

A dynamic background featuring a blue water splash at the top and numerous blue bubbles of various sizes rising from the bottom left towards the center. The overall color palette is light blue and white.

# **Aquatics 101**

## **Basic Theory**

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# Learning Objective

- **At the end of this presentation, the learner will be able to:**
  - Identify physics principles that apply to aquatic therapy and describe their impact on exercise and activity
  - Describe fundamentals of patient care and critical thinking processes related to aquatic therapy

# Why Water?

- **Adding aquatic therapy to a patient's plan of care may just may be the exercise and movement medium that changes the course of therapy. "The Game Changer"**
- **When patients FEEL the benefits, relief, and FREEDOM of movement, they are inspired to continue and are motivated to continue.**

# Key Points

- **Therapists must understand all aspects of physics principles relating to water.**
- **Liability and safety issues are TOP PRIORITY.**
- **You have to be comfortable in the water yourself; steady and strong on your feet.**



# Aquatic work is complicated.

- **Aquatic therapy is MORE than bringing land exercises under water**
- **You need to USE the water.**
- **Aquatic environments are not REAL life, so land therapy must be integrated early on to assess true progress and readiness for discharge.**

# Aquatic Strength Scales

<b>OXFORD SCALE</b>	<b>MOD. OXFORD</b>
<b>0= No contraction</b>	<b>1 contr w/ B assist</b>
<b>1= Flicker of movt</b>	<b>2 contr w/ B elim</b>
<b>2= Full ROM Grav Elim. position</b>	<b>2+ contr vs/ B, no movement</b>
<b>3= Full ROM vs. Gravity</b>	<b>3 contr vs/ B at speed</b>
<b>4= Movt vs. G plus resistance</b>	<b>4 Contr vs/ B and lt. float</b>
<b>5= Normal</b>	<b>5 Contr vs/ B speed and surface area</b>

# Water Height and % WB

- **If water is at ASIS level, there is approximately 50% WB**
- **If water is at xiphoid process level, WB is 30%**
- **If water is at C7 level, only 10% body weight bearing is achieved.**

# Aquatic Physics

- **Buoyancy**
- **Specific Gravity**
- **Hydrostatic Pressure**
- **Viscosity and Turbulence**
- **Refraction and Reflection**



# #1 Buoyancy

- **Definition: Upward thrust or force which acts in the opposite direction to gravity.**
- **Archimedes Principle is when the body is immersed in a fluid and it experiences an upward thrust equal to the weight of the fluid displaced.**

# Therapeutic Benefits of Buoyancy

- **Decreases the effects of gravity**
  - Decreased weight bearing
  - Decreased joint compression
  - Less effort for neurological clients
  - Increased functional abilities
  - Increased ease of handling for therapists
  - For CVA/TBI, buoyancy can help raise limb of neglect into visual field

# Buoyancy Problems

- **It may be difficult for therapist to “hold their ground” and stay fixed in the pool.**
- **May be difficult to stabilize patient**
- **Less overall proprioceptive input to patient after initial submersion**
- **Flaccid extremities will likely float and may cause control issues.**

# COG and COB

- **The COG (center of gravity) and COB (center of buoyancy) are DIFFERENT and tend to create a torque on the trunk unless they are aligned vertically and held stable with true TRUNK STABILIZATION.**
- **Rotation can occur longitudinally or on a transverse axes, and lever length impacts the speed of the rotation.**



# Bourgier's Theorem

- **A body in water is subjected to two opposing forces:**
  - Natural center of gravity of the body (COG)
  - Center of Buoyancy (COB) which is the center of gravity for the displaced water, usually around the xiphoid process.
- **Metacentric Effect: Body seeks equilibrium between the two forces.**

# Buoyancy changes everything.

- **Therapeutic application:**
  - HIP ABDUCTION in the water:
    - In sidelying, ABD is ASSISTED.
    - In supine or prone, ABD is supported and gravity eliminated.
    - In vertical, ABD is RESISTED by the water.

