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Education Department
American Association for Respiratory Care, 9425 N. MacArthur Blvd., Ste. 100, Irving, TX 75063-4706

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National Board for Respiratory Care WRT Examination Scores and the Relationship to Academic Degree

Kathy S. Myers Moss, MEd, RRT-ACCS, RCP

Abstract

Background: Eligible candidates for NBRC examinations in 2011 achieved an associate or higher degree from an accredited respiratory care education program. In 2011, 92% of eligible candidates applying to challenge the Written Registry Examination for Advanced Respiratory Therapists (WRT) had earned the associate degree. Relationship between academic degree earned upon completion of respiratory care educational program and WRT score is unknown. The purpose of this study was to identify any relationship that may exist between WRT score and the academic degree earned upon completion of the candidate's respiratory care educational program. **Methods:** Ordinary least squares analysis was employed to regress NBRC WRT examination z-scores on the academic degree earned from the candidate's respiratory care education program, controlling for the effects of age, gender, application status (new or repeat), and application type (WRT only or WRT and Clinical Simulation Examination, CSE). The analysis employed census data from the population of 11,677 individuals who challenged the NBRC WRT examination in 2011. **Results:** After controlling for the effects of age, gender, application status, and application type, the regression coefficient indicates that status of having earned a baccalaureate degree from an accredited respiratory care education program was associated with a .18 z-score unit increase in WRT examination score, on average. **Conclusion:** The status of having earned a baccalaureate degree upon completion of an accredited respiratory care education program is associated with a gain in WRT z-scores, though the effect is small. Data from this analysis could be used to support inferences regarding future attempts of taking the WRT

Key words: education, curriculum, educational measurement, assessment, respiratory therapy education, students, teaching, schools, universities.

Correspondence and Request for Reprints:
Kathy S. Myers Moss, MEd, RRT-ACCS, RCP
University of Missouri
School of Health Professions
Department of Cardiopulmonary and Diagnostic Sciences
Respiratory Therapy Program
605 Lewis Hall
Columbia, MO 65211

Introduction

The National Board for Respiratory Care (NBRC) received 16,701 applications to challenge the Written Registry Examination for Advanced Respiratory Therapists (WRT) during 2011. To become eligible to challenge this examination, applicants must have achieved a minimum of an associate degree from a respiratory care education program accredited by the Commission on Accreditation for Respiratory Care (CoARC). Nearly 92% of these applicants earned the associate degree from approximately 385 associate degree-granting respiratory care education programs in 2011. Just over 8% of these applicants earned the baccalaureate degree from 53 baccalaureate degree-granting respiratory care education programs in 2011. The relationship between academic degree earned upon completion of a respiratory care educational program and WRT examination score is unknown.

Literature Review

Previous research identifying a positive relationship between academic degree and performance on professional examinations has been conducted from the perspectives of nursing,[1] nurse midwifery,[2] and radiation therapy.[3]

Published research has also examined the influence of factors other than academic degree upon professional examination scores or outcomes, including: age, ethnicity, years of practice, highest educational degree, highest professional academic degree, highest academic degree, marital status, and country of professional training;[2] high school class rank, SAT-verbal score, SAT-math score, and didactic course grades;[4] and previous professional training and certification.[3]

Other literature has identified a relationship between academic degree and performance on professional examinations using the analysis of subtest outcomes and scores, including a nursing research subtest;[5] a radiation therapy treatment planning subtest;[3] and radiation therapy critical thinking questions.[3]

This review of published literature did not identify specific evidence related to the research question: Do graduates of associate and baccalaureate degree-granting respiratory care educational programs differ in their performance on NBRC examinations? An unpublished paper by Shaw and Traynor identified a small but statistically significant increase in the WRT examination pass rate associated with candidate achievement of the baccalaureate degree upon completion of a respiratory care educational program, compared with that associated with candidate achievement of the associate degree (Shaw RC, personal communication, 2012). The purpose of the present study was to identify any relationship that may exist between NBRC WRT examination score and the academic degree earned upon completion of the candidate's respiratory care educational program.

Human Capital Theory describes the varying effects of "…imbedding of resources in people" upon their current and future economic returns.[6] Because Human Capital Theory recognizes the effect of educational investment on economic returns, the current study proposes to apply this theoretical lens to identify any effect of postsecondary academic degree on the potential for economic benefit represented by success with a professional board examination. Results of this study will test the following research hypothesis: After controlling for the effects of gender, age, application type, and application status, an individual who has earned a baccalaureate degree upon completion of an accredited RC educational program will achieve a higher WRT examination z-score than that achieved by an individual who has earned an associate degree upon completion of an accredited RC educational program.

Methods

This study employed ordinary least squares multiple regression to examine variables from an existing data set obtained from the NBRC.

Data

The analysis employed census data from the population of individuals who applied to challenge the NBRC WRT examination in 2011. From the original 2011 National Board for Respiratory Care data set of 34,247 cases, I limited the final sample by excluding the cases of applicants with missing data for the selected variables, by excluding the 17,546 cases of participants who applied to challenge NBRC examinations other than the WRT (the Entry Level Certified Respiratory Therapist Examination, or CRT, and the CSE), and by excluding z-score statistical outliers (23 cases). After applying these limits, the common sample included 11,677 cases.

Dependent variable. The dependent variable employed in the current study is variation in z-scores achieved on the NBRC WRT examination for the year 2011.

Raw score (number of correct item responses) on the WRT examination does not allow comparison across the multiple test forms administered during 2011, since mean and standard deviation values are similar (but not identical) among test forms. To facilitate comparison across test forms, the NBRC transforms raw scores to scaled scores. The scaled score is an index with no unit of measure. Scaled scores range from 0 to 99, with the raw cut (or passing) score for a WRT test form set equal to 70 scaled units. WRT raw scores that are less than the raw cut are transformed from 69 down to 0, and raw scores that are higher than the raw cut are linearly transformed from 71 up to 99; the scaled score transformation is not linear throughout the range of raw scores, however

Figure 1
Scatterplot of NBRC WRT Z-scores and Scaled Scores for 2011

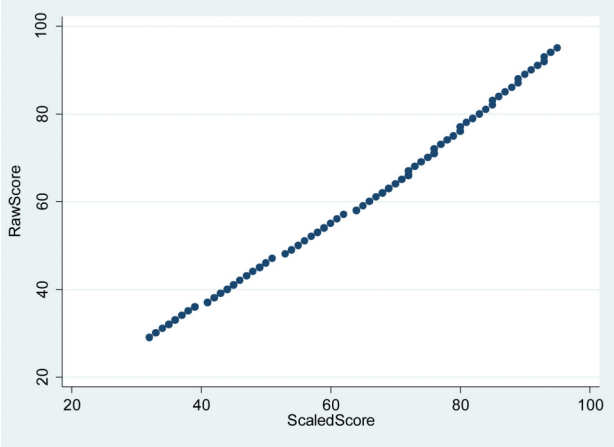
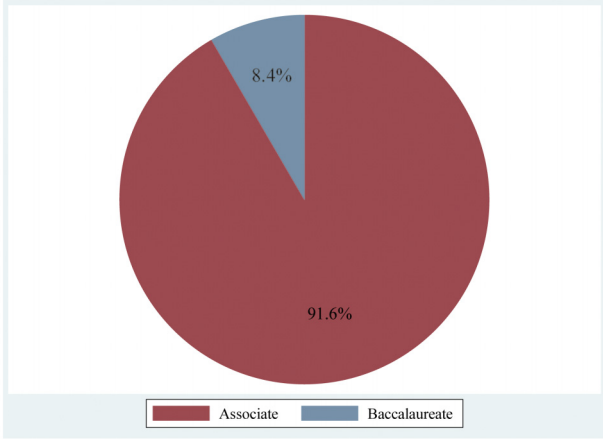


Figure 2
Academic Degree Earned Upon Completion of Respiratory Care Education Program for NBRC WRT Applicants in 2011



(see Figure 1). Finally, NBRC produced a z-score transformation of the scaled WRT scores by subtracting the mean score from the raw score, and dividing by the standard deviation of scores. These z-scores were produced using the mean and standard deviation for each test form challenged by the candidates.

Investigation of the distribution of z-scores identified the presence of low outliers. According to the NBRC, cases with very low scores are often associated with a premature end to the test after the candidate has responded to only a few test items (Shaw RC, personal communication, 2012). Twenty three cases with low z-score values that meet the standard statistical definition of an outlier (defined as 1.5 times the interquartile range) were eliminated from the study sample.[7] After removing low outliers, I generated a histogram of the interval level WRT z-scores to evaluate compliance with regression's requirement for normal distribution of data. The histogram of the WRT z-scores indicates a generally normal distribution. Regression analysis is robust to small deviations from normality when the sample size is large.[7]

Independent variable. The independent or explanatory variable is the variable whose relationship with the dependent variable this study seeks to estimate. Regression analysis will be used to analyze any effect of academic degree earned from an accredited respiratory care education program.

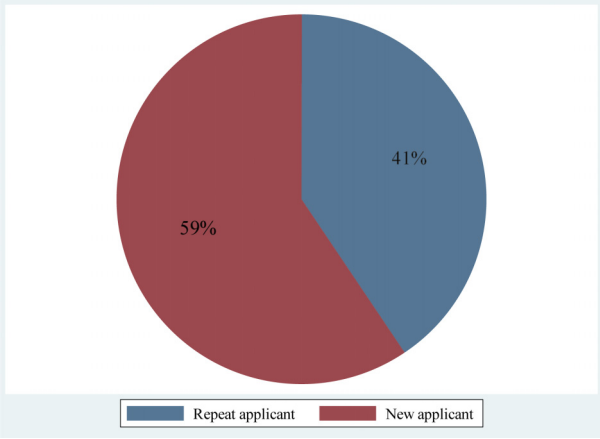
Tabulation of the degree variable indicated three categories of degree: associate (91.6% of candidates), baccalaureate (5.3%), and special certificate (3.1%). Because special certificate students were enrolled in baccalaureate programs (Shaw RC, personal communication, 2012), baccalaureate and special certificate categories are combined in the present study (see Figure 2). To facilitate regression analysis, an indicator variable was created by assigning the value of 0 to cases of people who had graduated with an Associate degree and the value of 1 to all other cases (people who had graduated with a Baccalaureate degree and people enrolled in a Baccalaureate degree-granting program who had earned a special certificate of completion).

Control variables. The control variables are the variables whose influence upon the dependent variable we seek to remove in this study: application status, application type, age, and gender.

Application status. Tabulation of application status identified two categories: new applicants (challenging the examination for the first time; 20,340) and repeat applicants (challenging the WRT examination after a failing result; 13,907) (see Figure 3). Published data indicate that 66% of new applicants and 30% of repeat applicants passed the WRT examination in 2011 (NBRC. Pass Rates Compared. NBRC Horizons: 37(4), 38(1). Available at www.nbrc.org/Pages/Credentialed-Practitioners.aspx). It is important to control for application status (new or repeat), given the significant disparity in pass rate. To facilitate analysis, an indicator variable was created by assigning the value of zero to cases of repeat applicants and the value of one to cases of new applicants.

Application type. Tabulation identifies four application categories, including applications to challenge the: Entry Level Certified Respiratory Therapist examination (CRT), WRT, CSE, and both the WRT and the CSE on the same date. No published evidence was identified to facilitate an understanding of any relationship that might exist between WRT examination scores and application type. Proceeding under an assumption that candidates who apply to challenge

Figure 3
Application Status for NBRC WRT Applicants in 2011



both the WRT and CSE on the same date may be more confident, and may score higher than candidates who apply for the WRT only, an indicator variable was created for application status by assigning the value of 0 to cases of WRT application type and the value of 1 to cases of persons applying to challenge both the WRT and the CSE on the same date (see Figure 4). Cases of persons applying to challenge the CRT and CSE examinations were recoded as missing, since they were not relevant to the current research question.

Age. No published evidence was identified to facilitate an understanding of any relationship that might exist between WRT examination score and age on the date of examination. House[8] identified significant correlations between the Graduate Record Examination (GRE) and graduate GPA, GRE-V score (GRE-verbal), and GRE-Q (GRE-quantitative) score, generally suggesting that older students perform better than predicted by their GRE score. Based on this published research regarding another standardized test administered to college-aged students, age (in days) is included in the regression model.

Graphical analysis of the age variable indicates the presence of a right (positive) skew (a larger number of younger cases). Skewed distributions are difficult to examine because most observations are confined to a small part of the range of data. This non-constant spread of the variable may be associated with a non-constant spread of the variable's error variance. A non-linear, logarithmic transformation of the age variable was performed to optimize normality of the distribution of age. This transformation attends to the assumption of normal distribution of error variance for inferential analysis.

Gender. Tabulation of the gender variable identified three categories of gender: female (67.51% of applicants), male (32.46% of candidates), and unknown (.03% of candidates). Given the relatively small percent of unknown gender cases, these were recoded as missing variables (see Figure 5).

No published evidence was identified to facilitate an understanding of any relationship that might exist between WRT examination score and gender. However, House[8] found significant correlations between the GRE and gender, generally suggesting that the GRE is a better predictor of graduate grade point average for females than for males. Based on this published research regarding another standardized test administered to college-aged students, this study assumes that gender may have some relationship with WRT examination score, and is designed to control for it. An indicator variable was created by assigning the value of 0 to females and the value of 1 to males.

