EXCITING NEW REHABILITATION INTERVENTIONS FOR PERSONS WITH SPINAL CORD INJURY

Guy Fried, MD
Christopher Formal, MD

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OUTLINE

- Systems for extremity electrical stimulation
- Ventilation options
- New forms of gait training

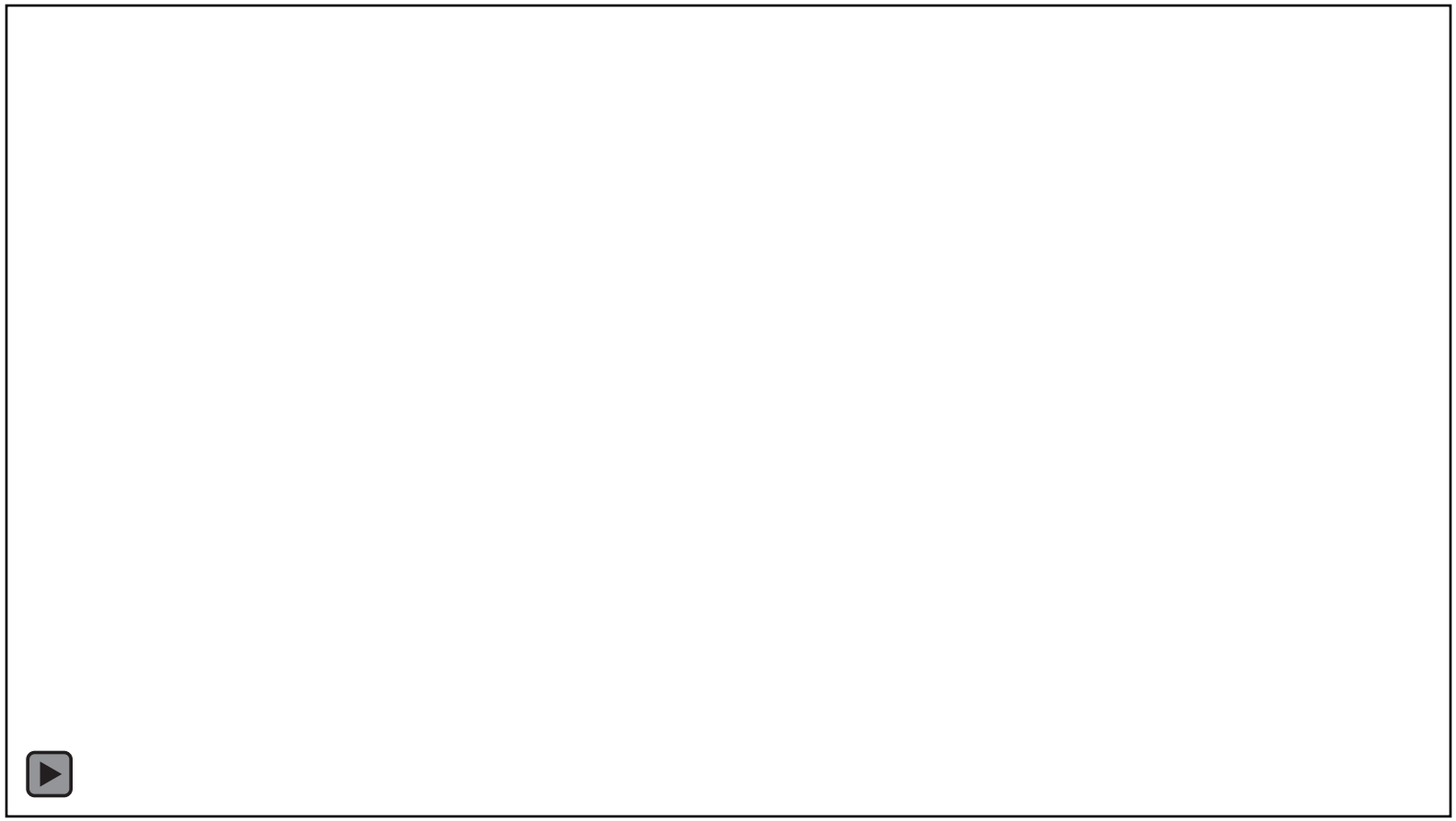
Systems for extremity (and trunk) electrical stimulation

- Basic science—
- Nerve and muscle are both electrically excitable
- Electrically stimulating a nerve causes an action potential, and the
- Contraction of an innervated muscle
- Direct muscle stimulation can cause contraction of the muscle
- Innervated muscle is much easier to stimulate than Denervated muscle

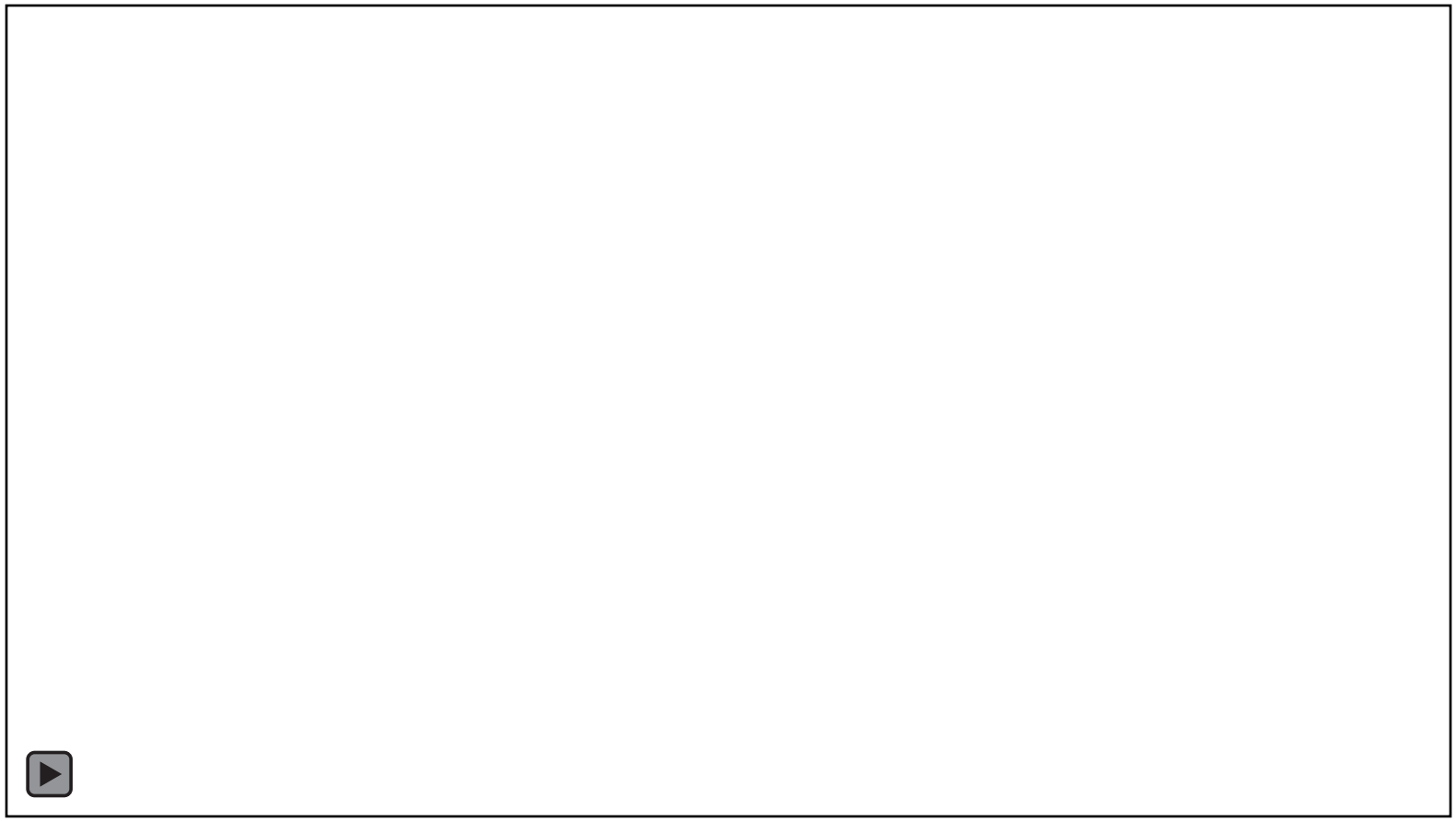
Why go through the trouble?

