

- o Lower extremities internally rotated walking toes to arch. Palms supinated with elbows extended. Focus on flat hands and feet.



- o Progressions:

- Bridge – once achieved L1 goal – add pillow squeeze between knees with hands and feet together until 2x10, symptom free, perfect form.



- Superman – once achieved L1 goal – progress to arms by sides – until 2x10, symptom free, perfect form.

- Zombie – once L1 goal – progress to eyes closed.

- Complex Motor:

- o Seated physioball 1234 chart – goal symptom free, 0 errors, demonstrate adequate dual tasking.

- Subject sits on a physioball and reads across the rows on a colored chart – touching the odd numbers with the left hand and the even numbers with the right while reading the number aloud. Errors are counted if the wrong hand is used or the wrong number is stated.

- o Peripheral awareness ball toss + cognitive load

- The subject stands sideways and catches a ball thrown first from the left side x10, then a cognitive load is added (letters of the alphabet A-J for animals or foods). This task is repeated on the right-side x 10 without a cognitive load, then a cognitive load letters K-T.

- If Dix-Hallpike remains + for BPPV – continue CRMs each visit until resolved.

## Module 3

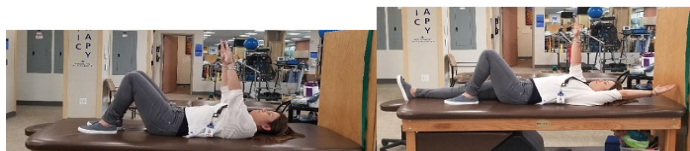
Subjective report

- Add/progress BBI exercises for HEP as indicated:

- o Discharge as achieves goals.

- o Deadbug – goal 2x10, symptom free, perfect form

- o Moving slowly, opposite arm and leg away from each other. The contralateral arm should remain still flexed to 90 degrees.



o Slap tap with and without callouts – goal 60 seconds, symptom free, perfect form

o Seated with hands on knees. Lifting opposite fingers and toes. Completed in isolation, while calling out left or right for the hands, and then repeated calling out the feet.



o Starfish – goal 60 seconds, symptom free, perfect form

o Crossing the opposite arm and leg. Increase difficulty by moving slowly and farther from midline.



o Robot – goal 2x10 symptom free perfect form with contralateral head turns progressing to ipsilateral head turns.

o Focusing on timing, flexing the ipsilateral arm and leg into a "crawl" position. Slowly returning to the start position. The contralateral leg should remain still (no abduction)



o Archer – goal 2x10 symptom free, perfect form.

o Front arm and leg extended, rear arm and leg flexed. Rotating on the heels. Both feet facing forward without leaning posterior to facilitate knee flexion.



• Vision:

o Super saccades – goal 30-35 seconds marching in place – add to HEP when you've discontinued enough reflexes to be <6-8 exercises

▪ The subject reads in a pattern first vertically and then horizontally to address saccadic eye movements including speed and accuracy.

▪ Repeated each visit for re-assessment and to ensure proper form.

o Line reading – goal 15-20 seconds marching in place – add to HEP when you've discontinued enough reflexes to be <6-8 exercises

▪ The subject reads horizontally only left right as if reading a book for speed and accuracy of saccades.

▪ Pages 1 & 4 completed in clinic for re-assessments each visit, for HEP patients to complete all 8 pages in the packet.

o bpqd chart + chair rotations for vestibulo-cervical reflex

o The subject moves the lower extremities and torso "in the direction of the belly of the letter" i.e., Right for a b or p and left for a d or q. If there are multiples in the same direction the subject changes tasks and claps for the repeat direction i.e., b (turn), p (clap)

o Kershner arrows + fim base of support

▪ Moving the arms and calling out the direction of the arrow on a chart while standing on a firm surface. ½ half chart "same direction" as arrow, 2nd ½ chart completed in the "opposite direction" as arrow.

• Balance/Vestibular:

o Eyes closed marching series foam.

▪ For 60 second intervals the subject first marching in place on the foam, then performs step ups right foot forward, then left foot forward.

#### Module 4

Subjective report

• Review BBI exercises: Bridge + pillow, Deadbug, Slap tap, Starfish, Robot, Archer

• Review vision exercises – eliminate if patient has achieved targets – continue if not. Super saccades, line reading.

