Prospectus

Redesigning the Incentive Spirometer
(Technical Topic)

End-of-Life Healthcare in the U.S.
(STS Topic)

By

Danna Du

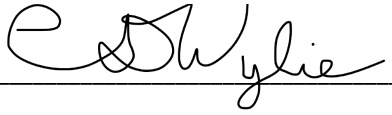
May 4th, 2021

Technical Project Team Members: Shirley Zhang

On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

Signed: Danna Du

Technical Advisor: Masahiro Morikawa, MD, MPH

STS Advisor: 

Introduction

The incentive spirometer (IS) is an important medical device used to prevent postoperative complications like pneumonia. Similar to other patient-administered therapies, patient adherence is critical to effective postoperative incentive spirometry. However, patient adherence is poor (Eltorai et al., 2018; Martin et al., 2018). We hypothesize that patient engagement is the most important patient factor and that self-motivation influences successful incentive spirometry. Our goal is to design an engaging, gamified IS that will hopefully improve patient usage and compliance.

The U.S. has the world's most expensive but least effective healthcare system (Kumar et al., 2011). Though elderly patients (65 years of age and older) only make up 11% of the US population, they account for 34% of health care expenditure (Marik, 2015). The aging American population will result in an increase in demand for health care as well as palliative care (PC) due to longer life expectancy and more chronic disease (*When I'm 64: How Boomers Will Change Health Care*, 2007). By reviewing scholarly literature and research from the fields of healthcare, economics, and philosophy through an ethics of care theoretical framework, this research illustrates that our healthcare system can and needs to be more cost effective by shifting our notion of care from treatment to prevention.

The goal of both my technical and STS research is to improve patient care. The IS, though usually used in a postoperative capacity, often acts as a preventive care tool to mitigate the development of various pulmonary complications. End-of-life care in the U.S. has much room for improvement and needs to change, as the current healthcare system is unsustainable.

Technical Topic: Redesigning the Incentive Spirometer

Proper use of an IS helps prevent postoperative and respiratory complications (Soh et al., 2019). Using an IS helps keep your lungs active, healthy, and free of fluid. The goal of incentive spirometry is to inhale slowly, which allows your lungs to fully inflate and prevent fluid buildup that can lead to pneumonia and cystic fibrosis. Proper use of an IS can also help manage symptoms of chronic obstructive pulmonary disease (COPD) and reduce the risk of developing postoperative complications like atelectasis and respiratory failure (Yetman, 2020). Moreover, an IS can be used by intensive care unit (ICU) COVID patients for inspiratory and expiratory muscle training and/or an IS can be used at home to help strengthen the muscles that help you breathe (Ambrose et al., 2020; *Recovering from COVID-19: A Patient Guide*, n.d.; Wang et al., 2020). Despite the importance of using an IS in postoperative recovery and pulmonary illnesses, patient adherence is poor (Eltorai et al., 2018; Martin et al., 2018). Patients prescribed an IS are typically not monitored in hospitals or at home. Patient adherence may also be low because of the boring design of the standard IS.

A 2019 peer-reviewed study by Soh et al. found that the use of Go-breath, a self-reporting and monitoring app for IS users, helps patients improve IS use but not significantly. For instance, the IS rate count and deep breathing of the test group was higher but not statistically significant from the control group (Soh et al., 2019). These findings align with our Capstone adviser's (Dr. Masahiro Morikawa) hypothesis that effective incentive spirometry may rely more on the patient's own motivation and interest in using an IS rather than a reminder system. Thus, our goal is to design an IS that is engaging enough that patients will want to use it on their accord.

Our plan is to improve upon the IS by designing a gamified, user-friendly, and patient-oriented IS that is simple, intuitive, fun, and gives the user instant reward/gratification. Being inspired by the ferris wheel and water ring toss game (a simple but engaging retro game), our design aims to pique the user's interest and intrinsically motivate the patient to regularly use their IS. Since the majority of patients using an IS are alone in their rooms for most of the day, self-motivation is an especially important factor. We will distribute our IS to family medicine inpatient service patients at the UVA Hospital to obtain consumer feedback and collect data on patient usage and other relevant patient factors such as instant reward/gratification, self-motivation, device proximity, patient perspective, and experience with IS use. Then, from those results, we will compare our device with the conventional IS and determine if our engaging design improves patient compliance.