Regression analysis. Analysis was completed to regress WRT z-scores on academic degree earned from an accredited

Figure 4
Application Type for NBRC Applicants in 2011

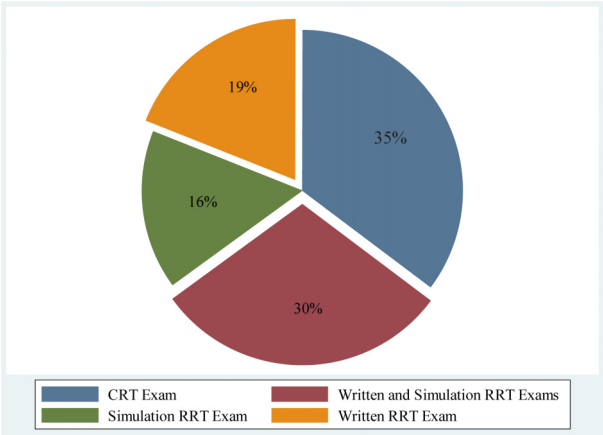


Figure 5
Gender of NBRC Applicants in 2011

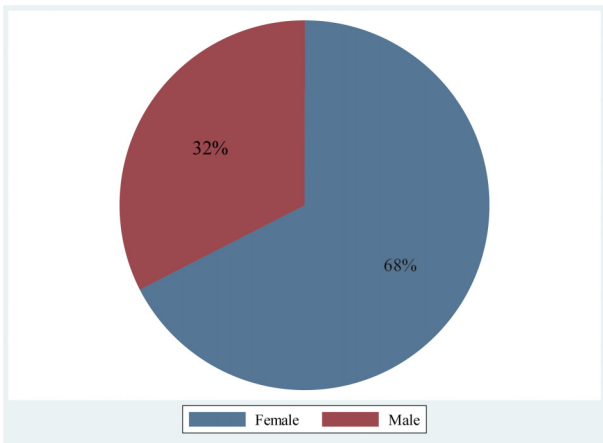


Table 1
Descriptive Statistics of Interval-level Variables among the Common Sample of 2011 National Board for Respiratory Care Applicants (N=11,677)

Variable	Mean	Standard Deviation	Minimum	Maximum
WRT z-score	.034	.984	-2.753	3.044
Age at Exam (in years)	33.005	9.206	19.436	68.545

respiratory care education program, controlling for the effects of age, gender, application status, and application type. To facilitate thorough examination of any relationship between WRT z-scores and academic degree, the regression also integrated interaction variables for degree and gender, degree and application status, degree and application type, and degree and age.

Results

The table of descriptive statistics includes the mean, standard deviation, minimum, and maximum for each of the interval level variables used in the analysis (see Table 1).

Multiple Regression Analysis, Linear Model

Model 1 regressed WRT z-scores on academic degree earned from an accredited respiratory care education program, controlling for the effects of age, gender, application status, and application type (see Table 2). The coefficient of determination (R^2) indicates that 21.3% of the variance in WRT z-score can be explained by variation in the additive effects of the independent and control variables. The root mean squared error (RMSE) indicates that a typical case deviates from its predicted value by approximately .873 z-score units.

After controlling for the effects of age, gender, application status, and application type, the unstandardized regression coefficient indicates that status of having earned a baccalaureate degree from an accredited respiratory care education program is associated with a .18 z-score unit increase in WRT examination score (range 0-99, nonlinear), on average. This is a statistically significant relationship ($p<.001$) for the population of candidates applying to challenge the WRT examination in 2011; the p value indicates that the probability of this relationship occurring by chance is less than .1%. This analysis supports the research hypothesis that the status of having earned a baccalaureate degree from an accredited respiratory care educational program is positively associated with WRT z-scores.

No hypotheses have been proposed regarding a relationship between WRT z-scores and the control variables, due to the exploratory nature of this research. Regression analysis has uncovered statistically significant relationships between WRT z-scores and the control variables, however, and these data are interpreted to inform future research. The data suggest the probability that these relationships occur by chance is less than .1%. After controlling for degree, gender, application status, and application type, a one unit increase in the log of age on the date of examination is associated with a .401 unit decline in WRT z-scores, on average. Controlling for degree, age, application status, and application type, male gender is associated with a .195 unit increase in WRT z-scores, on average. Status as a first time WRT applicant is associated with a .533 unit increase in WRT z-score, on average, after controlling for degree, age, gender, and application type. Challenging both the WRT and the CSE on the same date is associated with a .377 unit increase in WRT z-scores, on average, after controlling for degree, age, gender, and application status.

Table 2
Results of Ordinary Least Squares Regression Predicting WRT Z-Score (N=11,677)

Independent Variables	Unstandardized Coefficient (b)	Robust Standard Error
Degree	.181***	.030
Log of Age at Exam	-.401***	.032
Gender	.196***	.018
Application Status	.533***	.020
Application Type	.377***	.020
Constant	3.241***	.299
R^2	.213	
RMSE	.873	

****p<.001; All except degree are two-tailed tests.*

Multiple Regression Analysis, Interaction Models

To facilitate thorough examination of the relationship between academic degree earned from an accredited respiratory care education program and WRT z-scores, regression was also completed using the serial application of interaction variables for degree and gender (model 2), degree and application status (model 3), degree and application type (model 4), and degree and age (model 5). After controlling for the effects of all variables of interest, regression coefficients for each model indicate that there is no statistically significant relationship between the any of the interaction variables and WRT z-score (see Table 3). Particular caution should be exercised with regard to interpretation of the coefficient on degree estimated by model 5, because the model integrates an interaction using

Table 3
Results of Ordinary Least Squares Regression Predicting WRT Z-score (N=11,677)

	Model 1	Model 2	Model 3	Model 4	Model 5
Independent Variables	**Unstandardized Coefficient (b)**	**Unstandardized Coefficient (b)**	**Unstandardized Coefficient (b)**	**Unstandardized) Coefficient (b)**	**Unstandardized Coefficient (b)**
Independent variables					
Degree	.181*** (.030)	.183*** (.035)	.141** (.050)	.168*** (.043)	2.224* (1.298)
Log of Age at Exam	-.401*** (.032)	-.401*** (.032)	-.401*** (.032)	-.401*** (.032)	-.390*** (.033)
Gender	.195*** (.018)	.196*** (.018)	.195*** (.018)	.195*** (.018)	.196*** (.018)
Application Status	.533*** (.020)	.533*** (.020)	.528*** (.021)	.533*** (.020)	.532*** (.020)
Application Type	.377*** (.020)	.377*** (.020)	.377*** (.020)	.374*** (.021)	.377*** (.020)
Interactions					
Degree*Gender	—	-.007 (.064)	—	—	—
Degree*Application Status	—	—	.062 (.061)	—	—
Degree*Application Type	—	—	—	.026 (.058)	—
Degree*Age	—	—	—	—	-.222 (.141)
R^2	.213	.213	.213	.213	.213
RMSE	3.241	3.240	3.243	3.242	3.136

**p<.10; **p<.01; *** p<.001; All except degree are two-tailed tests.*
Note: Robust standard errors are in parentheses.

an interval-level variable (log age) rather than the categorical indicator variables employed in models 2-4, and because the coefficient on degree in model 5 estimates the effect on WRT z-scores for persons at an age (one day old) that is far outside the range of the age identified within the data set.

Discussion

The purpose of this study was to identify any relationship that may exist between WRT score and the academic degree earned upon completion of the candidate's respiratory care educational program. This study tested the hypothesis that people who have earned a baccalaureate degree upon completion of an accredited RC educational program will achieve higher WRT examination scores, on average, than those achieved by people who have earned an associate degree upon completion of an accredited RC educational program. Data employed for this analysis represents the entire population of individuals (11,677) who applied to challenge the NBRC WRT examination in 2011, and might be expected to support inferences regarding future WRT examination attempts. Results from this regression analysis provide evidence in support of the research hypothesis: Persons who have earned a baccalaureate degree upon completion of an accredited RC educational program achieve WRT examination z-scores that are .18 z-score units higher (on average) than those achieved by persons who have earned an associate degree upon completion of an accredited RC educational program, after controlling for the effects of gender, age, application type, and eligibility status.

This finding is consistent with a similar study by Raymond and Washington,[3] who compared test scores of candidates with associate and baccalaureate degrees on the American Society of Radiologic Technologists Examination in Radiation Therapy. Raymond and Washington found that the mean total scaled score achieved by candidates with an associate degree is lower (by .26 standard deviation) than that of candidates with a baccalaureate degree.

Results from the present study are also consistent with findings identified by Fullerton and Severino.[2] Fullerton and Severino regressed total z-score for the American College of Nurse-Midwives Certification Examination on academic level of the nurse-midwifery education program, finding that average certificate examination z-scores of candidates from pre-certificate programs were lower than certificate (.383), master's degree (.360), and doctorate programs (1.321).

Raymond[1] also found consistently positive and statistically significant effect sizes (corresponding to z-scores) associated with achievement of a higher academic degree (baccalaureate compared with pre-baccalaureate, .433; master's compared with baccalaureate, .334; and master's compared with pre-baccalaureate, .808) on mean scores for 12 different examinations administered by the American Nurses Association.

Results of the present study differ from those of the National Council of State Boards of Nursing (as cited in Raymond[1]) who report lower scores on the National Council

Licensure Examination for Registered Nurse Licensure (NCLEX-RN) for graduates of baccalaureate degree granting nursing programs compared with scores for graduates of associate degree granting nursing programs. Raymond suggests that the NCLEX-RN licensure examination may be ideally suited for identifying basic competencies taught by associate degree granting nursing programs, a conclusion which is supported by Woodham and Taube.[4]

Limitations

The present study included WRT z-scores as the sole dependent variable. The use of the WRT as an indicator of the benefit associated with achievement of a college degree is justified because a passing score on the examination serves as an objective measurement of "…essential knowledge, skills, and abilities required of advanced respiratory therapists" (http://www.nbrc.org/Pages/RRT.aspx, *Accessed April 30, 2012*). McMillan[5] identified a statistically significant association between baccalaureate degree (compared to associate degree) and score only for the research subtest of the Professional Performance Examination for nursing students, and suggested that other subtests of the examination were not sensitive enough to detect differences between the two groups, or that differences between the two groups were not significant in those areas. Similarly, the WRT may not be sufficiently sensitive to evaluate other competencies essential to the development of a respiratory therapist, such as effective written and verbal communication and the ability to review and critique published research[9,10] which may be facilitated by the achievement of an associate or baccalaureate degree. Because the present study employs WRT z-scores as the sole dependent variable, the dependent variable is subject to limitations of evidence associated with the validity of WRT examination scores.

For the common sample employed in the present analysis, the proportion of individuals challenging the WRT examination after earning an associate degree (10,688) is approximately 11 times larger than the proportion of individuals challenging the examination with a baccalaureate degree (989). This significant disparity in category size has the potential to increase the standard error associated with the regression coefficients, and will reduce the likelihood of achieving statistical significance. The large number of cases in the current study serves to offset this effect, however. Z-scores within the common sample have similar ranges (associate degree 5.79 and baccalaureate degree 5.34) and standard deviations (associate degree .98 and baccalaureate degree .96).

The current study employs data from a single year and from a single subset of examination candidates. While the data are recent, it is unknown if the relationships identified among the 2011 data represent consistent relationships across a larger time period. Generalization of the findings of this study to other years and to other examination candidates may not be valid.

The ability to infer causal influence from a particular college degree on WRT score is limited by the present study's non-experimental, retrospective analysis of archival data.[1,2] Any difference in WRT z-scores associated with achievement of an associate or baccalaureate degree may be attributable to factors (such as individual economic considerations) that are distinct from those associated with the curriculum. Though it is not practically or ethically feasible to randomly assign a population of students to associate- or baccalaureate-degree granting respiratory care educational programs, the inevitable self-selection bias confounds meaningful conclusions regarding the explanatory effect of academic degree.[3]

Conclusion

The status of having earned a baccalaureate degree upon completion of an accredited respiratory care education program is associated with a statistically significant gain ($p<.001$) in WRT z-score, though the coefficient for the effect is small.

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Inter-rater Reliability of a Respiratory Therapy Preceptor Training Program

Crystal Dunlevy, EdD, RRT, RCP

Sarah Varekojis PhD, RRT, RCP

Georgianna Sergakis, PhD, RRT, RCP

Abstract

BACKGROUND: While most respiratory therapy (RT) programs rely heavily on the preceptor model to provide clinical education, there is currently no standardized training program for clinical preceptors. New accreditation standards issued by the Commission on Accreditation for Respiratory Care (CoARC) in June 2010 mandated that RT programs provide evidence of inter-rater reliability among preceptors who perform student evaluations. The purpose of this study was to develop a standardized clinical preceptor training program that can be used by RT programs in preparing instructors to deliver effective clinical education and meet CoARC requirements. **METHODS:** The authors developed Clinical PEP (Practices of Effective Preceptors), a preceptor training program comprised of three modules (short PowerPoint presentations with scripted notes and videos illustrating both ineffective and effective implementation of module topics). Modules were evaluated in two rounds by RT preceptors (12 and 33, respectively) at Wexner Medical Center at The Ohio State University. Three experienced RT educators individually evaluated and categorized preceptor responses in order to determine consensus estimates of inter-rater reliability based on percentage agreement. **RESULTS:** RT preceptors evaluated eight videos and identified 29 ineffective behaviors. Inter-rater reliability was excellent for 20 behaviors (69%) and good for 9 behaviors (31%). **CONCLUSIONS:** The study revealed that the Clinical PEP training program has a high degree of inter-rater reliability. Further, this preceptor training program could be used nationally to fulfill an important RT education program accreditation requirement.

