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Preventing Postoperative Cognitive Dysfunction Through Preoperative Exercise

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Background

WHAT?

- POCD and postoperative delirium involve deterioration of memory, executive function, attention, focus, and other cognitive ability after undergoing anesthesia that cannot be attributed to another medical diagnosis. [11]
- Decreased quality of life and increased mortality rates.

WHO?

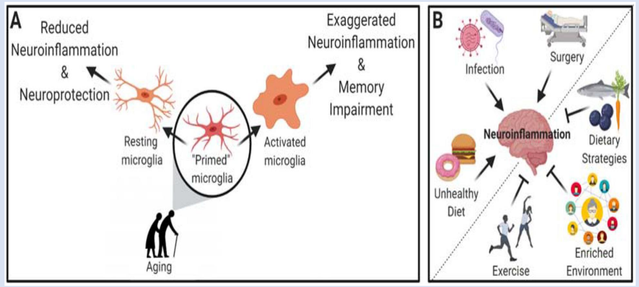
- Up to 40% of elderly patients show symptoms of POCD at discharge following surgery and undergoing general anesthesia. [12]
- Elderly population at increased risk: increased inflammatory cytokines with age, more reactive microglial cells. [7]

WHY?

- Surgery → Peripheral Inflammatory response → Anesthesia induced Blood-Brain-Barrier leaks → cytokines enter CNS → primed glial cells →cytokines /ROS → tissue damage→ Cognitive dysfunction (Modified from Skvarc DR, Berk M, Byrne LK, et al.)

WHAT CAN BE DONE?

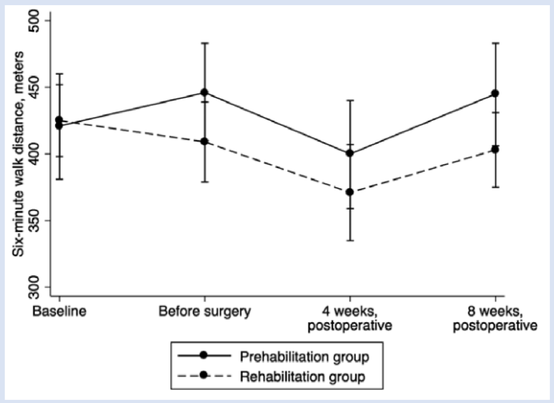
- Fitness and exercise capacity has been shown to have beneficial effects on preserving cognitive function following surgery.



Reproduced from Muscat SM, Barrientos RM. Lifestyle modifications with anti-neuroinflammatory benefits in the aging population. *Exp Gerontol*. 2020;142:111144. doi:10.1016/j.exger.2020.111144

Significance

- Aging population leads to increased surgery burden and many patients at risk.
- Prevention via exercise and fitness can significantly decrease risk and improve outcomes quicker than rehabilitation alone. [5]



Reproduced from Gillis C, Li C, Lee L, et al. Prehabilitation versus rehabilitation: a randomized control trial in patients undergoing colorectal resection for cancer. *Anesthesiology*. 2014;121(5):937-947. doi:10.1097/ALN.0000000000000393

Methods

Study selection:

- Systematic Reviews, Retrospective analysis, clinical trial, and randomized controlled trials published within the past 15 years, not limited to the USA
- Criteria included
  - Average age >60 and studies involved a population that underwent general anesthesia. Exceptions: studies on the effects of preoperative fitness on mice
- **Exclusion criteria**: studies with participants with diagnosis of dementia, studies involving cognitive prehabilitation
- **Interventions:** fitness programs or fitness levels between groups
- **Outcomes**: 6 minute walking distance, cytokine levels, delirium, timed up and go test, and other tests that measured cognitive ability .
- **Data Analyses**: Data on preoperative fitness and postoperative cognitive ability was analyzed in each.
- **Data Extraction:** Data was analyzed qualitatively.
- **Data analyses used in citations**: No further analysis was performed.

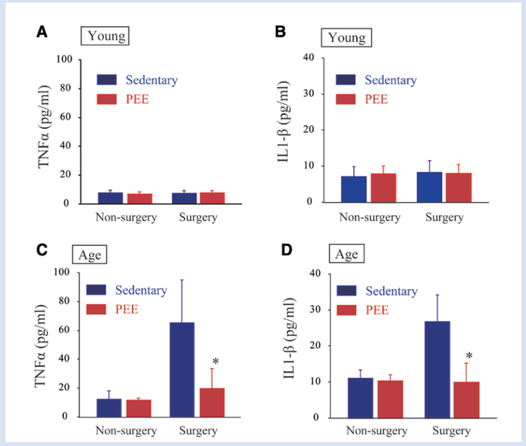
Search Strategy

Database Searched	Date of Search	Key Word String	Number of Results
PUBMED	September 23,2023	post-operative cognitive dysfunction	5756
		preoperative exercise and anesthesia	486
		preoperative exercise and inflammation	59
		preoperative exercise and cognitive dysfunction	17
		prehabilitation and postoperative cognitive dysfunction	69
		preoperative exercise and cognitive function	41
		exercise and post operative delirium	50