- Electrical stimulation of muscle will bring about strengthening—even if otherwise paralyzed
- Cardiovascular exercise
- Function

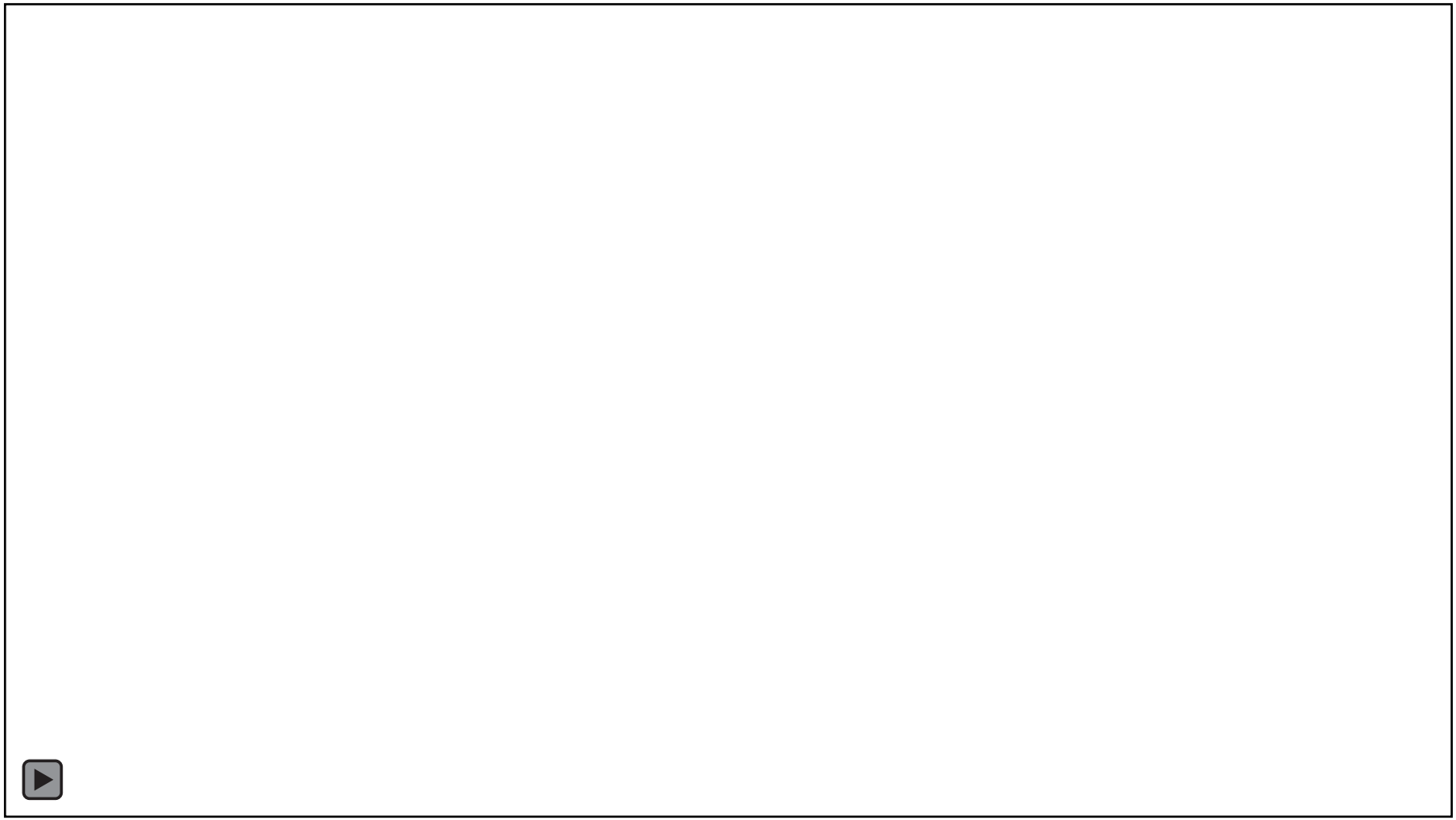
Upper limb



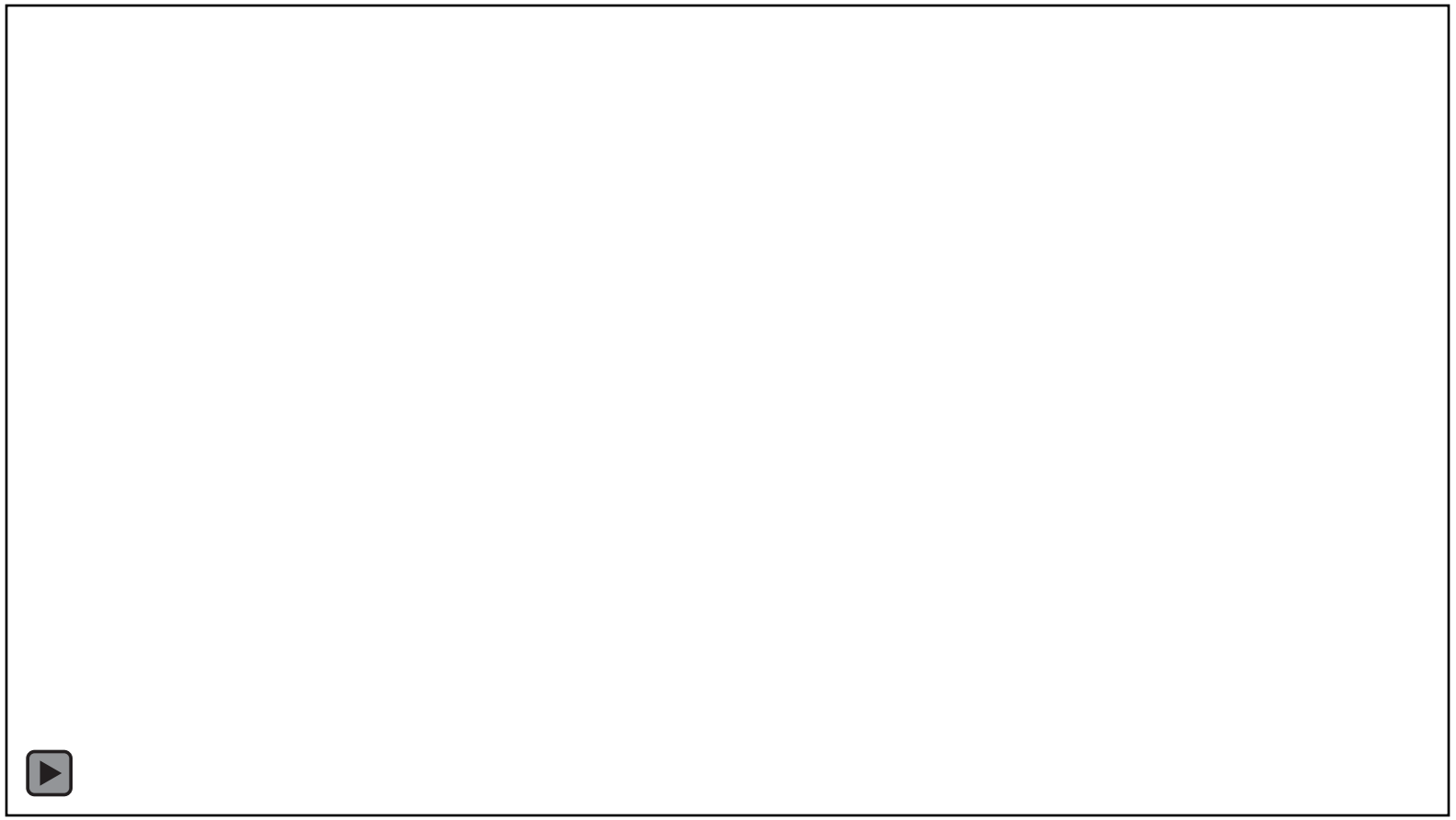
Trunk



FES cycle training