# #2 Relative Density

- **Definition:** The ratio of the mass of an object to an equal amount of water
- **Density = Mass / Volume**
- **If RD is less than 1, object sinks**
- **If RD is more than 1, object floats**
- **If RD = 1, it floats just under the surface.**

# Examples

- **RD of females= .75 (they tend to float more than men!)**
- **RD of males=.95**
- **RD of children and older adults is approximately .86**
- **A person with lungs deflated has a RD of 1.05-1.08**



# Remember this...

- ***"Flaccid FLOATS"***
- ***"Spastic SINKS"***
- ***Edematous extremities have a lower RD than "normal" and tend to float***

# Therapeutic Application

- **Hemiplegia extremities: Will cause the patient to roll towards the side of spasticity.**
  - Counteract: Turn patient's head away from affected side. Abduct unaffected arm. Put unaffected leg under affected leg and bring affected arm to midline.

# #3 Hydrostatic Pressure

- **Definition:** It is the pressure exerted by the molecules of a fluid upon the immersed body.
- **Pascal's Law:** There is no **RESTING** position in water, so stabilizing strength is always needed. Fluid pressure is exerted equally on all surface areas immersed at a certain depth.

# Therapeutic Benefits of HP

- **Decreases swelling with increased pressure (pressure increases with depth)**
- **Offsets tendency of blood pooling in lower extremities**
- **Contributes to the feeling of weightlessness**
- **Consistent tactile input – reduces tactile defensiveness**
- **Proprioceptive input causes SNS suppression and possibly decreased pain**
- **Helps build inspiratory and expirator strength in the water**



# #4 Viscosity and Turbulence

- **Definition:** The “thickness” of water provides the resistance to any object moving through it
- **Due to Eddy currents and concepts related to “drag,” a built-in method of loading therapeutic exercise exists within the properties of the water itself.**

# “Isokinetic” Property

- **One benefit of aquatic exercise is that an object can move only as fast as the drag allows, and the muscles are maximally loaded throughout full available ROM, not limited by the weakest point within that range.**
- **When the movement stops, so does the resistance.**
- **Great for post-operative, early intervention activities**

# Increasing Turbulence

- **How can we make exercise challenge progressive and more difficult?**
  - Increase surface area of the object moving through the water
  - Increase speed moving through the water
  - Increase the length of the lever arm

# Therapeutic Benefits

- **Can use Turbulence to passively move a body part in the water**
- **Provides resistance to movement and increases when it is less streamlined (or more surface area)**
- **Great to help with balance support**
- **Resulting drag will have a dampening effect on involuntary movement**
- **Body moves in slow motion – gives it time to prepare and react.**



# #5 Refraction and Reflection

- **Definition: Distortion of visual feedback – what is real and what appears to are different!**
- **Affects both therapists and patients**
- **Refraction BENDS the light coming through the water**
- **Reflection may cause distortion by moments of light blindness off the water surface**

# Refraction Can Fool You!

- **Refraction of light through the water can cause objects and extremities to appear 25% larger and 25% closer to the surface than they are. This can cause confusion about body position in space.**

# YOU DID IT!

- **That physics review wasn't so bad ...was it?**



# Physiological Effects of Immersion in Warm Water

## ● **Circulatory System Impact:**

- Hydrostatic pressure exceeds venous pressure so blood is displaced to the great vessels of the chest and into the heart.
- Central blood volume increases by 700 ml
- Central venous pressure increases
- Right atrial pressure increases by 14-18 mmHg with immersion to neck.
- Cardiac volume increases 27-30%



# More Circulatory Effects

- **Stroke volume increases by 35%**
- **Heart rate drops 15% in a COOL pool; HR drops less in warm water and may slightly increase.**
- **In general, use a HR of about 10 bpm less than you would on land.**
  - Consider using Perceived Exertion Scales
- **Peripheral resistance decreases; Blood pressure drops slightly**

# Pulmonary System Impact

- **Vital Capacity (VC) decreases about 10% with up-to-neck immersion**
- **Rate of respiration increases**
- **Total work of breathing increases about 60% with submersion to the level of the neck.**

# Musculoskeletal System

- **Hydrostatic pressure reduces edema**
- **Blood supply to muscles is significantly improved, as well as removal of metabolites.**
- **Muscle relaxation occurs**
- **Decreased joint compression forces**
- **Some inhibition of spasticity; decreases gamma and muscle spindle activity**