In his peer-reviewed study developing digital games for respiratory therapy, Fabio Balli found that the participation of users in the design process is imperative for creating an effective product (Balli, 2018). We will be able to collect patient feedback on our IS throughout the design and production process. Continuously receiving and implementing user feedback into our product will hopefully create a device with clinical value – a device that patients will enjoy and be motivated to use.

STS Topic: End-of-Life Healthcare in the U.S.

The U.S. healthcare system is expensive, inefficient, and unsustainable. A disproportionate amount of healthcare resources is spent on the elderly, and considering the aging American population, there is expected to be an increase in demand for PC (*When*

I'm 64: How Boomers Will Change Health Care, 2007). Additionally, the structure of our current healthcare system often does not act according to patient preferences. This research aims to demonstrate why our healthcare system should shift our notion of care from treatment to prevention and focus on preventive and PC. Such a shift would not only align better with patient preferences but also benefit the healthcare system by becoming more sustainable and cost effective.

Compared to other high-income countries, the United States spends nearly twice as much on health care yet has worse medical outcomes and the lowest life expectancy (Squires & Anderson, 2015; Tikkanen & Abrams, 2020). Hospitalization and using high technology health care resources at the end of life likely account for the U.S.'s uniquely high healthcare spending (Marik, 2015).

Surgery often doesn't help elderly patients live longer nor does it guarantee the same quality of life they had pre-operation. Some seniors report that they feel obligated to choose surgery because declining any life prolonging measures would disappoint others. In their peer-reviewed study, Nabozny et al. concluded that misunderstandings and false expectations dictate high-stakes surgical decisions and that it's difficult to align personal preferences with treatment decisions (Nabozny et al., 2016; News, n.d.).

Another reason why patient preferences may not be followed is because of death anxiety. Assistant Professor and geriatrician Gary Sinoff found that while the elderly had low levels of death anxiety, their children had high death anxiety. Children of the elderly fear death and often project onto their parents. This can cause children to not tell their parents relevant medical information (even if that contradicts the patient's preferences), highlighting the need for honest communication between elderly patients, their children,

and medical staff (Sinoff, 2017). We are essentially making older people die slower, sometimes against their wishes.

Instead of focusing on treatment and pressuring older patients to undergo treatment, we should shift our focus to preventive and PC services. Preventing disease is much more favorable to treating people after they get sick, especially for chronic diseases, which have increasing numbers of deaths and health care costs due to the aging population. In their peer-reviewed article, Levine et al. found that most providers do not prioritize preventive care services – although they know how such services can reduce the incidence of chronic diseases, hospitals and physicians alike are currently paid more to treat disease rather than prevent them (Levine, 2019).

Our current healthcare policies are predicted to not be able to support the aging American population (*Population Aging Will Have Long-Term Implications for Economy; Major Policy Changes Needed*, 2012; *The 2020 Long-Term Budget Outlook*, 2020). A leading ethical question of modern medicine is: how much money should be spent on keeping sick patients alive? Moral decisions become intertwined with economics as life – often perceived as priceless – encounters finite economic resources. Assistant Professor of Sociology Roi Livne argues this scarcity can be moralized in a positive way through the hospice ethic perspective, which emphasizes acceptance and limited treatment. Deciding to limit spending helps people come to terms with their approaching death and avoids prolonging unnecessary suffering from aggressive treatments (Livne, 2014). We often say that money is no object when it comes to keeping someone we care about alive, but we aren't taking into account the suffering that someone has to endure by receiving life prolonging treatments like surgery or chemotherapy.

Two problems people face at the end of life – the lack of quality care and the ever-increasing cost of health care – may both be mitigated with earlier and increased PC. Increasing PC intervention achieves the primary clinical effects (reducing symptom burden, increasing communication, better alignment between treatment and patients' goals) but also the secondary and unintended outcome of reducing cost due to terminating unwanted treatments and decreasing hospital services (Dalal & Bruera, 2017).

