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Effects of Enriched Environment on Cognitive Function in Heart Failure

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Heart failure is a chronic illness, affecting many organ systems in elderly patients. In particular, recent evidence has supported the association of heart failure and cognitive deficits. By utilizing enriched environments to improve learning and memory function, elderly heart failure patients may be able to care for themselves and better mange their treatment recommendations. Using Orem's self care theory as a guide, a proposed intervention is presented to demonstrate the effects of enriched environment.

Due to the nature of the disease, "…heart failure (HF), is usually a syndrome resulting from multiple, long-standing cardiovascular abnormalities, such as coronary artery disease or hypertension, the elderly are particularly affected" (Bennet, & Sauve, 2003, p. 219). Confounded by increasing age, elderly persons with HF may be at increased risk for cognitive deficits as well. The pathophysiology of HF may explain some of the cognitive deficits in elderly patients. Cerebral hypoperfusion and cerebral emboli are two plausible contributors to cognitive dysfunction in elderly persons with HF (Bennett & Sauve, 2003; Clark & McDougall, 2006), one of which is emphasized here.

Cerebral hypoperfusion has been demonstrated in patients with HF. In a study of HF patients before and after heart transplantation, Gruhn, Larsen, Boesgaard, Knudsen, Mortensen, and Thomsen et. al. (2001), found that HF patients had a, "31% reduction [in resting cerebral blood flow] compared with the control group" (p. 2531) before surgery. Although the authors did not comment on the cognitive function of the participants, the results support the theory that cerebral hypoperfusion is evident in HF patients. In animal studies, experimenters were able to measure cognitive deficits upon creating cerebral hypoperfusion artificially- mimicking the effects of HF.

Through surgical manipulation of cerebral blood flow, Sekhon, Morgan, Spence, & Weber (1997) reported that ischemic rats had more errors in working memory compared to control rats, based on the lack of improvement in accuracy rate during a T-maze test. In addition to working memory, Ohta, Nishikawa, Kimura, Anayama, and Miyamoto (1997) demonstrated that bilateral common carotid ligation had significant effects on long lasting learning impairments, compared to bilateral internal carotid ligation, on the Morris water maze task. Spatial memory can also be affected, as evidenced by rats traveling a longer distance during a Morris water maze test, when investigators occluded bilateral common carotid arteries (De Jong et al., 1999). Evidence from these animal studies supports the theory that altering cerebral blood flow creates significant cognitive deficits in animals. These experiments simulate in animals the effects of HF on cognitive function in humans.

Having demonstrated that cerebral blood flow significantly alters cognitive function in rats, what must be done to improve or restore these cognitive deficits? One way in which scientists- and nurses- can improve cognitive functioning is to manipulate the environment. Rats placed in an enriched environment following cerebral ischemia performed better on a Morris water maze test and had enhanced dendritic plasticity (Briones, Therrien, & Metzger, 2000). Improvements in behavior were also seen in rats after being housed in, “a novel and complex environment” (Fernandez, Collazo, Bauza, Castellanos, & Lopez, 2004, p.54) An enriched environment also helped improve spatial learning in rats subjected to ventral subicular lesions (Dhanushkodi, Bindu, Raju, & Kutty, 2007). These studies present strong evidence that an enriched environment has a significant effect on cognitive functioning.

Nurses have the unique responsibility of translating knowledge gained through animal experimentation into effective treatments for their patients. Interventions aimed at improving cognitive functions, such as learning and memory, are vital to maintaining the health of HF patients, who face complex treatment regimens. Through the enrichment of the environment, nurses can enhance the cognitive functioning of elderly patients with HF in order to improve their self care ability. Specifically, Orem's theory of self-care (Mc Ewen & Wills, 2006) provides the basis for engaging in interventions aimed at improving cognitive function in elderly HF patients.

In a sample of community residents, elderly patients with HF will improve learning and memory ability when exposed to an enriched environment. Support and rationale can be gleaned from the aforementioned animal studies. Additionally, no improvement in learning and memory will be seen during an exposure to a standard environment; conversely a decrease is expected. To test these hypotheses, the author has proposed the following experiment.

Sample

Elderly participants with heart failure from a local community will be selected for this experiment. Inclusion criteria stipulate that the participants must be over age 65, and have heart failure (New York Heart Association class II or III). The classification criteria serve to ensure that the participants have the functional capacity to perform the tasks of the intervention. Participants will be excluded based on any documented cognitive dysfunction (depression, Alzheimer's disease etc.), and stage IV HF due to the confounding effects on cognitive testing and the (in)ability to complete the intervention.