Lower limb

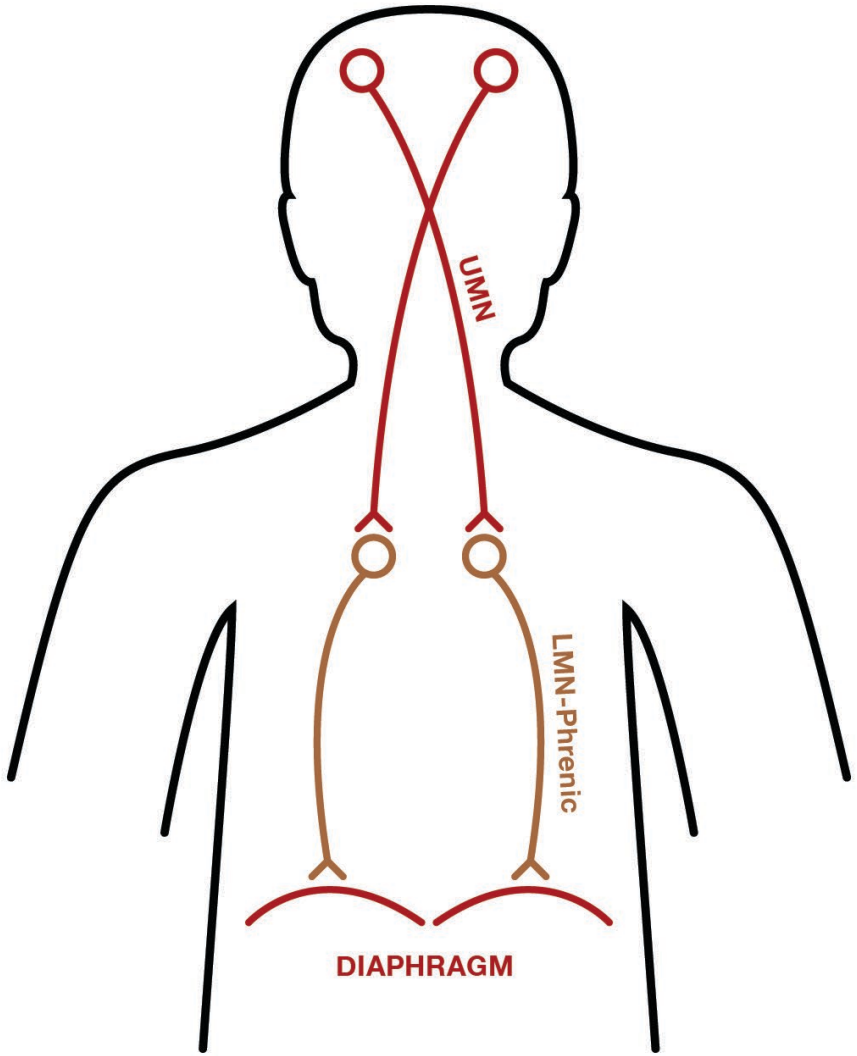


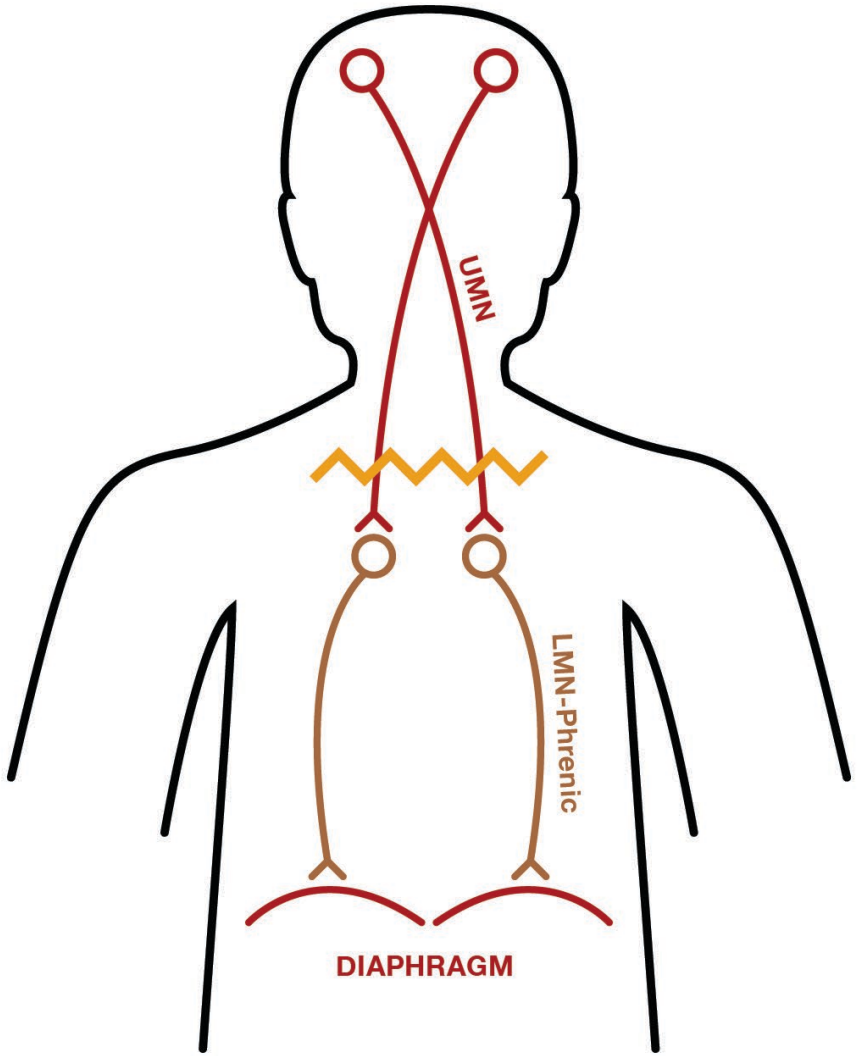
Ventilation options

- Basic science:
- The essential respiratory problem after SCI may not primarily involve the lungs
- The issue is loss of muscle function to ventilate