Hospitals, patients, and families spend tremendous amounts of money trying to prolong patients' death (sometimes despite patient preferences); this money may be better spent trying to promote health and well-being and thus preventing the need for treatment in the first place (Nabozny et al., 2016; Sinoff, 2017). The reason Americans are willing to go to such extensive lengths for medical care may be because of unrealistic expectations of modern medicine perpetuated by the media, a strongly individualistic culture, and the inability to accept death (Marik, 2015).

Much of what we associate with death is constructed and wouldn't exist without us. Sociology Professor Sarah Brabant claims that the construction of death is consistent with Berger and Luckmann's social construction of reality. Each construct is experienced while one is awake, is organized around the present "here and now," and is thought to be shared with others (Brabant, 2011). Other than the medical death itself, everything else associated with death – including healthcare and our attitudes regarding death – is constructed and can thus be changed.

Ethics of care is a feminist, contextual approach that emphasizes "human connectedness" and "communal relationships." American feminist philosopher Rosemarie Tong argues that ethics of care is an appropriate approach for healthcare, that healthcare

practitioners must try to become more caring people, and that healthcare cannot be just another marketed commodity (Tong, 1998). A system driven by capitalism leaves little room for care and compassion, which can lead to medical miscommunication. At the heart of it, ethics of care focuses on the person, which would be the patient in this context.

Conclusion

The IS is a helpful medical device that can prevent postoperative pulmonary complications. However, it is often not used properly due to various patient factors, of which we hypothesize patient engagement and self-motivation to be the most important. The current healthcare system in the U.S. is inefficient, expensive, unsustainable, and needs to become more cost-efficient by shifting the focus from aggressive treatments to preventive and PC. By synthesizing literature from various fields (healthcare, economics, philosophy) and by utilizing the ethics of care framework, this research aims to improve our overall understanding of why our current healthcare system needs to change, why end-of-life care has much room for improvement, and why having a patient-centric view is vital to creating effective medical devices.

References

Ambrose, A., Bartels, M., Verghese, T., & Verghese, J. (2020). Patient and caregiver guide to managing COVID-19 patients at home. *The Journal of the International Society of Physical and Rehabilitation Medicine*, *3*. https://doi.org/10.4103/jisprm.jisprm_4_20

Balli, F. (2018). Developing Digital Games to Address Airway Clearance Therapy in Children With Cystic Fibrosis: Participatory Design Process. *JMIR Serious Games*, *6*(4). https://doi.org/10.2196/games.8964

Brabant, S. (2011). Death: The Ultimate Social Construction of Reality. *OMEGA - Journal of Death and Dying*, *62*(3), 221–242. https://doi.org/10.2190/OM.62.3.b

Dalal, S., & Bruera, E. (2017). End-of-Life Care Matters: Palliative Cancer Care Results in Better Care and Lower Costs. *The Oncologist*, *22*(4), 361–368. https://doi.org/10.1634/theoncologist.2016-0277

Eltorai, A. E. M., Baird, G. L., Eltorai, A. S., Pangborn, J., Antoci, V., Cullen, H. A., Paquette, K., Connors, K., Barbaria, J., Smeals, K. J., Agarwal, S., Healey, T. T., Ventetuolo, C. E., Sellke, F. W., & Daniels, A. H. (2018). Incentive Spirometry Adherence: A National Survey of Provider Perspectives. *Respiratory Care*, *63*(5), 532–537. https://doi.org/10.4187/respcare.05882

Kumar, S., Ghildayal, N. S., & Shah, R. N. (2011). Examining quality and efficiency of the US healthcare system. *International Journal of Health Care Quality Assurance*, *24*(5), 366–388. https://doi.org/10.1108/09526861111139197

Levine, S. (2019). Health Care Industry Insights: Why the Use of Preventive Services Is Still Low. *Preventing Chronic Disease*, *16*. https://doi.org/10.5888/pcd16.180625

Livne, R. (2014). Economies of Dying: The Moralization of Economic Scarcity in U.S. Hospice Care. *American Sociological Review*, *79*(5), 888–911. https://doi.org/10.1177/0003122414547756

Marik, P. E. (2015). The Cost of Inappropriate Care at the End of life: Implications for an Aging Population. *American Journal of Hospice and Palliative Medicine®*, *32*(7), 703–708. https://doi.org/10.1177/1049909114537399

Martin, T. J., Patel, S. A., Tran, M., Eltorai, A. S., Daniels, A. H., & Eltorai, A. E. M. (2018). Patient Factors Associated with Successful Incentive Spirometry. *Rhode Island Medical Journal*, 5.