Key Words: clinical education, preceptor education, inter-rater reliability, preceptor training

Crystal Dunlevy, EdD, RRT, RCP
Clinical Associate Professor
The Ohio State University, College of Medicine, School of Health & Rehabilitation Sciences, Respiratory Therapy Division, Columbus, OH

Sarah Varekojis PhD, RRT, RCP
Clinical Assistant Professor
The Ohio State University, College of Medicine, School of Health & Rehabilitation Sciences, Respiratory Therapy Division, Columbus, OH

Georgianna Sergakis, PhD, RRT, RCP
Clinical Assistant Professor, The Ohio State University, College of Medicine, School of Health & Rehabilitation Sciences, Respiratory Therapy Division, Columbus, OH

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Class of 2011 – Lufta Bana RRT, Jacob Beach, Amanda Gradert RRT, Raimie Lewis RRT, Kathleen Stark RRT and Carlton Stewart RRT
Class of 2012 – Grace Leisenheimer RRT, Amanda Smith RRT and Brie Van Der Griend RRT

Correspondence and Request for Reprints:
Crystal Dunlevy, EdD, RRT, RCP
Clinical Associate Professor
The Ohio State University
School of Health & Rehabilitation Sciences, Respiratory Therapy Division
453 W. Tenth Avenue, 306 Atwell Hall
Columbus, OH 43210

Introduction

Although most respiratory therapy (RT) programs rely heavily on the preceptor model to provide clinical education, there is currently no standardized training program for clinical preceptors. This lack of standardized training may result in inconsistent and/or substandard education of respiratory therapy students in the clinical setting. Results of a 2004 study by Rye, Boone, and Neal-Rice underscored the importance of the clinical preceptor in the education process, concluding that the relationship between student and preceptor is the foundation of the RT clinical learning experience.[1] Further, accreditation standards issued by the Commission on Accreditation for Respiratory Care (CoARC) in June 2010 mandated that respiratory therapy programs "develop processes that facilitate the development of inter-rater reliability among those individuals who perform student clinical evaluations."[2]

According to CoARC standards, one way for RT programs to demonstrate compliance is to have clinical preceptors complete appropriate training – a strategy that has been effective in the nursing profession. A 2000 study conducted by Kaviani & Stillwell assessed the effectiveness of a 100-hour long preceptor program for clinical nurse educators.[3] The authors identified an overwhelming need for preceptor preparation due to the positive impact that the program has on student learning. Another study conducted in 2009 by Gross-Forneris and Peden-McAlphine reported that preceptors who had completed preceptor training were better able to develop critical thinking skills in their students.[4]

A study performed by Patrick, Rye, and Kennedy showed wide variation in evaluation of respiratory therapy students by clinical preceptors.[5] During the 2007 AARC Summer Forum, respiratory care educators attended a session entitled, "A Method of Evaluating Inter-rater Reliability" where they participated in a mock preceptor training session. Participants were asked to identify which of the 28 DataArc Nasal Cannula competency tasks were critical for demonstrating competency. Participants lacked agreement as to which DataArc items were "critical," leading the authors to conclude that, "… student assessment is based on educator preference and not on accepted standards of procedure performance." This study demonstrated a need for standardized training in student evaluation so that it is done correctly and consistently.

Both RT hospital managers and directors of RT education programs agree that standardized preceptor training is needed in order to provide students with comparable clinical experiences. In 2009, Rye and Boone surveyed respiratory therapy program directors about clinical preceptor training. One-third of the respondents indicated that no training was provided to preceptors. Training that was provided for the remaining two-thirds varied from one hour to six weeks. Eighty-one percent of directors responded that they believed a standardized training program is needed by the profession.[6] Barriers to provision of training were identified by RT program directors and included lack of time or resources or both; lack of incentives for participants; lack of a training curriculum; and staffing shortages that would prevent preceptors from completing the program. A similar study by the authors that surveyed respiratory therapy hospital department managers produced nearly identical findings (one-third of clinical preceptors did not receive any formal training; 79% reported a need for a standardized training program).[7]

The CoARC accreditation requirement for preceptor training, coupled with the findings described above, indicates the need for a standardized RT clinical preceptor training program. RT programs typically satisfy the CoARC inter-rater reliability requirement by having preceptors watch videos of RT students completing checklists, and comparing their assessments. But, inter-rater reliability is defined as, "the consistency with which two or more raters evaluate the same data using the same criteria."[8] Therefore, clinical preceptors can demonstrate a high or a low degree of inter-rater reliability by evaluating student or preceptor performance – the key component is the evaluation of performance. The purpose of this study was to develop a standardized preceptor training program with a high degree of inter-rater reliability that could be completed in a reasonable amount of time either on site or online.

Methods

Based upon a review of medical and educational research and input from RT students, educators and hospital-based preceptors at The Ohio State University (OSU), the authors identified topics to be included in the preceptor training program. These topics were further organized into the following modules: Principles of Adult Learning; Remember What It's Like; and Evaluation and Feedback. The "Principles of Adult Learning" module addresses the issues of autonomy, self-direction, the value of students' life experiences, and the importance of creating learning experiences that are relevant and practical; "Remember What It's Like" stresses the importance of support and supervision while providing many opportunities for practice; "Evaluation and Feedback" focuses on defining evaluation criteria early in the student's clinical rotation and providing feedback that is honest, descriptive, and prompt. Each module consists of a PowerPoint presentation with scripted notes and short videos depicting ineffective and effective preceptors demonstrating the behaviors introduced in the presentation.

RT students and faculty at OSU composed scripts for eight different scenarios and filmed and edited 16 videos (eight videos with the ineffective preceptor and eight with the ef-

fective preceptor) over the course of two years. In all there were 23 PowerPoint slides, and viewing time for the 16 videos was less than 30 minutes.

An online course was created through OSU's online learning management system that OSU preceptors could access at any time. The training program was entitled "Clinical PEP: Practices of Effective Preceptors." OSU preceptors were asked to review each module's PowerPoint presentation and notes, watch the accompanying ineffective videos, record errors made by the ineffective preceptor in each one, and view the parallel effective preceptor videos to see the mistakes corrected.

Three RT educators with a combined 60 years of experience in RT education individually evaluated and categorized preceptor responses in order to produce a complete list of ineffective behaviors. Consensus estimates of inter-rater reliability were determined by percentage agreement. The two most common ways to measure inter-rater reliability are percent of agreement and correlation – the authors chose percent of agreement over correlation because it is conceptually simpler and easier to calculate. For percentage agreement, the agreement rate (A) was the observed agreement (O) divided by the possible agreement (P). Therefore A=O/P.[9]

Results

"Principles of Adult Learning" and "Evaluation and Feedback" modules were created during the first year and evaluated by 12 preceptors. These modules included five videos portraying an ineffective preceptor; participants identified 20 ineffective behaviors. The "Remember What It's Like" module, created a year later, added three ineffective preceptor videos and was evaluated by 33 RT preceptors along with the existing modules. Twenty-nine ineffective behaviors were identified in this final version.

Consensus estimates of inter-rater reliability for each ineffective behavior was determined by percentage agreement and categorized as excellent (80 – 100%), good (60 – 79%), moderate (40 – 59%) or slight (20 – 39%).[10] Inter-rater reliability was classified as excellent for 20 behaviors (69%) and good for 9 behaviors (31%). Table 1 summarizes the ineffective behaviors identified by the RT clinical preceptors and the inter-rater reliability for each behavior as determined by percentage agreement.

Conclusions

Prior to the new CoARC standards (June 2010), RT education programs were not required to demonstrate evidence of inter-rater reliability among preceptors in order to obtain or maintain accreditation. Therefore, the medical literature lacks studies on the subject of inter-rater reliability among RT clinical preceptors.

Table 1
Inter-rater Reliability of RT Preceptor Behaviors.

Ineffective Behavior	Preceptor Agreement (%) = 45 unless otherwise indicated
VIDEO: LABELING (Adult Learning)	
Used electronics (cell phone)	92
Appeared uninterested & condescending	70
Gave minimal/poor direction	100
Assigned student a task that was not relevant	84
VIDEO: IPPB TREATMENT (Adult Learning)	
Annoyed to be assigned student; condescending	75
Gave minimal/poor direction	98
Did not review patient condition/indications for therapy, set-up, or operation of IPPB machine	92
Did not answer questions	100
Provided no supervision during treatment	92
VIDEO: MDI Instruct (Adult Learning)	
Appeared hurried and condescending	100
Did not value/acknowledge student's experience/input	92
Provided incomplete and incorrect instruction	92
VIDEO: O_2 Set-Up (Remember What It's Like)	
Embarrassed student for asking a question; condescending	100 (n=33)
Focused on a minor detail that the student missed vs. providing positive reinforcement for correct behaviors	87 (n=33)
Refused to allow the student to perform the task	92 (n=33)
VIDEO: Cardiac Output (Remember What It's Like)	
Made the student feel unprepared and ignorant	100 (n=33)
Interrupted the student	75 (n=33)
Quizzed the student with rapid-fire questions without providing answers/explanations	92 (n=33)
Did not review any aspect of the task, dismissing the student and performing the task herself	75 (n=33)
VIDEO: RT as Career Choice (Remember What It's Like)	
Caused students to feel badly about their career choice	75 (n=33)
Made derogatory comments about the RT profession	92 (n=33)
VIDEO: Performance Evaluation (Evaluation & Feedback)	
Began session with a negative comment	75
Did not provide an explanation for "bad attitude"	84
Waited too long to address the problem	75
Did not solicit feedback from other preceptors	92
VIDEO: Feedback (Evaluation & Feedback)	
Did not provide review, instruction or guidance re: procedure	75
Corrected student in front of patient	100
Embarrassed student	84
Did not instruct student on how to improve	75

The Clinical PEP program has been transferred to DVD and consists of the three modules described above as well as a workbook where preceptors can record their results and compare their answers with the answer key provided in the workbook. Clinical PEP can be completed online or offered on site, all at once or in sessions. Because the entire program can be completed in approximately two hours, it may serve as a convenient and cost-effective alternative to traditional clinical preceptor training.

Future research should be conducted to evaluate the training program in terms of both quality and effectiveness.

Based upon the high degree of inter-rater reliability produced by the Clinical PEP Training Program, our project may serve as the foundation for a standardized clinical preceptor training program that could be used nationally to fulfill an important RT education accreditation requirement.

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Respiratory Therapy Orientation and 2015 and Beyond Competency Assurance for Clinical Staff in Acute Care Hospitals

Kimberly Hehman, MS, RRT

F. Herbert Douce, MS, RRT-NPS, RPFT, FAARC

Sarah M. Varekojis, PhD, RRT

Abstract

Introduction: Orientation and competency assurance of new staff therapists are vital responsibilities of hospital employers to ensure safe and effective care for patients. There is a lack of research available that effectively describes the current state of respiratory therapy department orientations. The purposes of this study were to describe how respiratory therapy departments structure their new staff therapist orientation programs and to determine which competencies outlined in the AARC's 2015 and Beyond initiative are verified during orientation. **Methods:** We used the members of the AARC's Management and Education Sections and electronic survey research methods to assess clinical respiratory therapy staff orientation structure and implementation. The survey included demographics and 36 of the 69 competencies considered universally job-related for clinical staff. We compared average hours of orientation among hospital types, sizes, and locations. **Results:** Three hundred and twenty six respondents met inclusion criteria and provided data, which included hospital type, size, and location. There were no statistically significant differences in mean hours of department orientation (P = 0.758), precepting hours (P = 0.113), or total orientation hours (P = 0.337) between academic/teaching and community hospitals. There was a statistically significant difference in mean orientation hours between associate degree respiratory therapy graduates and baccalaureate degree respiratory therapy graduates (P = .002). Twenty-eight of the 36 competencies were assessed by greater than 75% of respondents. Statistically significant differences were found in competency assurance for both location and hospital type for several competencies. **Conclusions:** Orientation programs for newly hired staff therapists were approximately 200 hours in length. RT orientation programs currently assess competency for most of the areas included in the survey, indicating employers deem them relevant. Orientations may require more time in the future as RT evolves into the model described in the 2015 and Beyond publications.
Key Words: Respiratory therapist, respiratory care practitioner, orientation, training, competency assurance.