Nerve or muscle can be stimulated

- Nerve via phrenic stimulation—PNS
- Muscle via diaphragm pacing system--DPS


UMN
LMN-Phrenic
DIAPHRAGM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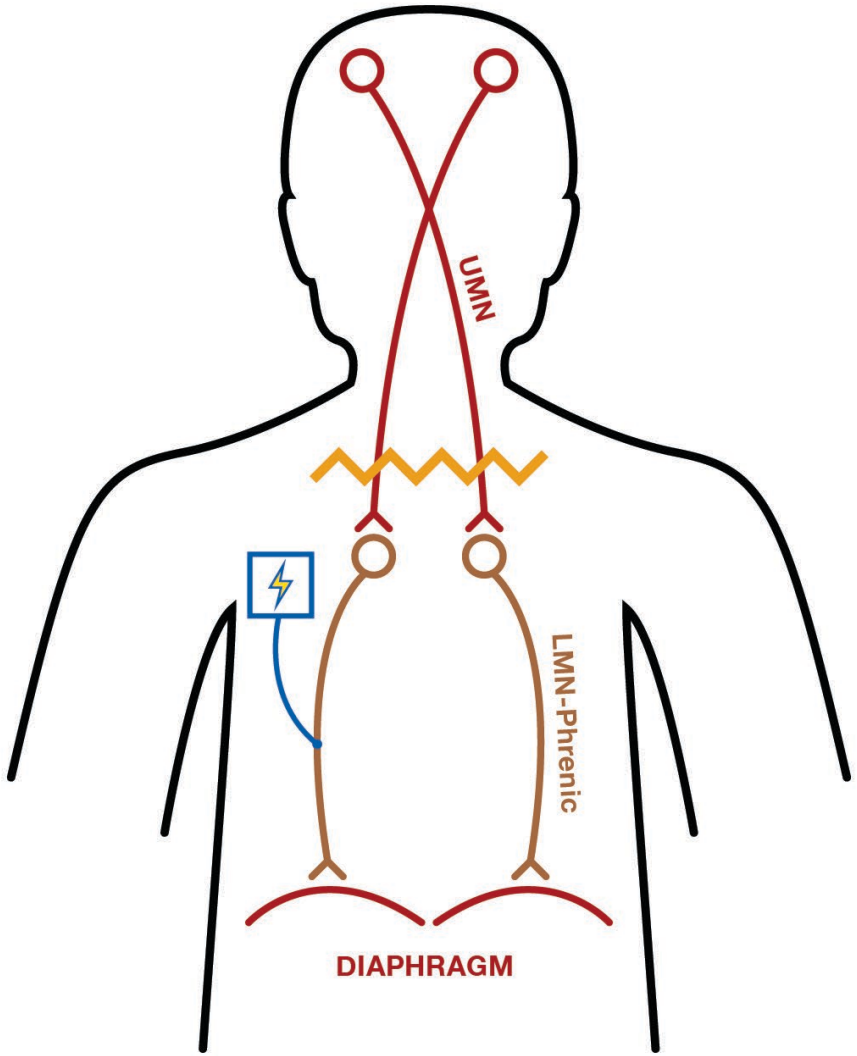
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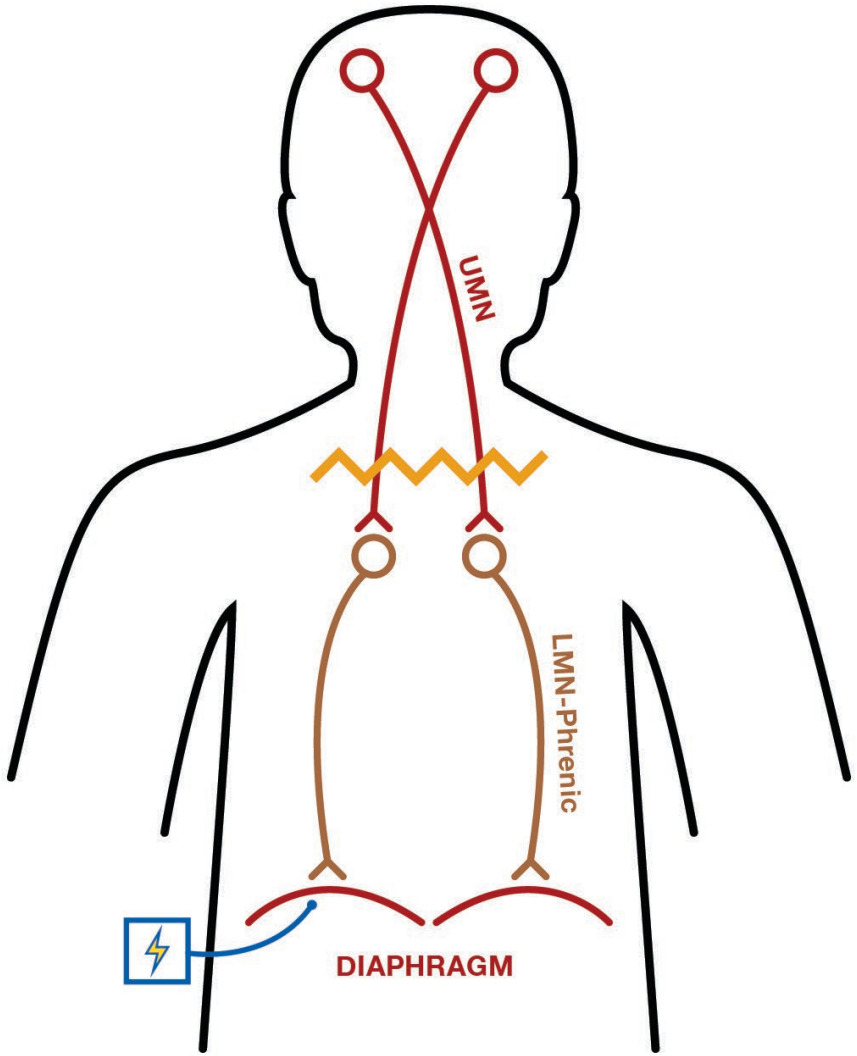
Phrenic nerve pacing