- Reassess King Devick and binocular vision screening tool.
- **Add vision exercises to HEP:**
  - o **Hart chart** – accommodation rock exercise – the subject reads back and forth between a near and far chart. 3 rows monocular, 3 rows other eye monocular, and 4 rows both eyes together.
  - **Add VOR adaptation exercises to HEP:**
    - o VORx1, VOR cancellation yaw and pitch with metronome. Speed should be adjusted for tolerance and oscillopsia (blurry vision with head movements)
    - o **VOR x1** – the subject holds the target still while rotating the head first side-side (yaw) with a metronome, then up-down (pitch) x 60 seconds each. Goal 180 bpm standing each. (1.5 cycles per second) 1 beat on the metronome per side to improve auditory processing and performance.
    - o **VOR cancellation** – the subject moves the target and their head in the same direction keeping the target in focus. Yaw and pitch planes x 60 seconds each to the beat of a metronome. Goal 150 bpm standing each.
      - Exercises during visit: 1234 marching foam, treadmill saccades @1.5mph, small wobble board eyes closed balance series.
        - o 1234 – progression from seated to marching on foam to increase difficulty of dual task.
        - o Peripheral awareness ball toss + cognitive load with progression of postural challenge via compliant surface
        - o Treadmill + saccades – vision in motion to increase vestibular load with visual exercises.
        - o Wobble board series – small wobble board with eyes closed – each 60 second duration.
          - Lateral – static hold, weight shifting
          - Anterior/posterior – static hold, weight shifting.
- Progress VOR adaptation exercises:
  - o VORx1, VOR CXL, VORx2 yaw and pitch with the metronome.
  - o **Add VORx2** – the head and target move in opposite directions while the target remains in focus. Goal 150 bpm standing.
    - Exercises during visit: Red/Green Tranaglyphs for vergences, kershner arrows on shuttle board, marsden ball, peripheral awareness exercises ball to the wall + vision chart, ball toss + 2 square rotations with trampoline.
      - o Red/Green Tranaglyphs – fusional range exercises for vergences.
      - o Kershner arrows – moving the arms and calling out the direction of the arrow on a chart while standing on a balance board. ½ half chart “same direction” as arrow, 2nd ½ chart completed in the “opposite direction” as arrow.
      - o Marsden ball – visual tracking exercise – following the swinging ball in a variety of directions while calling out letters on the ball.
      - o Peripheral awareness ball to the wall – tossing the ball at the wall while reading from a visual chart to increase load of exercise and ensure fixation.
      - o Ball toss + 2 square rotations to trampoline – subject’s left side faces trampoline – 1 visual chart in front of subject and 1 above trampoline. Subject reads sequentially 1st letter on forward chart, 1st letter on chart above trampoline until chart is complete while tossing the ball at the trampoline to increase peripheral awareness, visual tracking, and vestibular load. Repeat on the subject’s right side.

## Module 6

Subjective report and re-evaluation.

- Patient to complete questionnaires before leaving the office.
- Re-evaluation via “VOMS-Plus”.
- Red/Green Tranaglyphs final assessment
- Neuro-com testing – mCTSIB.
- King Devick and novel binocular vision screening tool.
- VOR testing – VORx1, VOR CXL, VORx2 with metronome for pitch and yaw.

Patient to be discharged with a final HEP to be completed independently based on the final evaluation results and exercises remaining above stated goals.

## Module 5

Subjective report:

- Review vision exercises from HEP – remove those that have reached the goals – super saccades, line reading, hart chart
- **Add vision exercises to HEP:**
  - o **Sticker sheet** – convergence and divergence exercise. The subject must use vergences to fuse 2 targets together into 3 targets. The goal is +30 diopters convergence and -18 diopters divergence.
  - o **Brock string** – the subject focuses on each bead in sequential order while fusing to obtain 1 bead and full X. The subject must move the bead to a location where a full X can be obtained (closer = more difficult for near), (farther = more difficult for far). 3 exercises are performed for 1 minute each until 2 inches are achieved for the near bead and 6 feet for the far. 1-2-3-4-5-4-3-2-1, 1-2-3-4-5-1-2-3-4-5, near-far-near-far.