Results

Preoperative Assessment Tests	Postoperative Dysfunction Group's score	Non-Postoperative Dysfunction Group's score
6 Minute Walking Distance (m)	400 m 330 m	450 m 408.3
Time Up and Go Test (s)	10.8 s	8.6 s
Skeletal Muscle Index (cm^2/m^2)	36.9 (cm^2/m^2)	39.6 (cm^2/m^2)

Figure 1: This table compares data of preoperative assessments for fitness and how these scores differed between participants with postoperative dysfunction and those without. Worse preoperative fitness scores were associated with post-operative dysfunction/delirium.

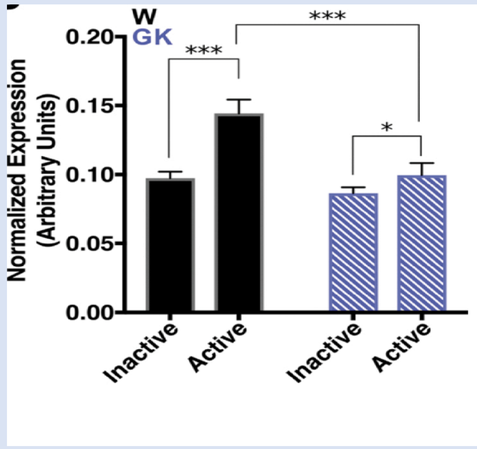


Reproduced from Kawano T, Eguchi S, Iwata H, Tamura T, Kumagai N, Yokoyama M. Impact of Preoperative Environmental Enrichment on Prevention of Development of Cognitive Impairment following Abdominal Surgery in a Rat Model. *Anesthesiology*. 2015;123(1):160-170. doi:10.1097/ALN.0000000000000697

Figure 3: These graphs show that enriched preoperative environment through physical and cognitive activity decrease inflammatory cytokines such as in aged mice undergoing anesthesia in comparison to sedentary mice. [7]

Preoperative assessment/intervention	Percentage that developed postoperative dysfunction
Frail and Non-Frail	47.05% and 2.63%
Non-Active and Active	25.4% and 10.9 %
Modified Frailty index (MFI) >.18 and MFI<.18	21.2% and 12.5%

Figure 2: Certain preoperative interventions such as exercise or preoperative frailty, play a role in the development of post operative dysfunction. Higher percentage of inactive/frail patients were diagnosed with POCD/delirium.

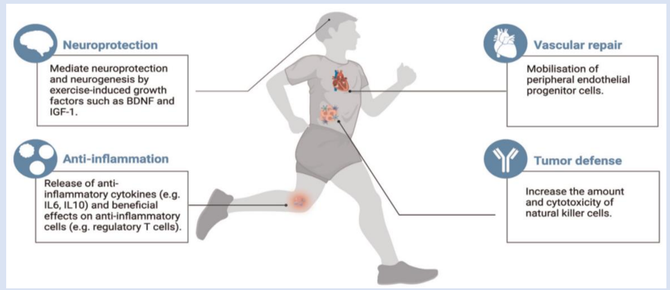


Reproduced from Sinon CG, Ottensmeyer A, Slone AN, et al. Prehabilitative exercise hastens recovery from isoflurane in diabetic and non-diabetic rats. *Neurosci Lett*. 2021;751:135808. doi:10.1016/j.neulet.2021.135808

Figure 4: This graph shows that activity increased the expression of hippocampal protein PSD-95 in diabetic and non diabetic rats, a protein produced known to increase synapse activity which plays a role in cognitive function.[13]

Discussion

- Preoperative exercise, high preoperative fitness levels, or a combination decreases risk of developing cognitive dysfunction and delirium after undergoing anesthesia. [9,11,15]
- Mice studies show sedentary cohorts had increased cognitive dysfunction and increased inflammatory markers. [4,8,13]
- Inflammatory proteins present show passage of cytokines to neurons and exercise's ability to reduce inflammatory markers. [3]



Reproduced from Esser T, Zimmer P, Schier R. Preoperative exercise and prehabilitation. *Curr Opin Anaesthesiol*. 2022;35(6):667-673. doi:10.1097/ACO.0000000000001188

- Decreased 6MD, Increased Time Up and Go Test, decreased skeletal muscle index, and increased frailty all correlated with negative cognitive outcomes postoperatively. [9,6,2,1]
- Preoperative fitness can further develop prehabilitation programs that increase post operative function.

Future Directions

- More studies need to be conducted to understand what kind of exercise, whether aerobic, resistance, or strength training produces the best outcomes.
- Continued study of the pathogenesis of POCD needs to be conducted.
- More specific studies on particular surgery types and the effects of preoperative exercise on outcomes can provide data for more specific prehabilitation programs.

Acknowledgement

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References