Kimberly Hehman, MS, RRT
Manager, Respiratory Therapy
Berger Hospital, Circleville, OH

Sarah M. Varekojis, PhD, RRT
Assistant Professor of Clinical Allied Medicine
The Ohio State University, College of Medicine, School of Health and Rehabilitation Sciences, Respiratory Therapy Division, Columbus, OH

F. Herbert Douce, MS, RRT-NPS, RPFT, FAARC
Associate Professor Emeritus
The Ohio State University, College of Medicine, School of Health and Rehabilitation Sciences, Respiratory Therapy Division, Columbus, OH

Correspondence and Request for Reprints:
Sarah M. Varekojis, PhD, RRT
The Ohio State University
School of Health and Rehabilitation Sciences
453 W. 10th Ave.
431 Atwell Hall
Columbus, OH 43210

Introduction

Education of respiratory therapists does not end at commencement from a CoARC-approved program. Orientation and competency assurance of new staff therapists are vital responsibilities of hospital employers to ensure safe and effective care for patients. Standards for orientation and competency assurance are set by The Joint Commission (www.jointcommission.org, Accessed August 2011), but each individual hospital defines orientation and competency assessments for required job duties. Orientations for new staff therapists can be costly components of personnel budgets. Over a decade ago, one large urban teaching hospital described orientation of new staff therapists as a three week program.[1] More recently, the American Association for Respiratory Care (AARC) initiated a taskforce that determined entry-level competencies therapists must possess in the near future.[2] The AARC is currently determining how to advance the profession through modifications to the educational system, and how to better equip the future workforce to acquire the needed competencies. Orientation and competency assurance programs conducted by hospital employers may supplement educational programs to this end.

In order to better develop new staff therapist orientation programs that verify competencies more effectively, it is important to describe current orientation practices in the profession. Nursing literature is useful for comparison since nursing and respiratory therapy share many professional similarities. However, there is a lack of research that effectively describes the current state of respiratory therapy department orientation programs, including the average duration of orientations, circumstances that modify orientations, and similarities among hospital types, sizes, and locations.[3,4]

The purposes of this study were 1) to describe how respiratory therapy departments structure their new staff therapist orientation programs, 2) to determine which competencies outlined in the AARC's 2015 and Beyond initiative are verified during orientation, and 3) to determine if orientation and competency assurance programs differ by hospital type, size, and location.

Methods

We used an electronic survey research method to assess clinical respiratory therapy staff orientation structure and implementation. We sent the survey invitation email to 2,907 members of the AARC's Management and Education Sections. These sections include the target population of respiratory therapy directors, managers, and hospital educators within the United States. The invitation included a request for the recipient to forward the survey to the individual in the department responsible for new employee orientation. A follow-up email was sent to the participants three weeks later as a reminder to complete the online survey by the deadline. After the deadline, surveys not completed were considered non-respondents. A firewall issue prevented some participants from accessing the online survey format. These individuals were asked to complete hard copies of the survey and they either faxed or emailed the completed survey to the researchers.

Survey questions included demographics for hospital type, location, and size; department organization; time spent in orientation; topics of the orientation program related to the competencies identified in the AARC's 2015 and Beyond initiative; and methods of presentation and evaluation. All seven of the major competency areas described by 2015 and Beyond participants were represented, which included 36 of the 69 competencies which we considered universally job-related for clinical staff and the skills likely to be assessed during orientation. The survey options for methods of presentation and assessment included patient simulator, computer based clinical simulator, written test, oral test, and observation of performing procedures. A field test was completed to test the validity of the survey instrument. Field test feedback was used to determine the average time required to complete the survey and to ensure that survey questions were understandable.

We used statistics software (SPSS 17.0, SPSS, Chicago, IL) for statistical analysis. Paired and independent t-tests were used to determine differences among hospital types and orientation hours. The frequency of assessment of the 2015 competencies that had greater than 10% differences between location and type of hospital were analyzed using a chi-square test for independence. The alpha level was set at a priori at 0.05.

Results

Four hundred forty-nine respondents accessed the online survey; 326 met inclusion criteria and provided useful data. One hundred thirty-eight (41%) of respondents described their hospital location as urban, 100 (31%) as suburban, and 88 (27%) as rural. The respondents' mean hospital size was 337 beds ± 260. All nine of the American Hospital Association (AHA) regions were represented in the respondents. Two hundred forty-five (82%) of the respondents described their departmental organization as centralized; whereas 30 (9%) described it as partially decentralized, and 22 (7%) as decentralized. Twenty-nine respondents did not describe their organization.

Table 1 presents the distribution of responding hospitals and orientation hours for new clinical staff therapists. Orientation programs for newly hired staff therapists were approximately 200 hours long. The variability in orientation times is noteworthy. There was no statistical difference in mean hours of department orientation (P = 0.758), precepting hours (P = 0.113), or total orientation hours (P = 0.337) between academic/teaching and community hospitals. Chil-

Table 1
*Orientation hours for hospital types and education type. *Children's hospitals not included in t-test analysis.*

	Academic/ Teaching (n = 84)	Community (n = 160)	Children's (n = 13)	*P*	Associate (n = 255)	Baccalaureate (n = 255)	*P*
Department orientation time, mean ± SD, hrs	83.0 ± 90.3	86.9 ± 97.8	55.1 ± 58.0	0.758*			
Precepting time, mean ± SD, hrs	141.4 ± 147.7	109.2 ± 185.2	171.1 ± 180.0	0.113*			
Total orientation time, mean ± SD, hrs	224.3 ± 185.0	196.1 ± 237.2	226.2 ± 195.7	0.337*	180.4 ± 195.2	173.4 ± 193.5	0.002

dren's hospitals were not included in the analysis due to the small number included in the sample (n = 13). There was a statistically significant difference (P = .002) between total orientation hours for associate degree respiratory therapy graduates (mean 180.4 SD 195.2) and baccalaureate degree respiratory therapy graduates (mean 173.4 SD 193.5).

Respondents were asked to indicate commonly used methods to assess proficiency for 36 of the 69 competencies defined by 2015 and Beyond participants. Competencies associated with BLS, ACLS, PALS, and NRP were most frequently assessed with a written test. All other competencies were most frequently assessed with a competency check-off form. Twenty-eight of the 2015 and Beyond competencies were assessed by more than 75% of respondents. The critique of published research, application of sleep study results to types of sleep disorders, description of health care and financial reimbursement systems, and interpretation of PFT results were least frequently assessed during orientation—assessed by only 15.1-44% of respondents. Many respondents included the description of bronchoscopy procedure, performance of endotracheal intubation, interpretation of lab results, and performance of basic spirometry, with assessment frequencies ranging from 51.2-70.2% (Table 2).

Several significant differences existed in frequency of competency assessment based on location of the hospital. Interpretation of PFT results, application of sleep study results to

Table 2
2015 and Beyond competencies assessed in hospital locations and types.

2015 and Beyond Competency	Topic Assessed	Assessment using "Check-off"*	Suburban (n=100)	Urban (n=138)	Rural (n=88)	*P*	Academic Teaching (n=98)	Community (n=181)	*P*
Diagnostics									
Perform basic spirometry (n=299)	210 70%	208 69%							
Relate results of sleep studies to types of sleep disorders (n=291)	44 15%	36 12%	17 17%	31 23%	32 36%	.008			
Describe the bronchoscopy procedure & RT's role (n=297)	169 57%	162 55%	67 67%	92 67%	40 45%	.002	71 71%	108 58%	.025
Perform arterial puncture and sampling (n=298)	282 95%	276 93%							
Chronic & Acute Disease Management									
Explain pathophysiology, dx, tx of respiratory diseases (n=299)	227 76%	193 65%							
Develop, administer & reevaluate care plans (n=294)	240 82%	222 76%					84	135	.116

(continued on next page)

Table 2 Continued

2015 and Beyond competencies assessed in hospital locations and types.

2015 and Beyond Competency	Topic Assessed	Assessment using "Check-off"*	Suburban (n=100)	Urban (n=138)	Rural (n=88)	*P*	Academic Teaching (n=98)	Community (n=181)	*P*
Evidence-Based Medicine & Respiratory Care Protocols									
Apply evidence-based medicine to clinical practice (n=300)	226 75%	204 68%					84%	73%	
Apply protocols for ICU patients (n=297)	253 85%	238 80%	91 91%	124 89%	68 76%	.004	95 95%	157 85%	.002
Apply protocols for non-critical patient (n=297)	254 86%	240 81%							
Critique published research (n=294)	45 15%	36 12%					32 32%	34 18%	.044
Assessment									
Complete a pt assessment through physical examination (n=298)	273 92%	268 90%							
Interpret PFT results (n=293)	129 44%	105 36%	46 46%	60 44%	57 64%	.007			
Interpret ABG results (n=297)	269 91%	226 76%							
Interpret lab results (n=297)	180 61%	151 51%					72 72%	109 59%	.135
Measure vital signs (n=299)	263 88%	255 85%							
Evaluate patient's WOB (n=299)	273 91%	265 89%							
Leadership									
Demonstrate effective written & verbal communication skills (n=297)	230 77%	206 69%							
Describe health care & financial reimbursement systems and the need for reducing costs of delivering health care (n=298)	89 30%	62 21%	32 32%	42 30%	44 49%	.009			
Emergency & Critical Care									
Perform BLS, ACLS, PALS, NRP as required by position (n=298)	290 97%	228 75%							
Perform endotracheal intubation (n=297)	152 51%	136 46%							
Perform as a member of rapid response team (n=297)	263 89%	249 84%	93 93%	127 92%	73 82%	.022			
Provide intra-hospital transport of critically ill patients maintaining airway control (n=299)	268 90%	262 88%							
Describe basic critical care pharmacology (n=294)	238 81%	189 64%							

(continued on next page)

Table 2 Continued
2015 and Beyond competencies assessed in hospital locations and types.

2015 and Beyond Competency	Topic Assessed	Assessment using "Check-off"*	Suburban (n=100)	Urban (n=138)	Rural (n=88)	*P*	Academic Teaching (n=98)	Community (n=181)	*P*
Apply invasive mechanical ventilation (n=293)	288 98%	283 97%							
Apply noninvasive mechanical ventilation (n=298)	295 99%	292 98%							
Interpret ventilator data (n=297)	280 94%	257 86%							
Interpret hemodynamic monitoring data (n=298)	190 64%	170 57%	68 68%	100 72%	51 57%	.058	77 77%	115 62%	.083
Use of therapeutic medical gases in treating critical patients (n=299)	253 85%	242 81%	89 89%	125 90%	67 75%	.003	93 93%	149 81%	.019
Therapeutics & Applications									
Evaluate various therapies (i.e. adverse effects, effectiveness) (n=299)	291 97%	274 92%							
Provide humidity therapy (i.e. HMEs, heated humidifiers) (n=298)	289 97%	282 96%							
Provide medical gas therapy (i.e. NO, He) (n=299)	235 79%	230 77%	81 81%	125 90%	57 64%	.000	95 95%	133 72%	.000
Provide aerosol therapy (i.e. medication, bland) (n=299)	293 98%	289 97%							
Perform hyperinflation therapy (i.e. incentive spirometer, CPAP, IPPB) (n=299)	295 99%	292 98%							
Perform bronchial hygiene therapy (i.e. IPV, cough-assist) (n=299)	289 97%	287 96%							
Perform airway management (i.e. trach care, sxn) (n= 299)	295 99%	288 96%							
Provide mechanical ventilation (i.e. CPAP, BIPAP) (n=296)	293 99%	290 98%							

sleep disorders, and description of health care and financial reimbursement systems were more frequently assessed in rural hospitals, whereas provision of medical gas therapy (i.e. INO, HeO_2) was more frequently assessed in urban hospitals, and description of bronchoscopy procedures and application of ICU protocols were more frequently assessed in suburban hospitals. Both suburban and urban hospitals assessed the description of a respiratory therapist's role in rapid response teams and the provision of therapeutic gasses in treating critical patients more frequently than rural hospitals. The only other competency with more than a 10% difference among hospital locations was the interpretation of hemodynamic data; however the difference was not significant (Table 2).

Comparisons among types of hospitals indicate that description of bronchoscopy procedure, application of ICU protocols, critique of published research, provision of therapeutic gasses in treating critical patients, and provision of medical gas therapy (i.e. INO, HeO_2) are all more frequently assessed in academic hospitals than in community hospitals. While application of evidence based medicine to clinical practice, interpretation of lab results, and interpretation of hemodynamic monitoring data all had a greater than 10% difference between

the type of hospital, none of those differences in frequency of assessment were statistically significant (Table 2).

Discussion

This survey was given to individuals responsible for conducting new staff therapist orientation at hospitals. The distribution of respondents included all locations and types of hospitals, as well as respondents from all AHA regions. Although children's hospitals represented only 4% of respondents, this is possibly a reflection of the population. The mean number of hours spent orienting newly hired staff therapists varied widely, which may mean orientations are flexible and individualized. Nursing literature describes the orientation time frame as "negotiable" based on the individual and experience. Nursing orientation timeframes were usually reported as requiring 12 weeks plus additional time for specialized areas such as pediatrics or cardiology.[4] Even though there was a statistically significant difference in mean orientation hours between AS and BS graduates, the seven additional hours for AS graduates do not likely represent a practically important difference. Although RTs in academic hospitals and community hospitals may differ in their scopes of services, this does not appear to affect the number of hours spent in orientation.

RT orientation programs currently assess most of the 2015 and Beyond competencies. The seven major 2015 and Beyond competency categories were represented in orientation content, and 28 of the 36 competencies were assessed by more than 75% of respondents. In addition, mean orientation hours across all hospital types represented approximately 5-6 weeks of total orientation, indicating that competency assurance during orientation of new employees is comprehensive.