Design

Participants will be randomized to 2 groups- Group A and Group B- upon consent to participate in the study. Prior to the intervention, baseline cognitive function will be assessed for both groups using a Trail Making Test (TMT) (Time 0). Using a cross-over design, Group A will participate in an enriched environment (intervention) for 1 month while Group B will receive standard treatment (control). During the second month, the groups will receive the opposite treatment (Group B- intervention, Group A- control, See Appendix A). Cognitive function will be assessed for each group at the end of each month. By using a cross-over design, the author hopes to determine the carry-over effects during the second month for Group A (Ratkowsky, Evans, & Alldredge, 1993), in addition to analyzing between-group differences at Time 1. This design will also illustrate the possibility that plastic changes in cognitive function can not only improve, but have the potential to be lost (Group A).

Cognitive Testing

Upon entry into the study, baseline cognitive function will be assessed through an established testing method. The TMT has been shown to reliable indicator of cognitive functioning, including "…attention, sequencing, [and] mental flexibility…" (Spreen, & Strauss, 1998, p. 533). Cognitive function also be assessed after 1 and 2 months (Times 1 and 2).

Intervention

Stemming from the recommendations of Briones et. al. (2000), the intervention environment that participants will be exposed to will be one of, "…formalized multisensory stimulation [program] to potentially enhance brain plasticity and reduce learning and memory impairment…" (p. 308). Key features of an enriched environment

in animal studies include: novelty, exploration of the environment, exercise, and stimulation of multiple senses (Briones et al., 2000; Dhanushkodi et al., 2007; Fernandez et al., 2004). The later two studies also used larger cages and multiple animals in the housed together to stimulate social interactions.

Similar characteristics of an enriched environment for animals are applied to this intervention involving human subjects. Participants will spend 1 hour per day, three days a week at one of two local community centers (1 intervention, 1 control). At the intervention center, participants will interact with trained research assistants and other participants (social stimulation). During the intervention session, multiple informal activities will be available such as puzzles, games, exercise equipment, listening to music, as well as structured activities such as arts and crafts and exercise classes. Activities will be changed regularly, thus creating the novelty effect of the animal studies mentioned above. The activities are meant to create a multi-sensory experience during the sessions.

In contrast, the control community site will consist of lectures related to health promotion. Participants will attend the lectures for 1 hour periods, 3 times a week. At the end of 1 month, the groups will switch sites and receive the opposite 'treatment'.

Results/Discussion

The hypothesis that elderly patients with HF will improve learning and memory ability when exposed to an enriched environment will be supported by an improved score (time) on the Trail-Making Test (TMT) after experiencing the intervention for 1 month (Group A after 1st month, Group B after 2nd month). If there is an improvement in the TMT, it is safe to assume that the participant will be better able to process treatment

recommendations and therefore perform the necessary self care behaviors. However, the hypothesis that no improvement in learning and memory will be seen during a standard environment will be supported if scores on the TMT remain constant after experiencing the control sessions for 1 month. If scores on the TMT remain constant, it is safe to assume that participants will not show an improvement in their ability to perform self care behaviors. In particular, if participants in Group A show a decline in TMT scores (from Time 1 to Time 2); this demonstrates not only the effects of a standard environment on cognitive function, but also plasticity of mental processes.

In regards to the evidence presented here, there is significant support for the intervention and its rationale. At least one level Ia was presented (Bennett & Sauve, 2003), documenting the prevalence of cognitive deficits in patient with HF. Along with two level Ib experiments (Briones et al., 2000; Dhanushkodi et al., 2007), there were four level IIa experiments (De Jong et al., 1999; Gruhn et al., 2001; Ohta, Nishikawa, Kimura, Anayama, & Miyamoto, 1997; Sekhon, Spence, Morgan, & Weber, 1997), one level IIb (Fernandez et al., 2004), and one level III article (Clark & McDougall, 2006). The articles at levels Ib and II a, respectively, reached similar conclusions.

Heart failure is a serious condition involving complex treatment regimens. However, many elderly patients with HF cannot comprehend the necessity of self care behaviors due to cognitive deficits. By enriching the environment, nurses can improve learning and memory capabilities of elderly clients with HF and ultimately improve their self care behaviors.

Appendix A

Study design

	Time 0	1 Month	Time 1	1 Month	Time 3
Group A	TMT	Intervention	TMT	Control	TMT
Group B	TMT	Control	TMT	Intervention	TMT

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