# Renal System Impact

- **Sodium excretion increases up to 10 times normal rates, leading to diuresis.**
- **The longer you are in the water, the greater the diuresis is!**
- **Increased central blood volume triggers a decrease in ADH production – more diuresis!**



# Other Physiological Considerations

- **Watch for overall increased body temperatures and overheating**
- **Head righting, a normal equilibrium reaction is stimulated in the water**
- **It is easy to overdo it!!**
- **May have chemical sensitivity and skin is more fragile in the water**
- **Easy to over-stimulate the vestibular system in the water!**

# Preparation Before Entering the Water

- **Take a detailed history and be careful to explain “what to expect” in informed consent with patients**
- **Include questions about how he or she may “feel” about the water.**
- **Be up front about combining land and pool activities**
- **Describe side effects: dizziness, thirst, headache and nausea**

# Don't Forget to Prepare YOU

- **Must learn to “hold” yourself to the bottom of the pool**
- **Should know about rescue breathing and holds**
- **Learn all of the therapy holds – ball, cube, triangle, stick**
- **Figure out how to keep notes dry!**
- **Watch for your own signs of fatigue**

# Recall and Review

- **How do these properties of water impact the choices I may for activities and exercises in the pool?**





# Let's Get Started!

## Aquatic Practice in Action

- **New Patient Barriers**

- “Skin to Skin” barrier
- Patients’ fear of the unknown or water
- Patient may feel false sense of freedom or pain relief and overdo or hurt themselves
- Highest level of substitution (WHY?)
- Tremendous safety risks – locker rooms, transfers, slips, near drownings
- High therapist physical demand
- Sense of vulnerability for both the therapist AND patient

# Basics for All Aquatic Patients

- **1. Assist everyone into the water manually, even if just with an extended hand, for the first time.**
- **2. Assistive device rule: Go up one device, unless you support with UE floats of some kind.**
- **3. It is not necessary for your patient to be a swimmer.**

# Basics

- **4. Convey Expectations:**
  - Prevent dehydration
  - Increased Urinary frequency
  - They will feel very **HEAVY** when they get out of the pool
  - Easy to **OVERDO**
  - Center of Gravity shifts; tell them about temporary loss of balance and adjustment
  - Emphasize the importance of **NEUTRAL SPINE**

# Basics

- **5 Vital Sign Monitoring:**

- HR may increase slightly initially, but should drop below normal
- BP will drop
- RR will increase
- Can't "see" the autonomic nervous system as well (sweating, cold, or clammy skin) so you need to ask often how they are – look for paleness or redness – until you know how they tolerate water.



# Basics

- **6. Warm-ups provide:**
  - Time for joint synovial fluid to adjust
  - Time for cardiovascular adjustment
  - Time for center of gravity shift
  - Time for muscle warm up

# Warm-Up Activities

- **Suggest normal walking forward and backward, maintaining a neutral spine and emphasizing trunk rotation, dragging arms through the water – 2-3 laps**
- **Include side stepping**
- **Basic stretching for LE's to avoid cramps: hams, gastroc, adductors**

# How to Find Neutral Spine

- **Stand straight**
- **Move into an extreme anterior tilt**
- **Move into an extreme posterior tilt**
- **Imagine where the midpoint would be and move your pelvis to this point**
- **Pull into your naval and contract your abdomen to hold this position**

# Aquatic Therapeutic Exercise

- **Maintain the best position of FUNCTION when performing exercise.**
- **Avoid extremes of movement or speed**
- **Measure exercise by time, not repetitions**
- **Any exercise causing pain should be stopped.**
- **Emphasize 5-6 exercises and modify intensity as you go – keep movements pure and create motor learning and memory.**



# Aquatic Exercise Progression

- **Change the intensity...make it more challenging... by**
  - Increasing SURFACE AREA
  - Increasing SPEED
  - Increasing LEVER ARM LENGTH
- **These are the principles that the equipment are based upon**

# Increasing Intensity

- **If you OPEN your fingers, not only do you increase your surface area, but also eddy currents around each finger are creating, adding to drag (resistance.)**
- **If you break the surface tension of the water, it is harder than being completely UNDER the water.**