- Implanted system; nothing through the skin
- Challenging surgery
- Diaphragm must be conditioned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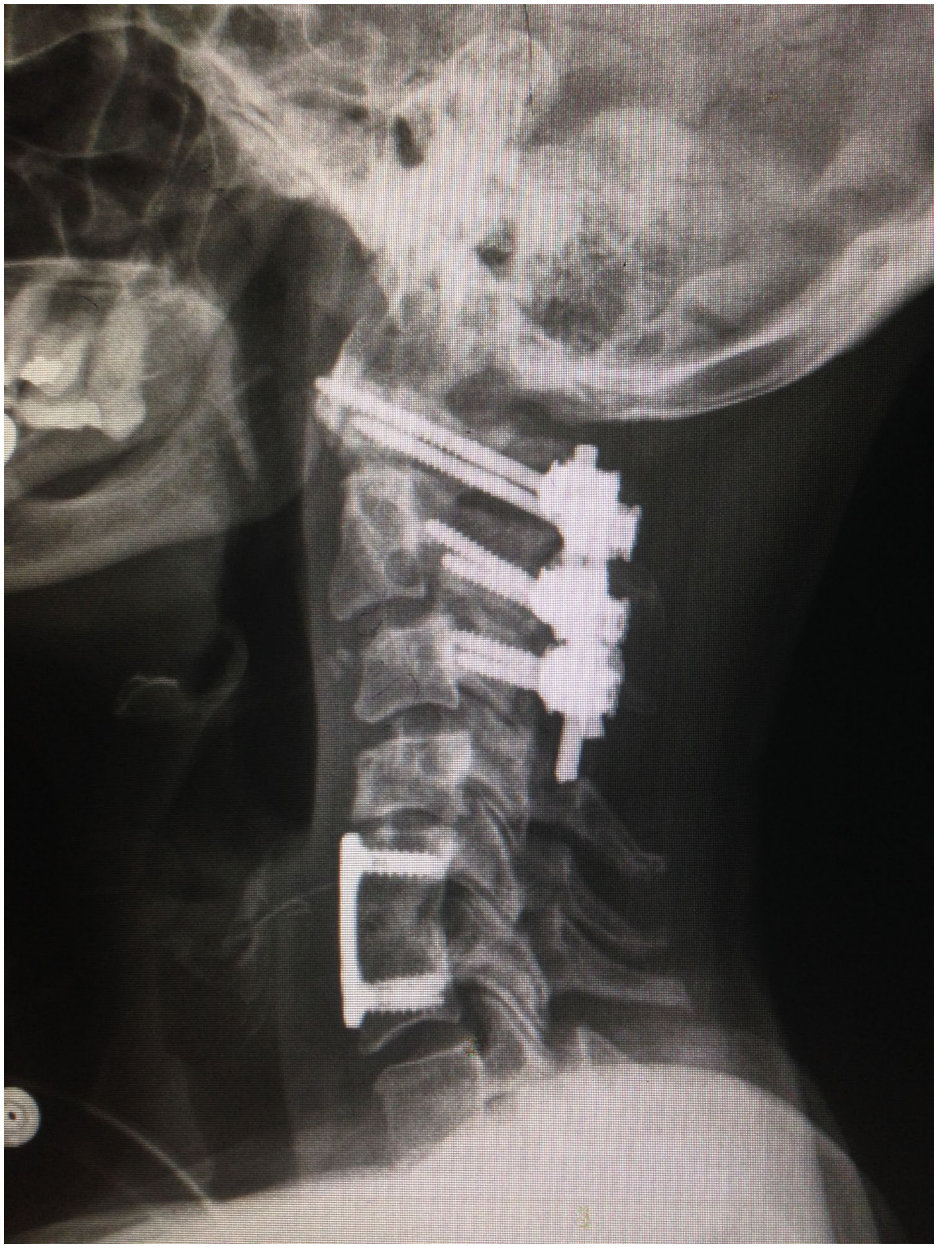
DIAPHRAGM

Diaphragm Pacing System

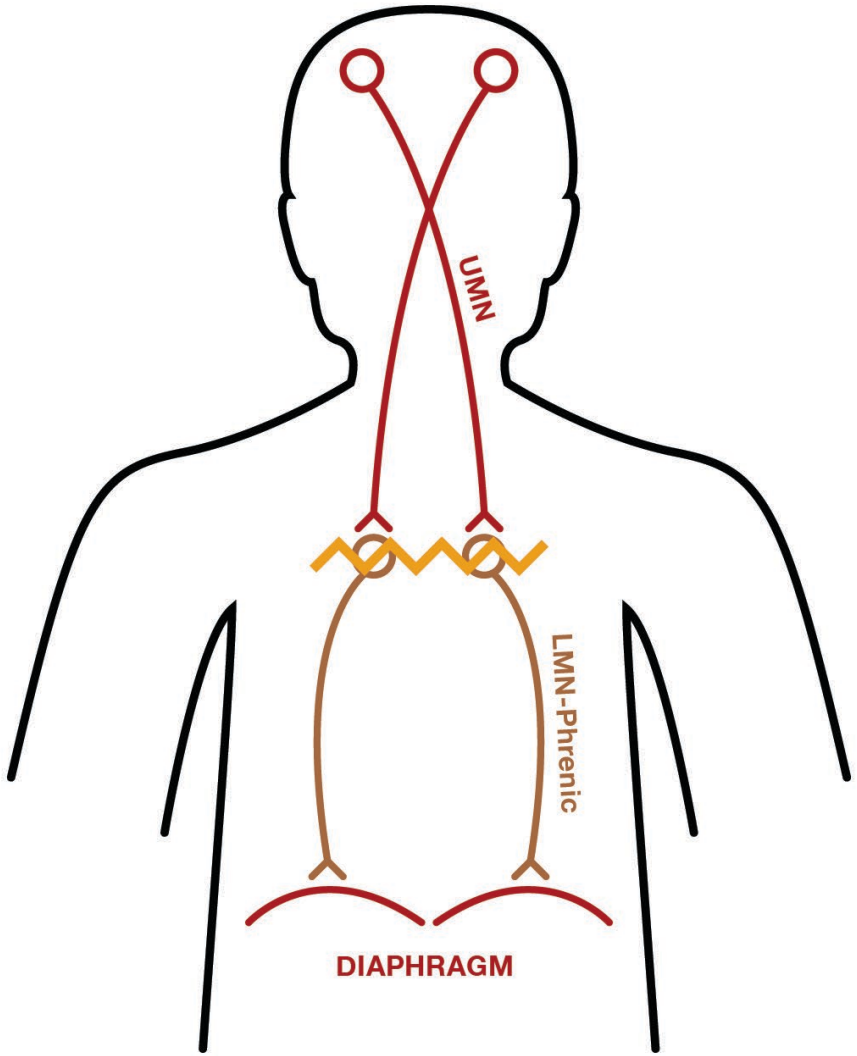
DPS

- Relatively easy to place …
- Diaphragm must be conditioned
- A “bridge”, or a “destination”
- Parameters are managed externally
- “Percutaneous”