Three of the four topics assessed by 51.2-70.2% of respondents may reflect facility-specific scopes of practice, including the description of bronchoscopy procedure, and the performance of endotracheal intubation and basic spirometry. However, the interpretation of lab results, assessed by 61% of respondents, would seem to have universal applicability to all respiratory therapists (Table 2). It is possible that orientation coordinators simply assume graduate respiratory therapists possess this competency, but this may be an area of potential improvement. Several of the 2015 and Beyond topics were only assessed by a relatively small number of respondents, including the critique of published research, application of sleep study results to types of sleep disorders, the description of health care and financial reimbursement systems, and interpretation of PFT results (Table 2). These topics represent areas to which RT department orientation coordinators may need to devote more time as the practice of respiratory therapy evolves into the model described in the 2015 and Beyond publications.[1]

Limitations

This survey collected data on orientation practices in respiratory therapy departments in acute care hospitals in the United States. The target population was orientation coordinators; however, there is no complete listing of these individuals. The use of the AARC's Management and Education Section discussion lists to recruit participants may have inadvertently excluded potential respondents. Although we invited 2,907 to participate in the survey and only 326 were included, the number of acute care hospitals with a respiratory therapy department orientation coordinator is unknown, making an overall survey response rate unknown. The 2015 and Beyond list of 69 competencies was reduced to 36 in order to control the size of the survey instrument and to include topics that could reasonably be found in an orientation program designed to assess competency of a new staff therapist in an acute care hospital. Therefore, conclusions regarding the current state of orientation programs with respect to the needed competencies of the respiratory therapist of the future are somewhat incomplete.

Conclusions

Orientation and competency assurance of new staff therapists are vital responsibilities of hospital employers to ensure safe and effective care for patients. The results of a national survey of hospitals showed that the orientation programs for newly hired staff therapists had large variation in the mean number of hours spent for department orientation, precepting hours, and total orientation hours, with approximately 202.5 hours of orientation overall. RT orientation programs currently assess competency for most of the areas included in the survey, indicating employers deem them relevant. Orientations may require more time in the future as RT evolves into the model described in the 2015 and Beyond publications.

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Teaching Students to Apply Principles of Evidence-Based Protocol-Guided Clinical Practice Using a Hospital-Based Research Practicum

Charles J. Gutierrez, PhD, RRT, FAARC

Cathy Stevens, BS, RRT

Gina Ricard, MS, RRT

Abstract

Background: The American Association for Respiratory Care has projected that among competencies needed by registered respiratory therapists by 2015 will be the ability to engage in respiratory care clinical practice that is evidence-based and protocol-guided. While respiratory clinicians and educators agree that such a competency will be required, there are diverging views regarding the best educational strategies for attaining the competency. The hypothesis of the current study is that competent development and utilization of evidence-based protocol-guided clinical practice are based on successful application of respiratory care research methods and that a hospital-based problem-focused inquiry-centered capstone clinical research practicum may be an efficacious educational model for learning these competencies. **Methods:** Advanced-standing students, who required additional hours in their last clinical practicum prior to graduation from an associate degree program, indicated a strong desire for a clinical practicum that would expand their repertoire of clinical experiences. To assess feasibility of instituting a clinical research practicum at a clinical affiliate, a three-year study was undertaken with one pair of students participating each spring in a six-week capstone clinical research practicum. **Results:** Students were evaluated on their ability to demonstrate improved content knowledge and psychomotor skills in five learning domains that included the ability to: 1) discuss the scientific method, 2) identify a research question, 3) administer a clinical respiratory care protocol 4) perform bedside research, and 5) present a scientific poster of findings with recommendations for changes to the protocol. Students also completed a pre- and post-practicum exam consisting of ten essay questions pertaining to clinical research. Exam results revealed significant (P = .01) improvement in comprehension of research content. **Conclusion:** Participation in a hospital-based problem-focused inquiry-centered capstone clinical research practicum appears an efficacious andragogical strategy for helping students in an associate degree program achieve competency in applying principles of evidence-based protocol-guided clinical respiratory care practice.

Key Words: hospital-based, problem-focused, inquiry-centered, evidence-based, protocol-guided, clinical research practicum, educational model, respiratory care competencies.

Charles J. Gutierrez, PhD, RRT, FAARC
VA Affiliate Faculty, James A. Haley Veterans Hospital, Dept. Respiratory Care & Diagnostic Services and University of South Florida, Morsani College of Medicine, Dept. Internal Medicine, Tampa, FL

Cathy Stevens, BS, RRT
Program Leader, Bilirakis Spinal Cord Injury/Disorders Center of Excellence, Dept. Neurorespiratory Care, Tampa, FL

Gina Ricard, MS, RRT
Director of Clinical Education, Hillsborough Community College, Respiratory Therapy Program, Tampa, FL

Correspondence and Request for Reprints:
Charles J. Gutierrez, PhD, RRT, FAARC
James A. Haley Veterans Hospital
Dept. Respiratory Care & Diagnostic Services (128C)
13000 Bruce B. Downs Blvd.
Tampa, Florida 33612

Introduction

In the project *2015 and Beyond*, the American Association for Respiratory Care (AARC) identified multiple professional competencies that will be required by practicing registered respiratory therapists (RRTs) in the near future. One of the main recommendations from the first of three project conferences was that the profession should improve the quality of respiratory care while reducing health care costs.[1] To facilitate this objective, project participants recommended that RRTs should engage in clinical practice that is evidence-based and protocol-guided.[2] The current study took the AARC recommendation one step further by suggesting that RRTs should be competent in designing evidence-based protocol-guided clinical practice, not just implementing it. While most respiratory clinicians and educators generally agree with this recommendation, the best educational strategy by which to implement this recommendation has not been completely elucidated. The hypothesis of the current study is that competent development and utilization of evidence-based protocol-guided respiratory care clinical practice are based on the application of scientific research methods. Such methods may be best learned by engaging students in a capstone, clinical research practicum prior to graduation from a respiratory therapy degree program. This experience would ideally be hospital-based, problem-focused, and inquiry-centered. That is, the experience would take place in a hospital environment, would focus on a specific, real-world clinical problem of importance to the clinical affiliate, and would involve scientific inquiry performed by students in collaboration with clinical affiliate research mentors.

Discussions pertaining to scientific research and experimental design should be part of every course in a respiratory care curriculum. These discussions play an important role in preparing students to cognitively transition into the role of a clinician-scientist who would able to not only use but also produce clinical research findings at the bedside. However, discussions alone, without application, may not be sufficient to successfully learn the envisioned competency. Compelling andragogical evidence from the biological sciences suggests that training in undergraduate research methods should include structured opportunities that enable students to apply constructs that have been learned.[3] These opportunities should be designed to prepare students for the complex, clinical research roles they will play in the future. These findings suggest that academic programs, and in particular associate degree programs, should offer a capstone experience prior to graduation that enables students to combine their knowledge of respiratory care with training in scientific research and experimental design within the context of a mentored, clinical research practicum.

As the acknowledged respiratory care experts on the multidisciplinary clinical teams of tomorrow, RRTs will be expected to formulate compelling recommendations regarding clinical practice and to reference scientific evidence upon which their clinical recommendations are based. In order to improve patient care using evidence-based protocols, respiratory therapists will need to be conversant with scientific methods that enable them to design and implement clinical practices. Therapists will need to carefully monitor clinical outcomes following implementation of protocols to determine whether desired patient care outcomes have been achieved. They will need to know how clinical research findings, from appropriately powered studies, inform clinical practice and the extent to which such findings may be generalized to patient populations that may or may not be similar to previously studied cohorts. RRT clinician-scientists will need to understand how strengths and limitations of scientific evidence translate into strengths and limitations of clinical protocols before these are employed at the bedside.

This study presents preliminary findings on teaching respiratory care research methods to respiratory care students with the certified respiratory therapist (CRT) credential in an associate degree program. Students gained research experience by engaging in a hospital-based clinical research practicum similar to clinical practice encountered in intensive care unit, pulmonary function laboratory, and neonatal unit rotations. Like other practicums, a clinical research practicum affords students opportunities to adopt attitudes and behaviors they will need in clinical practice. The clinical research was problem-focused in that students' research addressed specific problems associated with mechanical ventilation of a cohort of neurologically compromised patients. The clinical research was inquiry-centered in that the emphasis was on performing research rather than discussing what scientific research might involve.[4] Such a capstone project was intended as a last structured experience providing students with an opportunity to apply principles of evidence-based protocol-guided clinical practice.

Rationale for Designing and Implementing Protocols

Declining Medicare payments and a problematic health care financing system are among the factors that have necessitated steps to enhance clinical quality and increase clinical productivity by empowering health care practitioners to assume a more expansive set of responsibilities.[5] Practitioners who can apply principles of evidence-based protocol-guided clinical practice will be well positioned to assume expanded responsibilities. Clinician-scientists with these competencies will be highly valued by hospital administrators who will view them as important partners who can rapidly adapt to changing conditions in order to improve quality of care and reduce health care costs.

Respiratory therapy protocols were initially described by Nielsen-Tietsort in 1981.[6] Today, evidence-based protocol-guided clinical practice is commonplace in top-tier departments working diligently to maintain a clinically competitive advantage. Advances in cardiopulmonary sciences will progressively transform the clinical landscape. These transformations will require clinician-scientists who can recommend modifications to established protocols or even design protocols de novo.[7] In order to perform these advanced tasks, RRTs will need a working knowledge of the fundamentals of evidence-based medicine, a familiarity with the best available scientific literature,[8] and research experience.

Respiratory Care Degree Programs

A recent survey by Barnes et al., of 348 directors of respiratory care degree programs revealed that three of five competencies related to evidence-based protocol-guided respiratory care clinical practice were taught significantly less often in associate degree programs than in baccalaureate degree programs.[9] Competencies included: 1) the ability to critique published research, 2) the ability to explain the meaning of general statistical tests, and 3) the ability to apply evidence-base medicine to clinical practice. The importance of assuring that graduates with the RRT credential possess these competencies arises from the premise that evidence-based protocol-guided respiratory care practice is expected to directly affect a clinical institution's ability to deliver high quality health care in an economically competitive environment.[7]

When compared with baccalaureate degree programs, it is clear that associate degree programs may possess inherent spatial and temporal limitations that may place them at a disadvantage in offering their students research experiences comparable to those encountered in baccalaureate degree programs. Results of the survey by Barnes et al.[9], and our own experience suggest that more creative efforts could be undertaken by associate degree programs to train students to become clinician-scientists. Conceptually, the competencies of critiquing published research and explaining the meaning of general statistical tests could be nested within the competency of applying evidence-based medicine to clinical practice. Hence, an adgragogical strategy for helping students achieve that competency might be development of a hospital-based problem-focused inquiry-centered research practicum by an associate degree program in collaboration with a clinical affiliate with expertise in clinical research.

Importance of Undergraduate Research

In 2011, the National Science Foundation funded workshops by the Council on Undergraduate Research designed to help community colleges develop original research programs. While most programs were established in the biological/life sciences, opportunities also exist for clinical, allied health programs. Students in undergraduate biological science programs collect data that are just as valuable as data produced by graduate students at major research universities, even though the scope of research projects for the former is usually more circumscribed. There is some evidence that students in associate degree programs who engage in undergraduate research tend to complete degrees in science, transfer to a university, and pursue a higher-level academic degree.[10]

Critical Thinking Skills

Engaging respiratory therapy students in evidence-based protocol-guided clinical practice is not a "cookbook" enterprise and does not eliminate their need to exercise critical thinking skills and institute problem solving measures.[11, 12] On the contrary, engaging in evidence-based protocol-guided clinical practice heightens the need for higher-order thinking skills. Parenthetically, there is considerable concern among health care employers that new health care graduates may not always possess sufficiently robust critical-thinking skills.[13] Some studies provide convincing evidence that dealing with real-world problems in class, encouraging open-ended discussions, fostering inquiry-oriented experiments,[14] and adopting community-based inquiry methods[15] are all established mechanisms for enhancing development of higher-order critical-thinking capabilities needed for respiratory care clinical practice in the future.

Methods

A proof-of-concept study was undertaken to determine the feasibility of instituting a clinical research practicum that would be part of curriculum requirements for students graduating from an associate degree program in respiratory care. Two sophomore students were admitted each Spring, for three consecutive years, to a clinical research program located in a clinical affiliate that provided training in research methodology to RRTs completing a one-year post-graduate subspecialty, clinical residency in neurorespiratory care.

CRT Students

Students (n=6) with the CRT credential who had chosen to earn an AS degree in respiratory care in preparation for the registry examination, were granted advanced standing in a respiratory therapy program at a community college. These students required additional hours in their fifth and final clinical practicum to graduate from their associate degree program. Students (two male and four female; mean age=45 years; mean length of clinical experience=17 years) unanimously and formally expressed a strong desire for a clinical

practicum that would expand their repertoire of clinical experiences instead of revisiting well-known, well-practiced clinical skills.

Each pair of students participated as a team in a six-week, clinical research training session taught by clinical affiliate staff members with expertise in clinical research and publishing. None of the students were formerly involved in clinical research nor did they know respiratory therapy colleagues who had been involved in clinical research.