# Essential Equipment for the Pool

- **Kickboards**
- **Floatations: vests, belts, noodles**
- **Balance boards**
- **Aquatic Step**
- **Things that increase surface area and lever arm length – fins, gloves, paddles**
- **Things that impact the role of buoyancy – cuff floats, cuff weights, all sizes!**
- **Paddles, dumbbells, things to hold on to support balance**

# Recall and Review

- **If I put a flipper on a patient, which principles are you using to make things more challenging (or easier?)**





# Bad Ragaz Techniques

- **What we will briefly review**
  - Theory
  - Positioning
  - Patterns and Exercises

# History of Bad Ragaz

- **Bad Ragaz Ring Method (BRRM) is a collection of techniques that evolved from years of practice in Bad Ragaz, Switzerland.**
- **Method is used for muscle re-education, strengthening, spinal elongation, relaxation and tone inhibition.**

# BRRM

- **Three main focus areas:**
  - Relaxation
  - Stabilization
  - Progressive resistance

# Bad Ragaz and PNF

- **Differences:**

- No stabilization from gravity with BRRM
- BRRM requires movement on stability
- PNF resistance is provided manually
- BRRM resistance is provided by the water
- BRRM does not allow for quick strength



# Bad Ragaz and PNF

- **Similarities:**

- Provides maximum resistance throughout ROM for isotonic and isometric exercises
- Therapist “holds” stimulate muscles and proprioceptors controlling the movement
- Therapist commands facilitate active movement
- Strong muscle facilitation produces overflow to weaker muscles
- Patterns are functional and natural

# Goals of BRRM

- **Tone Reduction**
- **Relaxation**
- **Improved range of motion**
- **Tissue elongation**
- **Muscle re-education**
- **Spinal traction and elongation**
- **Improved alignment**
- **Spinal stability**
- **Functional training**

# BRRM Techniques

- **Use of the water can provide a variety of exercise techniques**
  - Isokinetically
  - Isotonically
  - Isometrically
  - Passively

# Treatment Guidelines

- **Initial sessions of 5 – 15 minutes are recommended due to maximum muscle contractions and patient effort**
- **Treatments can progress to a maximum of 30 minutes**



# Treatment Guidelines

- **Therapist: strength, skill, planning**
  - Waist deep (T8-T10); Walk-stand position
  - Therapist is the stabilizing point
  - One on one treatment
- **Pool size and utilization**
  - Need space to move bodies on the surface of the water!

# Exercise Progression

- **Resistance is provided by the movement of the body through the water**
- **Frictional forces in front; negative pressure behind the body**
- **Increase intensity with speed, more distal hand hold, change of stabilization point, quick reversals, reciprocal support and less floatation**

# Indications

- **Orthopedic and rheumatological including fibromyalgia, arthritis, pre and post surgical**
- **Neurological: CVA (after 6 weeks) parkinsons, para and quadriplegia**
- **Pain syndromes; RSD**
- **Mastectomy and cardiac surgery**
- **Tactile defensiveness**

# Contraindications

- **Avoid excessive fatigue**
- **Be cautious with history of vestibular or balance problems**
- **Acute back, neck, or extremity injuries**
- **Acute flare up of RA – can overstretch capsule**



# Exercise Examples

- **Trunk stabilization in neutral**
- **D1 Shoulder ABD, ER, Wrist/finger Ext. moving to ADD, IR, Wrist/finger flexion**
- **D2 Shoulder Ext. ADD, Elbow Pro, Wrist/Finger Flex moving to Flexion, ABD, elbow supination, Wrist/finger extension**

# Bad Ragaz LE Patterns

- **D1 Hip ADD, Extension with Knee extension, moving to ABD, Extension with knee extension**
- **Knee/ Hip extension moving to Knee/ Hip flexion**
- **For complete references to all patterns, consider Aquatic Rehabilitation by Richard Ruoti; ISBN: 0-397-55152-5**

# Quick Wrap-Up

- **6 Fundamentals related to water that impact therapeutic intervention and patient monitoring**
- **Patient preparation is important!  
Be sure and review what to expect.**
- **Immersion causes systemic effects that must be considered.**
- **Bad Ragaz is one aquatic specialty area**

# Jot Down Your Questions...

- **Looking forward to meeting you soon!**
- **Be thinking about your questions and cases... bring to class!**