THIS IS
Lazy
Days


INSPIRE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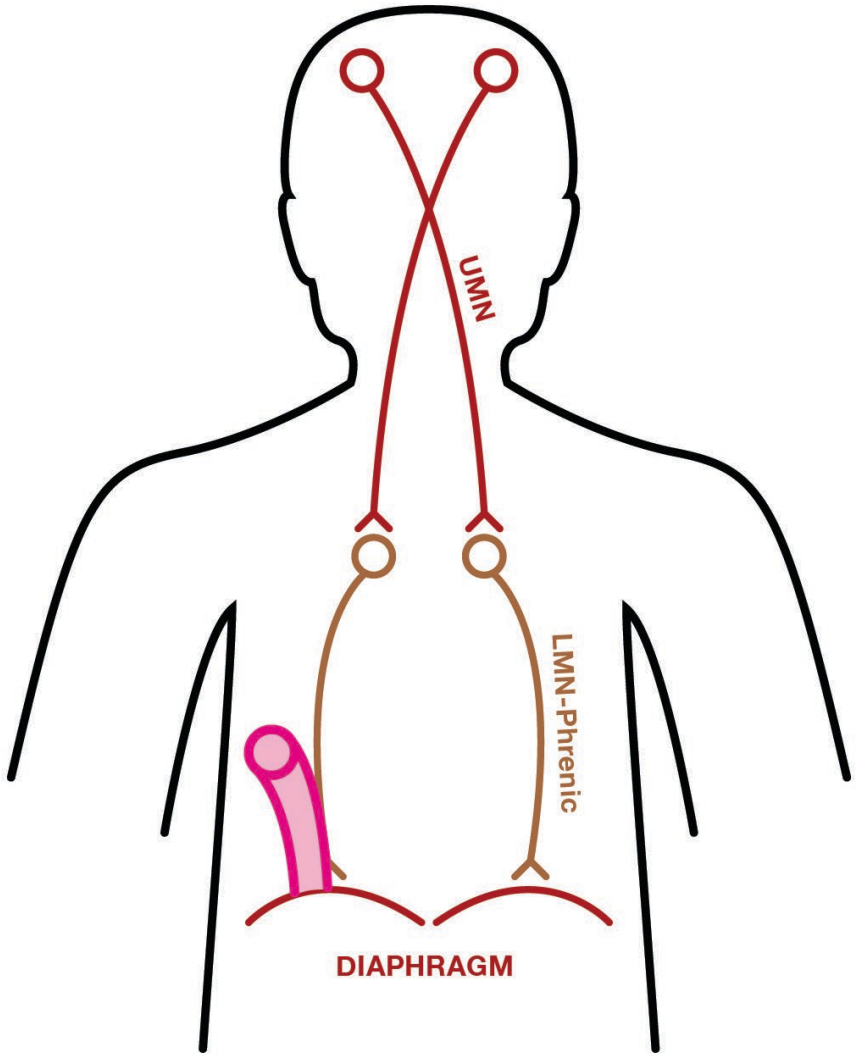
Denervated diaphragm

- No phrenic nerve to stimulate
- Denervated diaphragm can't be stimulated
- Approach: nerve grafts to innervate the diaphragm—THEN nerve stimulation or DPS


UMN
LMN-Phrenic
DIAPHRAGM

Why go through the trouble?

- Less tethering
- Less noise
- Satisfaction of using body's own machinery to ventilate
- Improved sense of taste and smell

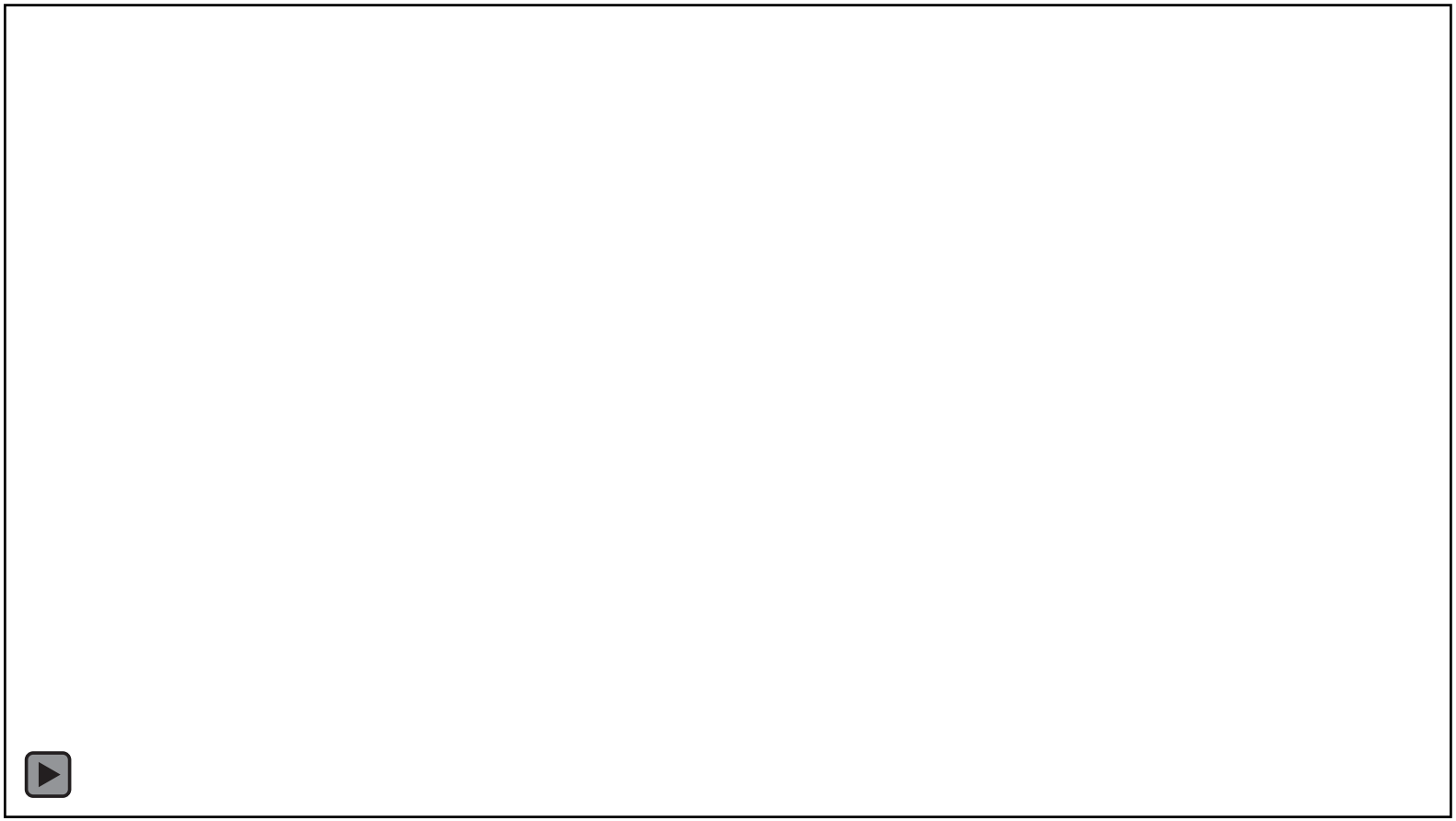
New forms of gait training

- Basis science:
- Stegasaurus
- Chicken
- Perhaps a less discrete spinal center in higher animals and humans—“spinal stepping center”
- Hess’s law
- Spinalized cats underwent treadmill training and developed rudimentary stepping