Learning Objectives and Exam

The five learning objectives shown below were assessed as satisfactory or unsatisfactory during the course of the practicum. Each objective was aligned with learning activities using a backward design[16] plan of assessment. A research mentor determined attainment of educational objectives with guidance from an educational assessment rubric (Appendix A). Satisfactory attainment of all objectives was deemed evidence that a student had achieved competency in applying principles of an evidence-based protocol-guided form of clinical practice. Objectives included the ability to:

1. Discuss Scientific Method: Teams were expected to become conversant with fundamentals of the scientific method, experimental design, and statistical analysis to be able to navigate the pathway from scientific evidence to improved patient care.
2. Identify Research Question and Develop Hypothesis: Teams were expected to formulate a research question and research hypothesis in collaboration with their hospital-based mentors and in alignment with extant clinical research endeavors.
3. Administer Clinical Protocol: Teams were expected to learn to administer the Chest Optimization Protocol (COP) to specific patient cohorts under study. As depicted in Table 1, COP is an evidence-based protocol-guided intervention designed by the clinical affiliate to help prevent or mitigate pulmonary complications in ventilator-dependent neurologically-compromised patients.[17]
4. Perform Bedside Research: Teams were expected to learn volumetric capnographic methods and then measure six defined cardiopulmonary variables at bedside pre- and post-administration of the COP.
5. Present Poster of Findings and Recommend Modifications to Protocol: Teams were expected to construct and present a poster of their bedside research findings and to recommend possible modifications to the COP that were supported by their findings and best available scientific evidence.

Table 1

Components of Chest Optimization Protocol For Ventilator-Dependent Patients With Cervical Spinal Cord Injury (CSCI)

1. Body Positioning Component:
   Thirty minutes after clamping feeding tube, and with full cardiopulmonary monitoring, place patient in 10-degree Trendelenburg body position.

2. Sputum Mobilization Component:
   Engage bed-based thoracic vibration at high intensity for 20 minutes.
   Insert enclosed suction catheter via trach tube while delivering mechanical insufflation via manual mode, then withdraw catheter while suctioning and delivering exsufflation via manual mode.

3. Aerosolized Bronchodilator Component:
   Administer one unit dose of prescribed ß-2 adrenergic agent and one unit dose of prescribed anti-cholinergic agent via small volume nebulizer at 10 liters (air) per minute for 20 minutes.

4. Pulmonary Hyperinflation Component:
   Maintain tidal volume at 15-20 ml/kg of ideal body weight while maintaining peak inspiratory pressure < 50 cm H_2O and plateau pressure < 30 cm H_2O for 20 minutes.

In addition, an essay exam was collaboratively constructed by two clinical affiliate research mentors. The exam consisted of ten questions pertaining to selected aspects of neurorespiratory care research (Appendix B). At the time of grading, the name blanks of pre- and post-practicum essays were obscured with folded index cards and paper clips so that the examiner/grader could not see the identity of the examinee. Pre-practicum essays served as a tool for identifying topic misconceptions possessed by students and addressing these during the subsequent six-week research practicum. The pre-practicum essay also enabled students to preview selected principles on which they would later focus. One mentor remained constant as the principle examiner/grader during the three years of the study while a second mentor served in a collaborative role.

Educational Model

Guidelines for the hospital-based problem-focused inquiry-centered educational model were adopted from a conference entitled V*ision and Change in Undergraduate Biology Education* sponsored by the American Association for Advancement of Science.[18]

Guidelines included:

- Help students relate scientific concepts to a real-world problem.
- Make scientific content relevant by presenting the problem in a real-world clinical research context.
- Model passion that clinician-scientists feel for science and their delight in sharing their understanding with others.
- Engage students as active participants, not passive recipients, in an inquiry process.
- Ensure students have authentic opportunities to experience the process, nature, and limitations of science.

The six-week clinical research practicum was modeled after interdisciplinary graduate training in life science teaching labs[19] and hospital-based research experiences that are part of specialty training for Fellows in pulmonary medicine.

Hospital-Based Training

Week one. Students in this study had full-time jobs at other clinical institutions and therefore attended the clinical research practicum on Monday mornings and afternoons. Students used the balance of the week to complete assignments and prepare for the following Monday. During the first Monday students received instruction on research methods and experimental design based on content of selected research method articles in RESPIRATORY CARE.[20, 21, 22, 23, 24] Bedside discussions stressed application of clinical problem-focused research. The cohort under study consisted of patients with amyotrophic lateral sclerosis (ALS). Therefore, the first Monday afternoon was spent providing instruction on neurorespiratory care, neuropathology, and epidemiology of patients with ALS.

Week two. Students were oriented to an ongoing program of clinical research located in the clinical affiliate, a regional spinal cord injury center staffed by neurorespiratory therapists. The affiliate research program had been in operation since 2008 and focused on elucidating cardiopulmonary changes following neurorespiratory care interventions in mechanically-ventilated patients with ALS. Students were trained in performing evidence-based protocol-guided chest optimization consisting of positioning the patient in supine and Trendelenburg body positions, performing mechanical in/exsufflator-assisted tracheal suctioning with bed-based thoracic vibration, providing aerosolized pharmacologic bronchodilation, and instituting lung/chest hyperinflation.[17]

Week three. Students received bedside clinical training in volumetric capnography methods in preparation for undertaking clinical research. They learned to measure and record data from six cardiopulmonary variables that included: cardiac output (CO), pulse oximetry (SpO_2), alveolar minute volume ($\dot{V}_{Alv}$), airway resistance (Raw), static chest compliance (Cstat), and carbon dioxide elimination (VCO_2) using a noninvasive cardiac output (NICO) monitor (Novametrix Medical Systems, Wallingford, CT). Each team of two CRTs collaborated with a clinical affiliate research mentor in developing a written research proposal of interest to the students. The proposal included delineation of independent and dependent variables, generation of hypothesis, formulation of experimental design, determination of methods and materials, use of statistical analysis, and projection of possible experimental results. Students on each team collaborated with a mentor to align their research question with a pre-existing arm of the clinical affiliate research program. Research questions focused on changes in cardiopulmonary variables pre- and post-chest optimization protocol.

Week four. Teams collected data using a convenience sampling method that culminated in a clinical intervention trial. Students randomly placed patients either in 10-degree Trendelenburg or supine body position while performing the COP. Mechanical in/exsufflation-assisted tracheal suctioning was performed while patients received bed-based thoracic vibration plus pharmacologic bronchodilation and pulmonary hyperinflation. Students performed a crossover analysis by having patients who received Trendelenburg positioning first subsequently receive supine positioning. Those who received supine positioning first subsequently received 10-degree Trendelenburg positioning.

Week five. Measurement of the six cardiopulmonary variables pre- and post-chest optimization enabled CRT students to perform a repeated-measures analysis of variance (RM-ANOVA) statistical model using the statistical package for social sciences (SPSS) software. In this manner, it was possible to determine whether body positioning was associated with improvement or decrement in cardiopulmonary status following administration of the COP in a specific body position.

Teams used large card stock to construct cardboard posters modeled after samples of posters produced by clinical affiliate research mentors. To facilitate frequent review by students, model posters were installed near the chronic ventilator unit where students worked. Students produced tables, graphs, figures, and text with PowerPoint and affixed these to the large card stock. Posters included abstract, introduction, methods, results, and conclusion.

Week six. Each team was tasked with recommending modifications to the COP where warranted. Arguments regarding modifications had to be based on data obtained and the best available scientific evidence. Students presented their findings and recommendations to hospital-based colleagues. The abil-

ity of students to reconcile their research proposals with multiple limitations inherent in a real-world clinical research program was deemed an important facet of their training. Students' ability to align their proposals with extant clinical research tracks enabled improved mentoring by clinical affiliate researchers who were expected to balance daily patient care duties with their research commitment. This also facilitated standardized evaluation of new students admitted to the research practicum each year.

Results

CRT students (n=6) who entered the six-week research practicum completed the five learning objectives in a satisfactory manner. Objectives included: 1) discussing the scientific method, 2) identifying a research question, 3) administering a clinical protocol, 4) performing bedside research and 5) presenting a scientific poster of findings and recommendations to hospital-based clinical colleagues. Students also completed a ten question essay exam[25] administered before and after completion of the six-week clinical research practicum. Pre- and post-practicum scores were analyzed using a paired samples t-test statistical model which resulted in data shown in Table 2. Post-practicum exam scores were significantly greater (M = 90.83, SD = 9.7) than pre-practicum exam scores (M = 50, SD = 17.61), suggesting a significant improvement in comprehension of selected research content.

Results in Table 3 reveal a significant (P =.01) difference of 40.83 points between pre- and post-practicum scores.

Table 2
Essay Exam Mean Scores for CRT Students (n=6) in NRC Clinical Research Practicum

Practicum Essay Scores	Mean	Std. Deviation	Std. Error Mean
Pre-Practicum Essay Exam	50.00	17.61	7.19
Post-Practicum Essay Exam	90.83	9.70	3.96

Table 3
Difference Between Mean Essay Exam Scores for CRT Students (n=6) in NRC Clinical Research Practicum

Practicum Essay Scores	Paired Differences			Sig. (2-tailed)
	Difference	95% Confidence Interval of the Difference		
		Lower	Upper	
Pre-Practicum scores — Pre-Practicum scores	40.83	50.46	31.20	.000

Table 4
Correlation Between Pre- and Post-Practicum Exam Scores

Practicum Essay Scores	Correlation	Sig.
Pre-Practicum & Post-Practicum	.936	.006

As indicated in Table 4, pre- and post-practicum exam scores for CRT students revealed a significant correlation. Students who earned higher scores on the pre-practicum exam tended to earn higher scores on the post-practicum exam.

Standardization and consistency of educational assessment was maintained by utilizing an educational assessment rubric (Appendix A), a constant examiner/grader, and a constant pre- and post-research practicum essay exam (Appendix B) for the duration of the study period.

Discussion

To remain competitive, the AARC has recommended that the profession of respiratory care should further improve the quality of respiratory care practice and continue efforts to reduce health care costs.[1] To achieve these objectives, practitioners of respiratory care will need to systematically engage in clinical practice that is evidence-based and protocol-guided.[2] The current study proposed that respiratory therapists should not only be competent in administering evidence-based protocol-guided clinical practice but should also be competent in modifying or designing de novo clinical practice that is personalized for patients in accordance with their type and stage of pathophysiology.

Findings of the current study suggest that competent development and utilization of evidence-based protocol-guided respiratory care clinical practice are based on systematic application of principles of scientific research methods that are best learned in a hospital-based problem-focused and inquiry-centered educational context. This study presents evidence that engaging students in a capstone clinical research practicum prior to graduation from a respiratory therapy degree program may be an efficacious andragogical strategy for teaching them how to systematically apply principles of scientific research methods. Educational opportunities that help students internalize these principles will facilitate emergence of clinician-scientists who can provide the expertise necessary to progressively improve patient care and reduce health care costs.

This study described how collaboration between a community college and clinical affiliate produced a program that offered students an opportunity to combine their knowledge of respiratory care with training in scientific research and experimental design within the context of a structured, men-

tored, clinical research practicum. Prior to this time, students had not received educational opportunities that enabled them to build content knowledge and to apply psychomotor skills they would need to practice evidence-based protocol-guided respiratory care.

Satisfactory attainment of all five objectives was deemed evidence that students had achieved competency in modifying and utilizing evidence-based protocol-guided clinical practice. Significant gains in comprehension of selected research constructs, as evidenced by significant improvement in essay exam scores, served to further confirm attainment of competency.

Students who complete this practicum will have the research experience required to serve on future multidisciplinary clinical teams tasked with modifying, developing, administering, managing, designing, and implementing clinical practice to improve care and reduce costs. They will be able to offer their expertise as to how the best available scientific evidence informs clinical practice and the extent to which changes in practice may need to be considered in light of emerging evidence.

Findings of this study demonstrate that collaboration between a community college and clinical research affiliate is mutually beneficial and should be expanded and supported. The next phase of research program development should be to offer an elective, capstone clinical research experience to traditional, non-CRT students in their fifth and final practicum of their associate degree program. Projections indicate that six to eight students per year could elect clinical research as their capstone practicum. After three years of operation, a summative evaluation would be promulgated for administrative review by the college and clinical affiliate. Few changes within a respiratory care curriculum would have a greater positive effect on the future of respiratory therapy students, the respiratory care profession, and the community-at-large than the addition of a research practicum with its potential to significantly impact health care outcomes and costs in 2015 and beyond.

Benefits for Clinical Affiliates

This cooperative, experimental venture between the college and clinical affiliate resulted in a unique clinical research experience for students. The venture also enabled the clinical affiliate to undertake student-associated research that enabled the affiliate to determine whether the COP as designed for patients with CSCI would be applicable to ventilator-dependent patients with ALS. Student-associated clinical research resulted in multiple changes in the original protocol, making it distinctly appropriate for respiratory patients with neurologic degenerative disorders as opposed to those with neurotraumatic injuries. In many instances, important questions, fresh perspectives, and new evidence from student-associated research prompted hospital-based clinicians to re-examine and modify established clinical practice guidelines. Hence, student-associated clinical research may be an important, previously untapped resource for institutions seeking periodic reality checks of their clinical processes as a way of maintaining effective protocols.

Limitations

A major limitation of this feasibility study was the small number student participants. Additionally, the participants were CRTs who were, on average, older and had more clinical experience than what may be typical for entry-level students in associate degree programs. The maturity and experience of the CRT students may have been an intervening variable that gave them an advantage in applying scientific research methods. The extent to which these preliminary findings are applicable to non-CRT students in associate degree programs will not be known in a definitive fashion until additional, appropriately powered studies are conducted with traditional, non-CRT students. Additional studies with students from baccalaureate degree and graduate programs will also be necessary.

