A Focus on the Current State of Research and Clinical Understanding Regarding the Cardiopulmonary System in Health and Disease

Sabbatical Summary Report

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Introduction
My sabbatical was oriented around observing cardiopulmonary research, investigating human physiology laboratory modules and providing clinical patient care at Oregon Heart & Vascular Institute (OHVI 5). These experiences were supplemented with text readings emphasizing cardiopulmonary pathologies.

The stated goals of my Sabbatical Project were to:

1. Strengthen my understanding of current laboratory practice.
2. Strengthen my understanding of medical practice and acquire clinical skills.

1. Strengthen my understanding of laboratory practice
Laboratory research continues to advance our knowledge of the intricate physiological processes which govern our internal homeostasis. While I have attempted to keep up with research, as reported in professional journals such as the New England Journal of Medicine, it had been 20 years since I last had the opportunity to actually participate in a research laboratory setting. The last research I had participated in was as a subject in a study examining VO_2 max and perceived exertion. Now, two decades later, I was very anxious to observe advances in research and techniques. In order to achieve this goal, I contacted Dr. Chris Minson, Chair of the Dept. of Human Physiology at the University of Oregon. Dr. Minson put me in touch with Dr. Andrew Lovering. I arranged with Dr. Lovering to observe the weekly studies being conducted in his Cardiopulmonary and Respiratory Physiology Lab. Along with weekly observations at the Cardiopulmonary and Respiratory Physiology Lab, arrangements were also made to observe in the HPHY human physiology course labs and the Human Cardiovascular Control Lab.

Sabbatical outcomes for strengthening my understanding of laboratory practice:
On **Thursdays** I observed research conducted in the Cardiopulmonary and Respiratory Physiology Lab at the University of Oregon. There were two primary studies being conducted during my fall term sabbatical. The primary study examined inducible intrapulmonary arteriovenous anastamosis in exercise and hypoxia. The second study examined the cardiopulmonary and respiratory sequelae of preterm birth.

i. Inducible intrapulmonary arteriovenous anastamosis in exercise and hypoxia

- I felt very privileged to observe this seminal study. The findings of Dr. Lovering's previous studies on intrapulmonary arteriovenous shunting are controversial and counter to the current medically accepted understanding of shunting. There was a vigorous debate being waged in the *Journal of Applied Physiology* regarding Dr. Lovering's research. If Dr. Lovering's reported research were to stand up against the scrutiny of his peers it would, according to Hopkins, Olfert and Wagner of the Departments of Medicine and Radiology at the University of California, San Diego "… Involve rewriting the textbooks on the effects of oxygen on the pulmonary circulation".
- Synopsis of clinical observation
    - In Dr. Lovering's lab I learned diagnostic methods employed to determine patent foramen ovale (PFO). In this lab saline contrast echocardiography was used to determine the presence of intracardiac shunts. The set up involved placing a 22 gauge intravenous catheter in the antecubital vein. Attached to the end of the catheter were a three way stop cock and two 10 ml syringes. One syringe contained

1 ml medical grade O_2 gas. The other contained 3 ml of saline. The syringes were agitated to produce a mixture containing microbubbles. The microbubbles were then injected into the peripheral forearm vein. Microbubbles are echogenic and were used to detect shunts. If transesophageal echocardiography demonstrated the presence of bubbles in the left atrium, within three beats of the appearance in the right atrium, it confirmed a spontaneous shunt via PFO and excluded these individuals from further study.

- Individuals who were negative for PFO were studied to determine the PaO_2 at which intrapulmonary ateriovenous shunts open. In this study subjects engaged in exercise bouts consisting of three - eleven minute sets of submaximal cycle ergometer at 60% of VO_2 peak. Low resistance, two-way, non-rebreathing mouthpieces allowed for control of pulmonary gas composition. During the exercise bout, saline contrast echocardiography was used to demonstrate the appearance of microbubbles in the left side of the heart, which indicated IPAV shunting. It is important to note that shunting of microbubbles, which are ~25 um in diameter, could not occur through the pulmonary capillaries, as they larger than 13 um in diameter. Pulmonary capillaries are typically only 7 -10 um in diameter
- Preliminary results of Dr. Lovering's investigative studies demonstrated that hypoxia ($FiO_2 = 0.14$) and normoxia, both produced significant levels of IPAV shunting during exercise
    - Hypoxia resulted in more pronounced shunting
        - Note: FiO_2 is the fraction of inspired oxygen in a gas mixture
            - Normoxia = $FiO_2 = 0.209$
    - Hyperoxia ($FiO_2 = 1.0$) prevented exercise – induced IPAV shunting
- Subsequent studies demonstrated that IAVP shunts became active at rest in hypoxic states
    - At rest, 100% of the 16 subjects displayed shunting after 30 minutes breathing a $FiO_2 = 0.10$.

ii. Cardiopulmonary and respiratory sequelae of preterm birth

- This ongoing study was examining the effects of bronchopulmonary dysplasia on pulmonary function tests in later life.
    - Bronchopulmonary dysplasia is related to preterm birth.
- Adolescents and young adults with bronchopulmonary dysplasia were evaluated during bike ergometer exercise to determine pulmonary parameters and flow loops
    - Subjects typically possessed normal lung volumes but lung function variables were diminished