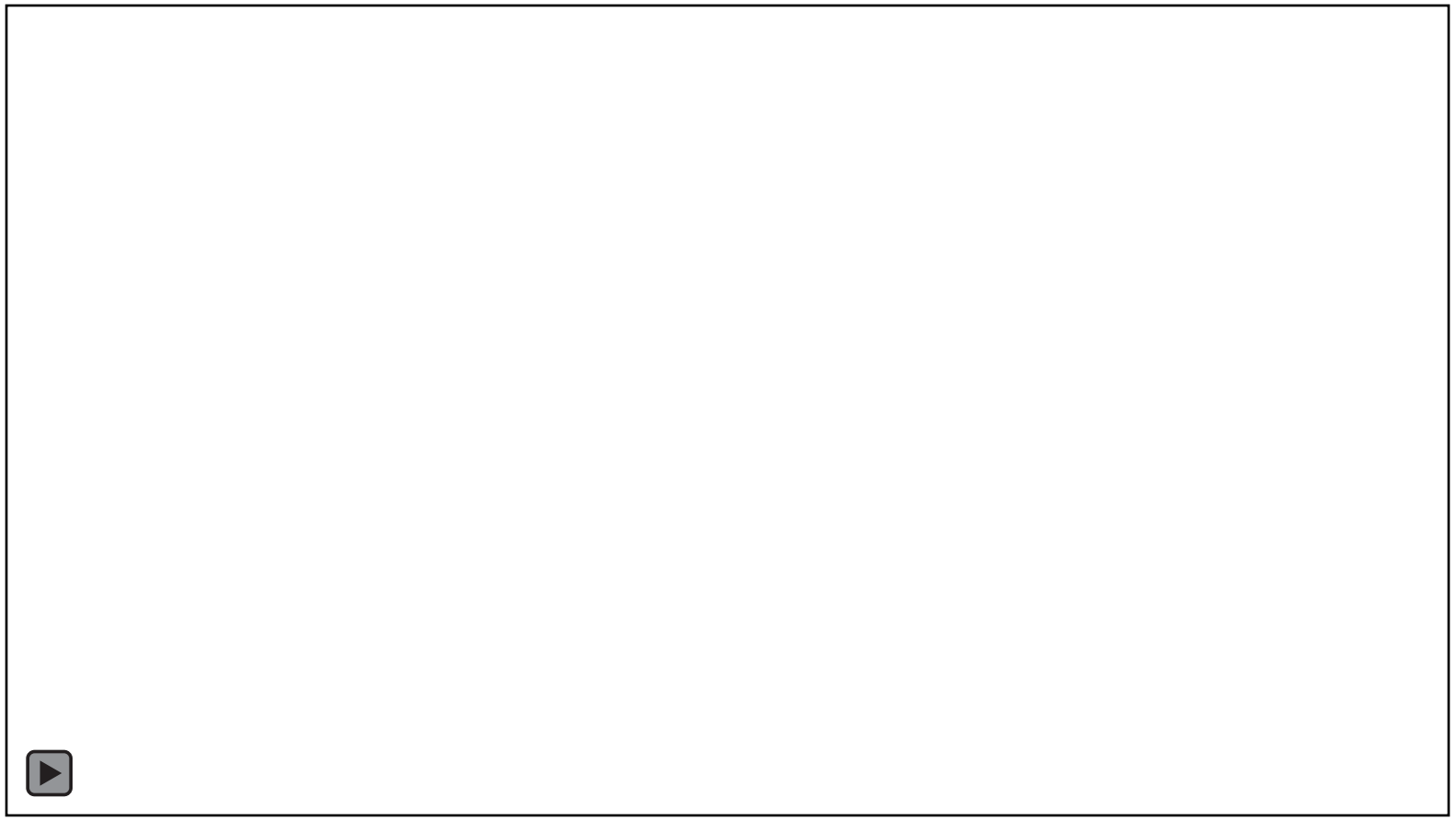
Why go through the trouble?

- Traditional exercise and gait training doesn't allow free movement of the arms; they don't swing in sync with the lower limbs
- Velocity more natural
- Input through the lower limbs is optimized