An additional limitation of this study was that the educational assessment rubric used to evaluate student attainment of the five learning objectives used a simple, dichotomous rating designation of satisfactory versus non-satisfactory rather than grade weighting. In future studies, the five learning objectives and post-practicum essay will have grade weights assigned to them (90 points for learning objectives, 10 points for essay exam) with a combined score of 100 points for the practicum. The change would be expected to improve quantification and subsequent statistical analysis so as to enhance the yield of information about the educational process associated with the practicum.

Conclusions

Sophomore respiratory therapy students with the CRT credential participated in a capstone clinical research practicum during the last six weeks of their respiratory therapy associate degree program. Students constructed clinical research content knowledge and applied psychomotor skills by successfully completing five learning objectives and a ten question essay pre- and post-practicum. Student participation in a hospital-based problem-focused inquiry-centered capstone clinical research practicum appears to be an efficacious educational mechanism for enabling students to transition into the role of a cardiopulmonary clinician-scientist capable of practicing evidence-based protocol-guided respiratory care from now to 2015 and beyond.

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APPENDIX A - Assessment Rubric for NRC Research Practicum - Educational Objectives

Overall objective(s): Build clinical research content knowledge and apply appropriate clinical research psychomotor skills.

Objective	**Exceeds** practicum expectations	**Meets** practicum expectations	**Approaches** practicum expectations
To discuss scientific method.	Typically discussed scientific method using appropriate course-related language in a way that demonstrated mastery of content.	Generally discussed scientific method using course-related language in a way that demonstrated understanding of content.	Did not discuss scientific method using course-related language and/or omitted significant content.
To identify a research question and develop hypothesis	Identified research question and developed hypothesis in a way that demonstrated mastery of content.	Identified research question and developed hypothesis in a way that demonstrated understanding of content.	Did not identify research question and/or hypothesis in a way that demonstrated understanding and/or omitted significant content.
To implement clinical research protocol.	Typically implemented Chest Optimization Protocol safely and in a way that demonstrated superb psychomotor skills and mastery of content.	Generally, implemented Chest Optimization Protocol safely and in a way that demonstrated good psychomotor skills and understanding of content.	Did not implement Chest Optimization Protocol safely and in a way that demonstrated good psychomotor skills and/or omitted significant content.
To perform bedside research	Typically applied volumetric capnography safely and measured selected cardiopulmonary variables in a way that demonstrated superb psychomotor skills and mastery of content.	Generally applied volumetric capnography safely and measured selected cardiopulmonary variables in a way that demonstrated good psychomotor skills and understanding of content.	Did not apply volumetric capnography safely and/or did not measure selected cardiopulmonary variables in a way that demonstrated good psychomotor skills and/or omitted significant content.
To present poster of findings and recommend modifications to protocol	Presented poster of findings using appropriate course-related text and language and recommended findings-supported modifications to protocol in a way that demonstrated mastery of content.	Presented poster of findings using course-related text and language and recommended findings-supported modifications to protocol in a way that demonstrated understanding of content.	Did not present poster of findings using course-related text and/or language and/or did not recommend findings-supported modifications to protocol and/or omitted significant content.
Essay Exam	**Exceeds** practicum expectations	**Meets** practicum expectations	**Approaches** practicum expectations
	Responses employed appropriate course-related language in a way that demonstrated mastery of content. 100-90%	Responses employed appropriate course-related language in a way that demonstrated understanding of content. 89-80%	Responses did not employ appropriate course-related language and/or omitted significant content. 78-70%

APPENDIX B – Essay Exam

Department of Veterans Affairs

Hillsborough Community College/Veterans Administration
Neurorespiratory Research Practicum

Name_____ Date _____

Pre- and Post-Training Evaluation

1. Explain the role that best available scientific evidence from respiratory clinical studies might play in designing and implementing evidence-based protocol-guided respiratory interventions for mechanically ventilated patients with neurodegenerative disorders.

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2. Explain the main difference between scientific findings that are clinically significant and statistically significant and discuss how respiratory clinician/scientists might use these concepts in deciding which interventions to incorporate into clinical practice guidelines.

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3. Teaching research skills to RT students is becoming an integral part of undergraduate respiratory care training. Discuss how such training might impact a respiratory patient's: 1) length of hospital stay, 2) mortality risk, 3) quality of life, 4) total healthcare expenditures.

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4. Formulating a hypothesis is part of the scientific method. Explain how a clinical study in which the null hypothesis is rejected could lead to modifications in clinical practice guidelines.

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5. A focused scientific literature search plays a role in designing and implementing a clinical respiratory protocol. Explain the role that the literature search might play in determining whether the patient cohort receiving the independent variable(s) has attained desired clinical outcomes.

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6. List the following learning objectives in the order they would most likely occur in a clinical research training program:
   - Present scientific poster with findings from study
   - Review the scientific method
   - Identify a research question
   - Implement clinical protocol
   - Perform bedside research

7. Explain main differences between randomized controlled study, case study, observational study and meta-analysis and discuss how each might contribute to designing and implementing a respiratory clinical protocol for mechanically ventilated patients with neurodegenerative problems.

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8. A nurse in the chronic ventilator care unit overheard your comment that SPSS would play a significant role in determining whether the chest optimization protocol for ventilator-dependent patients would need to be modified. Explain what SPSS is and how its use might lead to re-designing the protocol.

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9. The hospital research committee has read your research proposal and requests a functional definition of the crossover design that you intend to use in your proposed research design. Explain to the committee what that design entails and why you are proposing to use it.

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10. You are presenting your team's poster to the staff when an RT who works in ICU asks why you used the non-invasive cardiac output monitor (NICO) to measure cardiac output instead of doing "real" cardiac outputs like they do them in the ICUs. Help the RT understand your reasoning.

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Service Learning and Community Engagement by Respiratory Therapy Students at the Hilltop YMCA

Georgianna Sergakis, PhD, RRT, RCP

Crystal Dunlevy, EdD, RRT, RCP

Sarah M. Varekojis, PhD, RRT, RCP

Abstract

Background: COPD is now the third leading cause of death in the United States. Community screenings are critical in order to screen and educate at-risk individuals. Respiratory therapy (RT) students in the course, RT 420: Pulmonary Rehabilitation and Continuing Care, investigate respiratory care in settings outside of the acute care environment. The course includes topics such as pulmonary disease management, tobacco dependence counseling, and cultural competence. The culminating course experiences were COPD screening events at the Hilltop YMCA Senior Expo. This service learning (SL) experience allowed students to apply course concepts and provide a valuable community service. The purpose of this study was to identify common themes from reflections following a service learning experience involving community health screening and health coaching as part of an SL course for first year allied health and RT students. **Methods:** Twenty-two undergraduate RT students facilitated a COPD screening and submitted written commentary following the event. The authors applied inductive analysis and ultimately reached consensus on three common themes: awareness, health communication, and functional health. **Results:** All of the RT students described their experience as positive and valuable. Most reported growth in the areas of communicating health information and interpersonal interactions with older adults. Following the SL experience, students noted functional health definition variations in the elderly participants, decreased alarm for living with pulmonary disease symptoms, and increased interest in improving health . **Conclusions:** SL as a teaching and learning strategy was appreciated by RT students and contributed to deeper understanding of the complex social and professional issues in the provision of respiratory care. The promotion of community involvement in this way is mutually beneficial for both the student and the community.

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Key Words: respiratory therapy education, service-learning.

Georgianna Sergakis, PhD, RRT, RCP
Assistant Professor of Clinical Allied Medicine
The Ohio State University
College of Medicine
School of Health and Rehabilitation Science
Respiratory Therapy Division
Columbus, OH

Crystal Dunlevy, EdD, RRT, RCP
Associate Professor of Clinical Allied Medicine
The Ohio State University
College of Medicine
School of Health and Rehabilitation Science
Respiratory Therapy Division
Columbus, OH

Sarah M. Varekojis, PhD, RRT, RCP
Assistant Professor of Clinical Allied Medicine
The Ohio State University
College of Medicine
School of Health and Rehabilitation Science
Respiratory Therapy Division
Columbus, OH

Correspondence and Request for Reprints:
Georgianna Sergakis PhD, RRT, RCP
The Ohio State University
School of Health and Rehabilitation Science
Respiratory Therapy Division
453 W. l0th Ave.
431 Atwell Hall
Columbus, OH 43210

Introduction

Service learning (SL) is defined as a "teaching and learning strategy that integrates meaningful community service with instruction and reflection to enrich the learning experience, teach civic responsibility, and strengthen communities.[1] As a teaching and learning strategy, SL has been reported to contribute to deeper understanding of complex social and professional issues.[2-5] The development of a true SL experience for respiratory therapy (RT) students is multifaceted and involves far more than arranging a clinical experience in a community area.

SL is distinctly different from community service in that it is not merely episodic volunteerism. For students to truly "make meaning" from the experience, the instructor must carefully engineer this learning experience. The SL literature emphasizes numerous benefits, such as: 1) a cooperative benefit between the students and the community, 2) an opportunity for problem solving, 3) uncontrived experiences, and 4) personally meaningful learning.[1] For true SL to take place the service and learning goals for the interaction must carry equal weight, each enhancing the other for all participants.[6] To accomplish this goal of a balanced SL experience, the students should have an active role in addressing authentic community issues and appreciate the experience through critical reflection.

The literature is rich with the various outcomes of this teaching learning strategy, including personal, cognitive, and social outcomes. Personal outcomes include increased personal efficacy, identity, and spiritual and moral growth. Other professional development includes growth in leadership, communication, and teamwork,[7] all of which are competencies identified in the 2015 and Beyond conference reports.[8] Students also gain interpersonal insight from the experience, which contributes to their personal and professional development. This suggests critically important professional attributes might be further nurtured and enhanced by SL experiences.

Several cognitive learning outcomes are difficult to measure and cultivate in the classroom or laboratory. The "messiness" of the community and the unpredictable nature of SL environments allow facilitation of problem analysis and foster critical thinking. Other cognitive and behavioral outcomes include a deeper understanding of pulmonary disease and social issues, as well as continued development of cultural competency.[7]

The social outcomes in SL include hearing and understanding the voice of the community in which the students learn. Furthermore, linking to the community agency can lead to future volunteerism and enhanced civic engagement. Eyler and Giles (1999) emphasize that the SL experience enhances understanding, which leads to more effective action.[6] Lastly, a social outcome for respiratory care as a profession is that the community is able to realize the contribution of RTs to community and public health.

One method identified by the RT program faculty to engage students and contribute to their professional development was to participate in the AARC's national DRIVE4COPD campaign. COPD is now the third leading cause of death in the United States.[9] Approximately 12 million Americans are currently diagnosed with COPD and an estimated additional 12 million are unaware that they have the disease due to the slow progression of signs and symptoms.[10] The American Lung Association advocates conducting community lung health screenings to raise awareness of COPD in urban and rural communities, perform or provide referrals for tobacco cessation, and identify abnormal lung function in individuals without a preexisting diagnosis.[10] Community screenings are critical to identify and educate at-risk individuals and to provide them with secondary and tertiary prevention strategies designed to improve their quality of life, decrease the incidence of exacerbations, and slow progression of the disease.[10] The purpose of this study was to identify common themes from reflections following an SL experience involving community health screening and health coaching (HC) as part of an SL course for first year allied health and RT students.

Methods

The study was approved by the University Institutional Review Board. First year respiratory therapy and health sciences students in the School of Health and Rehabilitation Sciences at The Ohio State University conducted COPD risk-assessments and screenings for adults attending health fair events at the Hilltop YMCA in Columbus, OH, at three time periods during 2011.

Respiratory Therapy Course Description

To prepare for the service learning experiences, the RT students in the course, RT 420: Pulmonary Rehabilitation and Continuing Care, studied respiratory care in settings outside of the acute care environment. Students participated in class activities designed to complement and inform their upcoming SL experiences. The course included topics such as pulmonary disease management, aging sensitivity exercises, health literacy and health promotion, tobacco dependence counseling, and cultural competence. The culminating course experiences were the COPD screening events at the Hilltop YMCA. To prepare for the SL experiences and become familiar with the community and goals of the YMCA program, the students completed an agency background evaluation of the YMCA and Hilltop community. Students also examined the evidence-based guidelines surrounding COPD and com-

munity health screenings to become aware of best practices, learn about COPD self-management, and develop a plan for the COPD screenings. This SL experience allowed students to apply these course concepts and provided a valuable service to the community. The students facilitated each COPD screening and submitted written commentary following the events.

Community Engagement

Each health event at the YMCA was advertised through a monthly newsletter, the YMCA website, and flyers distributed to the community and YMCA clients. At each of the three events, participants were provided an informational letter upon approaching the table explaining the purpose of the research; their role, responsibilities, and time commitment; and assurance of the confidentiality of the data collected. The letter also explained that participation was voluntary and that if the community member chose not to participate in the telephonic HC and follow-up, he could still receive the spirometry and breath carbon monoxide measurement and complete the COPD screening, as well as receive the referral information.

Upon the participant's consent, the RT students performed basic spirometry to determine current lung function and carbon monoxide measurement to quantify smoking status. They also administered a standard COPD screening instrument.[11] The participants were asked to provide information regarding their medical history, symptom assessment, tobacco history, health care utilization, and contact information.