On **Fridays** I observed the undergraduate HPHY 316 Human Physiology labs at the University of Oregon. A part of my sabbatical plan was to explore alternative offerings in the human physiology lab. My discipline had discussed updates to our own laboratory modules and equipment. This observation provided me the opportunity to gain insight into what other human physiology labs on other campuses were doing, which we could potentially incorporate into our labs at Lane. The two hour HPHY 316 human physiology labs introduced students to foundational concepts in physiology through the use of ADInstruments PowerLabs. My discipline had discussed the integration of computer based labs into our own curricula, and I had previously attended an ADInstruments PowerLabs demonstration to see if I should proceed with generating a funding request. One thing I had not had the opportunity to do was to observe students using the computer based modules to gather data. The sabbatical gave me the opportunity to determine if these labs would meet the goals and objectives of our own human anatomy and physiology labs. During the course of the sabbatical I observed students gather, analyze, interpret and report data on:

- Neuromuscular physiology and autonomic nervous system
    - Action potential properties

- Electromyography (EMG)
    - Measures electrical activity in skeletal muscle during force production
- Motor nerve conduction velocity

The experience demonstrated that the ADInstruments PowerLabs, in my opinion, would not meet the needs of our students. While the labs were very well designed, the time frame required to complete the activities was too long. We offer human anatomy and physiology in a 12 credit sequence, while the UO offers a 23 credit sequence, this affords them the opportunity to spend longer on the lab portion.

During my fall sabbatical there was not much research being conducted in the Human Cardiovascular Control lab. However, I was able to meet with a graduate student who gave me an overview of the research and demonstrated the various techniques being employed in this particular laboratory, such as audibly transducing nerve fiber conduction.

2. Strengthen my understanding of medical practice and acquire clinical skills

Having taught courses on anatomy and physiology, microbiology, immunology, infectious disease and pathophysiology, I was looking forward to stepping away from the theoretical presentation and gain practical, hands-on application in a clinical setting. My sabbatical occurred during the fall term of my second year in the nursing program. The settings for the accomplishment of this goal included the Oregon Heart & Vascular Institute (OHVI 5) on the fifth floor at Sacred Heart Medical Center (SHMC) and the nursing laboratory at LCC.

Sabbatical outcomes strengthening my understanding of medical practice and acquire clinical skills:

Monday mornings of my fall term sabbatical were spent in the lecture course "NRS221A Foundations of Nursing in Chronic Illness 2 and End of Life".

Monday evenings of my fall term sabbatical were spent doing clinical prep on OHVI 5.

- I would travel to SHMC and gather information in order to do client prep for the following day
- This prep included
    - Dx , Hx and current state of being
    - Med sheets
    - Lab sheets
        - From the above data I would plan interventions centered on evidence based rational

Tuesday and **Wednesday** during my fall term sabbatical I spent from ~ 3:30 p.m. to ~ 10:00 p.m. providing direct client care on OHVI 5. My clinical instructor, the highly esteemed, respected and distinguished, Sue Roders, provided me with expert guidance, insight and feedback throughout my fall term clinical experience.

- The clinical experience allowed me the invaluable opportunity to gain clinical skills. It also afforded me the opportunity to gain a current understanding of the advances in clinical medicine along with the applications. Additionally I was able to acquire a familiarity with laboratory and clinical tests.

Supplemental Readings

- Pathological Basis of Disease (8^{th} edition)
    - Text examines intracellular and extracellular signaling mechanism leading to cellular expressions of pathology.
- Harrison's Principles of Internal Medicine (16^{th} edition)
    - Exceptional text detailing the pathogenesis, expression and treatment of disease
- Guyton's Medical Physiology (12^{th} edition)
    - One of the best selling, world-wide, upper-division physiology texts

CONCLUSION

This sabbatical provided me the opportunity to enrich my understanding of current laboratory methods, findings and applications. Through my observations in the Cardiopulmonary and Respiratory Physiology Lab, I was able to gain an awareness of the current state of cardiopulmonary research at the University level. The observations in the University of Oregon undergraduate physiology laboratory were very informative in regards to evaluating the outcomes and goals of our own physiology labs. As a discipline we evaluate our human physiology labs to ensure the modules are providing relevant, updated learning opportunities. While the UO ADInstruments PowerLabs provided students an opportunity to gain a detailed understanding of physiological phenomena, they also required a significant time commitment. Based upon time and credit restraints, it would likely not work to integrate the ADInstruments PowerLabs into our 4 credit human anatomy and physiology lecture/lab courses. This insight allows us to move forward and examine other potential laboratory experiences that would best serve our A&P students.

The opportunity to increase my understanding of advances in clinical medicine, by preparing for and providing direct patient care on the cardiac floor (OHVI5) at Sacred Heart Medical Center, was invaluable. The sabbatical allowed me the time to examine the clinical and medical applications of the A&P and microbiology courses I teach and bring that information back into the classroom. A&P students consistently ask questions concerning clinical application. The experience I've gained has allowed me to be a competent and current source of clinical information. The applications and theoretical knowledge I've acquired have been incorporated into my lectures through the use of timely and relevant examples. It has brought a greater depth of understanding to the classroom in regard to clinically applied physiology. It should also be noted that as a direct result of the sabbatical experience I'm examining the goals and outcomes we have set for our A&P students to ascertain if these outcomes adequately prepare students for their health career programs. As a direct result of my sabbatical I have already changed my own course curriculum to better fit the expectations of student preparedness for health career programs.

My A&P discipline serves approximately 494 students each term and we place a strong emphasis on clinically applied A&P. The majority of our courses are taught by eight part-time faculty. Our three full-time faculty members have a strong commitment to be both a mentor and a resource for our adjunct faculty. Gaining hands-on clinical experience has allowed me to be a current resource to adjunct A&P faculty, who themselves may have been away from clinical settings for awhile.

Lastly, I would like to thank the members of the Faculty Professional Development Committee. I am very grateful to them for allowing this sabbatical opportunity.