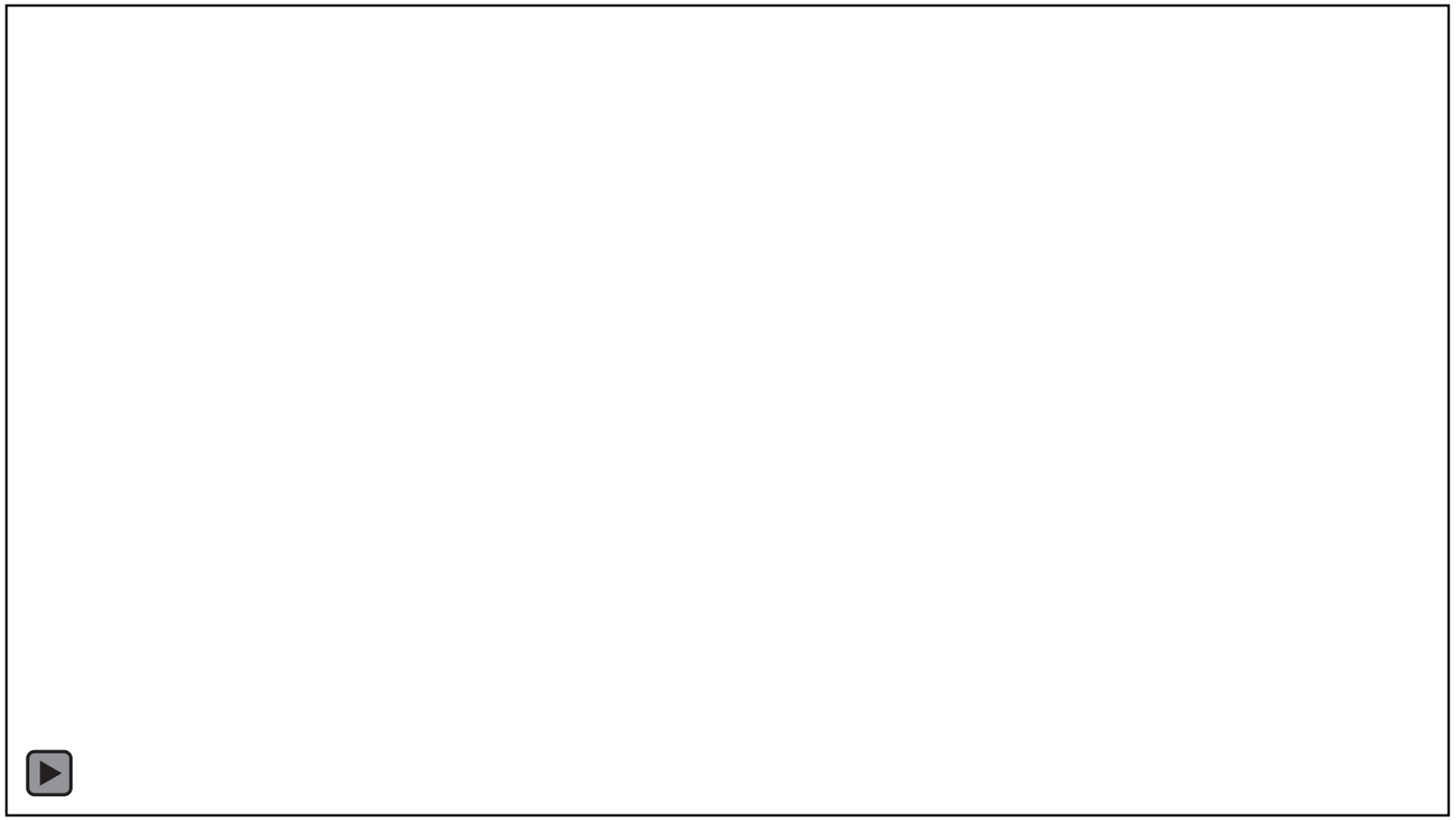
Manually Assisted BWS



Rotobotic BWS



Suspended overland



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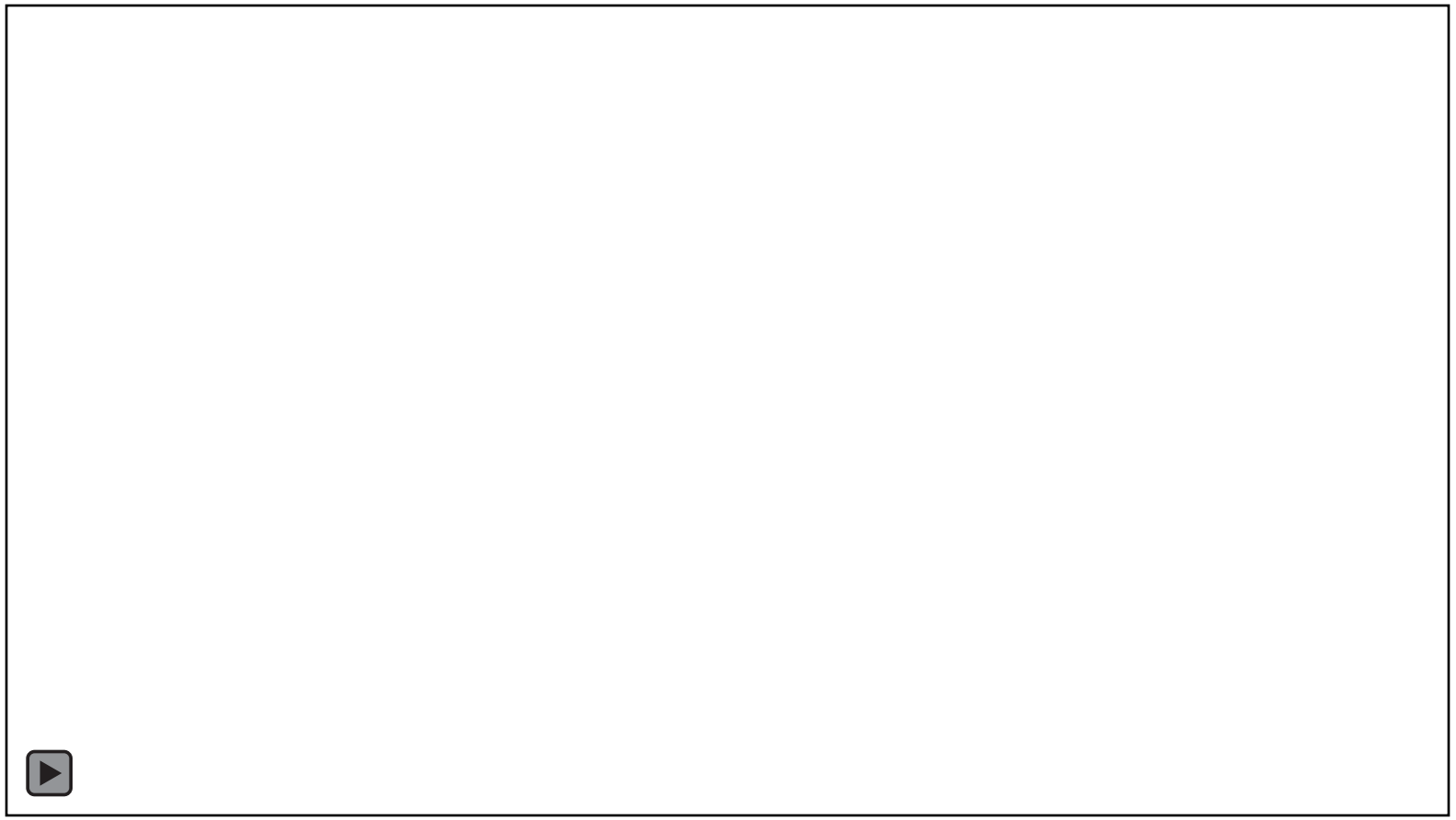
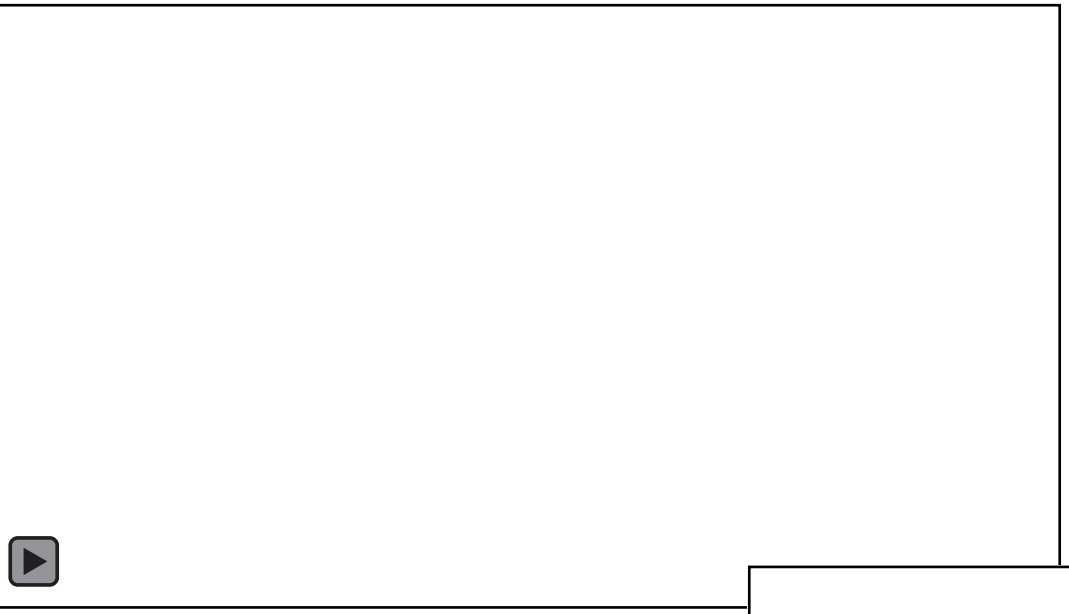


Exoskeletal training



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Thomas Jefferson University Hospital

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