Nabozny, M. J., Kruser, J. M., Steffens, N. M., Brasel, K. J., Campbell, T. C., Gaines, M. E., & Schwarze, M. L. (2016). Constructing High-Stakes Surgical Decisions: It's Better to Die Trying. *Annals of Surgery*, *263*(1), 64–70. https://doi.org/10.1097/SLA.0000000000001081

News, L. S., Kaiser Health. (n.d.). *Surgery Near End of Life Is Common, Costly*. Scientific American. Retrieved March 2, 2021, from https://www.scientificamerican.com/article/surgery-near-end-of-life-is-common-costly/

Population Aging Will Have Long-Term Implications for Economy; Major Policy Changes Needed. (2012, September 25). National Academy of Sciences. https://www.nationalacademies.org/news/2012/09/population-aging-will-have-long-term-implications-for-economy-major-policy-changes-needed

Recovering from COVID-19: A Patient Guide. (n.d.). Weill Cornell Department of Rehabilitation Medicine & Columbia Department of Rehabilitation and Regenerative

Medicine. Retrieved February 25, 2021, from https://www.ps.columbia.edu/file/37657/download?token=46YIwI_N

Sinoff, G. (2017). Thanatophobia (Death Anxiety) in the Elderly: The Problem of the Child's Inability to Assess Their Own Parent's Death Anxiety State. *Frontiers in Medicine*, *4*. https://doi.org/10.3389/fmed.2017.00011

Soh, J. Y., Lee, S. U., Lee, I., Yoon, K. S., Song, C., Kim, N. H., Sohn, T. S., Bae, J. M., Chang, D. K., & Cha, W. C. (2019). A Mobile Phone–Based Self-Monitoring Tool for Perioperative Gastric Cancer Patients With Incentive Spirometer: Randomized Controlled Trial. *JMIR MHealth and UHealth*, *7*(2). https://doi.org/10.2196/12204

Squires, D., & Anderson, C. (2015, October 8). *U.S. Health Care from a Global Perspective: Spending, Use of Services, Prices, and Health in 13 Countries*. The Commonwealth Fund. https://www.commonwealthfund.org/publications/issue-briefs/2015/oct/us-health-care-global-perspective

The 2020 Long-Term Budget Outlook. (2020, September). Congressional Budget Office. https://www.cbo.gov/publication/56598

Tikkanen, R., & Abrams, M. K. (2020, January 30). *U.S. Health Care from a Global Perspective, 2019: Higher Spending, Worse Outcomes?* The Commonwealth Fund. https://www.commonwealthfund.org/publications/issue-briefs/2020/jan/us-health-care-global-perspective-2019

Tong, R. (1998). The Ethics of Care: A Feminist Virtue Ethics of Care for Healthcare Practitioners. *The Journal of Medicine and Philosophy*, *23*(2), 131–152. https://doi.org/10.1076/jmep.23.2.131.8921

Wang, T. J., Chau, B., Lui, M., Lam, G.-T., Lin, N., & Humbert, S. (2020). Physical Medicine and Rehabilitation and Pulmonary Rehabilitation for COVID-19. *American Journal of Physical Medicine & Rehabilitation*, *99*(9), 769–774. https://doi.org/10.1097/PHM.0000000000001505

When I'm 64: How Boomers Will Change Health Care. (2007, May). American Hospital Association. https://www.aha.org/system/files/content/00-10/070508-boomerreport.pdf

Yetman. (2020, March 27). *Incentive Spirometer: What It's for and How to Use It*. Healthline. https://www.healthline.com/health/incentive-spirometer