The RT students evaluated the participants lung function using established guidelines,[12] and the COPD screening instrument was scored using the scoring key.[11] For those determined to be at risk of developing COPD, information on obtaining an appointment with The Ohio State University Wexner Medical Center's pulmonary clinic was provided, as was information on local tobacco cessation programs if appropriate. At risk individuals were offered the opportunity to participate in a series of personalized telephonic HC sessions on the topics of exercise, nutrition, tobacco cessation, and breathing retraining administered by the RT and health sciences students. The content of these HC sessions was developed during RT 420: Pulmonary Rehabilitation and Continuing Care and Allied Medicine 645: Health Risk Assessment in the spring quarter of 2011. The telephonic HC sessions were conducted by health sciences students under the guidance of one of the authors over a nine month period from June 2011-March 2012.

Results

COPD Screening and Health Coaching

All participants were adults and were asked to provide consent to participate. The first event, the Hilltop YMCA spring health fair, attracted approximately 150 participants. Two additional screening events were conducted at the Hilltop YMCA to further recruit participants to the study. A total of 36 participants consented and participated in the full health screening. Of those 36, 13 consented additionally to the telephonic HC.

Cumulative data from the three screenings are reported. Two people were male and nine (69%) were 60 years or older. Eleven of 13 (85%) participants were overweight or obese, and seven (54%) had pre-hypertension or hypertension. One individual had a history of pulmonary disease, while five reported experiencing respiratory symptoms in the last four weeks. Four participants were current smokers and three individuals were former smokers. Only one person who never smoked reported experiencing respiratory symptoms in the last four weeks, while two current smokers and one former smoker denied experiencing respiratory symptoms in the last four weeks. Three of the 13 (23%) participants had COPD screening scores of 5 or greater, two of which were current smokers and the other of which was a former smoker. Only three of 13 individuals completed telephonic HC sessions, ranging from 2-5 sessions. Topics included tobacco cessation, nutrition, and diabetes. When contacted to arrange HC sessions, two people declined because they were asymptomatic, three individuals said they would prefer in-person HC, and one person was too busy. Six community members were not contacted, some because the phone had been disconnected.

RT Student Reflections

Twenty-two undergraduate RT students facilitated COPD screenings and submitted written commentary following the event. The authors applied inductive analysis and ultimately reached consensus on three emerging themes from their reflections: awareness, health communication, and functional health. Representative comments from the student reflections include the following:

Awareness

"I met a lot of people who may be at risk for or already have the start of COPD and many of them didn't even know what COPD is."

"I have learned that people living with COPD or at a risk of developing COPD usually have a lot of symptoms that limit their everyday activities. Usually they are very aware that smoking is bad for their health and know they need to quit."

"Performing a service such as this provided us with an experience that helps us understand more about this niche of respiratory care. Clinicals in the hos-

pital definitely doesn't provide us with an experience like this one."

Health Communication
"It allows us to improve our communication skills and teach others about their diseases or why it is important to quit smoking."

"I think service learning is a great learning tool because part of being an RT is working with people of all ages and a service project is a perfect transition into learning to work with different populations."

"I think service learning should be a part of the class curriculum because it's another chance to meet people and have a hands on experience not only with the technology RTs have to be familiar with but we also get a chance to talk to people who are surviving with the illnesses we learn about every day."

Functional Health
"I learned that it was possible to live with COPD and not know it, or to never have even contemplated visiting the doctor for persistent breathlessness."

"It was interesting how many people are willing to live with being short of breath without seeking some sort of medical attention or advice. People just seem to accept it as normal."

"It isn't that I thought the seniors were completely oblivious to their health but I didn't realize how much they truly knew and how interested they were in working to improve it."

All of the RT students described their experience as positive and valuable. Most reported growth in the areas of communicating health information and interpersonal interactions with older adults. Students noted functional health definition variations in the elderly participants, decreased alarm for living with pulmonary disease symptoms, and increased interest in improving health.

Discussion

The outcomes reported by this cohort of students align with findings in the literature regarding the value of SL in the professional development of allied health students.[1-7] Areas of growth described by the students also parallel projected 2015 and Beyond competencies such as health communication and disease management.[8]

However, some interesting findings were noted with regard to community participation in HC, as there was a lack of interest for this method of health counseling. Telephonic coaching as the delivery method was less than optimal for this group. The method of interaction with the participants was not a good match. Health coaches noted that the group that was enrolled in the study was more invested in the social aspects (friendly conversation and interpersonal interactions) provided by the small classes at the YMCA. The decreased investment in HC and lack of connection with the "new" telephonic health coach were not optimal. The health coaches communicated that the participants often cut sessions short, did not engage in the HC process, and did not follow through with weekly goals developed in HC telephone conversations. Other reasons for the low commitment to HC included lack of understanding about the time commitment for HC and other obligations in the home which were superseded by the conversation with the health coach. In addition, common aging-related physiologic changes of the older adult population caused difficulty with telephonic HC. There were also several participants who did not have access to a consistent telephone number. Other approaches to deliver HC, such as small group or individual face-to-face meetings, are recommended.

Despite active engagement through YMCA activities, these older adults still demonstrated a need for HC in several health areas. All in all, mutual benefits were demonstrated by both the community participants and the students in their preprofessional training. The community participants benefitted from the health screening and health information provided through HC and the students communicated meaningful educational outcomes and competencies from the SL experience.

Limitations

Due to their limited opportunities for HC, the health sciences students were not able to engage in reflection about their experiences. Additionally, due to the number of RT students at the YMCA at one time, the interaction with community members was episodic and sometimes limited.

Conclusions

Service learning as a teaching and learning strategy was appreciated by RT students and contributed to their deeper understanding of complex social and professional issues in the delivery of respiratory care. The promotion of community involvement in this way is mutually beneficial for both the student and the community.

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Disruptive Behavior in the Respiratory Therapy Workplace

Amanda L. Roby, MHHS, RRT, RPSGT

Salvatore A. Sanders, PhD, RRT

John M. Hazy, PhD

Teresa A. Volsko, MHHS, RRT, FAARC

Abstract

BACKGROUND: The purpose of this study was to explore the prevalence, setting, sources, and types of disruptive behavior respiratory therapists experience. Three hypotheses were tested: (1) respiratory therapists experience disruptive behavior in the workplace; (2) verbal disruptive behavior is the most common form reported by respiratory therapists, (3) the incidence of disruptive behavior is higher among bedside caregivers than managers or educators. The greatest source of disruptive behavior is described. **METHODS:** A 23-question survey gleaned data to evaluate disruptive behavior respiratory therapists may witness or experience at their place of employment. This research was approved by the institutional review board and informed consent was obtained prior to participation. The survey was distributed electronically to respiratory therapists who were members of the American Association for Respiratory Care's adult acute care, management and education specialty sections. **RESULTS:** A total of 119 of a possible 3,941 participants (3%) completed the survey. Ninety-six percent of individuals surveyed experienced a form of disruptive behavior. Both hypotheses two and three were not supported. Similarly 96% witnessed a co-worker experiencing a disruptive event. No difference in the type of disruptive behavior was experienced by job category. Bedside caregivers did not experience disruptive behavior more often than department technical directors, educators, or supervisors. Disruptive behavior was deemed unacceptable. "Zero tolerance" initiatives were identified by some participants as a means to control disruptive behavior. **CONCLUSIONS:** Respiratory therapists in all job categories experience disruptive behavior. Those affected by disruptive behavior were willing to explore effective ways to control disruptive behavior.

Key Words: disruptive behavior; verbal abuse; physical abuse; sexual abuse; psychological abuse; disruptive work environment

Amanda L. Roby, MHHS, RRT, RPSGT
Cuyahoga Community College
Westlake, OH

Salvatore A. Sanders, PhD, RRT
Department of Health Professions
Youngstown State University
Youngstown, OH

John M. Hazy, PhD
Department of Criminal Justice
Youngstown State University
Youngstown, OH

Teresa A.Volsko, MHHS, RRT, FAARC
Department of Respiratory Care and Transport
Akron Children's Hospital
Akron, OH

Correspondence and Request for Reprints
Amanda L. Roby, MHHS, RRT, RPSGT
Cuyahoga Community College
31001 Clemens Road
Westlake, OH 44145
Amanda.Roby@tri-c.edu

Introduction

There is a need for research as workplace disruptive behavior in health care organizations gains increasing recognition as a growing concern. Violence in health care settings is a pervasive problem and an epidemic that constitutes an occupational hazard.[1] The literature reports disruptive behavior and threats of violence are major stressors for health care professionals of all disciplines.[2] Although this problem has been recognized by leading national organizations such as the National Crime Victimization Surveys, The Joint Commission (TJC), and the American Medical Association (AMA), there is a lack of agreement on the definition of disruptive behavior. Furthermore, there is no uniform testing instrument to measure disruptive behavior.

TJC acknowledges the negative effects intimidating and disruptive behaviors such as verbal outbursts, uncooperative attitudes, and impatience with questions create for a health care organization.[3] This organization describes disruptive behavior as "…behavior or behaviors that undermine a culture of safety."[4] The AMA describes disruptive behavior as, "Personal conduct, whether verbal or physical, that affects or that potentially may affect patient care negatively."[5] Disruptive behaviors compound the stress health care workers experience, which is inherent to the physical and psychological demands of the workplace. The additional stress contributes to hypertension, ulcers, mental exhaustion, and other disease processes, as well as adverse stress-triggered health behaviors such as smoking, overeating, and substance abuse.[1]

There are many types of disruptive behaviors. Verbal disruptive behavior is manifested in the words, tones, and nonverbal mannerisms an individual uses. This form of workplace violence leaves no visible scars, but can be emotionally devastating.[6] Power over another can be also be used with the intent to dominate. Bullying, horizontal or lateral violence, and mobbing are examples of this type of disruptive behavior. Bullying is currently widespread and refers to situations of repetitive harassment that occur between persons of the same level of authority or in differing hierarchical levels (i.e. manager to a subordinate).[7] Horizontal or lateral violence is associated with displays of aggression towards someone on the same hierarchical level (i.e. staff respiratory therapist).[8] Mobbing occurs when disruptive behaviors stem from a group and impact one individual.[9] This type of behavior dismantles cohesive teams, threatens the victim's well-being, and contributes to serious safety events.[4]

Disruptive behavior may affect the victim and health care organizations differently. Hamlin and colleagues reported that victims of disruptive behavior experienced physical and psychological ailments such as nausea, stomachaches, headaches, weight change, blood pressure changes, fatigue, and insomnia, which influenced their willingness or decision to leave the organization.[10] A disruptive work environment compromises the function of the health care institution through litigation, job performance issues, employee dissatisfaction, decreased work effectiveness, decreased productivity, high absenteeism, low staff morale, and high staff turnover.[10] A dearth of literature exists to describe the prevalence or types of disruptive workplace behavior respiratory therapists experience. Most of the research in this area is nursing focused. The purpose of this research is to determine whether respiratory therapists experience disruptive behavior, where disruptive behavior is most prevalent with regard to work environments, and if disruptive behavior is different among job classes. Three hypotheses were tested: (1) respiratory therapists experience disruptive behavior in the workplace, (2) verbal disruptive behavior is the most common form reported by respiratory therapists in the health care environment, (3) the incidence of disruptive behavior is higher among bedside caregivers compared to managers and educators. Finally, the greatest source of disruptive behavior is described.

Methods

Research Design

A survey was used to ascertain the prevalence, type, and past and current experience with and impact of disruptive behavior on respiratory therapists. This study was approved by the institutional review board and conducted in a non-experimental approach.

Instrument

The testing instrument, Appendix A, was an electronically distributed 23-question survey. Since a published validated survey was not readily available, a survey instrument was constructed. Validation of this instrument was conducted on a small sample of respiratory care practitioners 12 months prior to the initiation of this study. Six questions addressed participant demographics such as age, gender, and longevity in the field. Workplace data, including organizational type, bed capacity, and geographic location, were also collected. The remainder of the questions elicited responses on the occurrence, setting, and details of the disruptive behavior experienced or witnessed by the participant, as well as precipitators of the disruptive behavior. One open-ended question collected ideas for ways to minimize and/or eliminate disruptive behavior in the workplace.

Validation of the Instrument

Prior to the initiation of this research project, validation of the survey instrument was performed to test for construct and content validity. The respiratory care staff at a large academic medical center in Youngstown, OH, was recruited. A hard copy of the testing instrument was distributed to credentialed and licensed respiratory therapists at the 500-bed

academic medical center. The survey was anonymous and confidential. It was administered and proctored by the co-investigator after informed consent was obtained. Bedside caregivers, educators, supervisors, and managers were eligible to participate. Thirty-two participants were recruited and a 100% survey return rate realized. The process allowed participants to address concerns and ask or clarify questions prior to the completion of the instrument. Participant comments regarding question clarity were recorded and used to refine questions for the final survey instrument.

Selection of Subjects

The sample consisted of practicing credentialed respiratory therapists who were also members of the American Association for Respiratory Care (AARC) and subscribed to one or more of three specialty sections. Specifically, AARC members of the adult acute care, management, and/or education specialty sections were recruited. This sub-section was selected to make efficient use of the research time and financial resources. The listing of AARC members recruited for the study was accessed through the association's member services and provided the potential for a convenience sample of 3,961 participants. Subscribers to more than one specialty section were only listed once. Prior to the distribution of the survey the AARC president and executive committee reviewed the instrument and study procedures and approved distribution to the sample population.

Participants were not selected on the basis of job function, but were stratified by job function for sub-analysis and comparison of the incidence and type of disruptive behavior encountered.

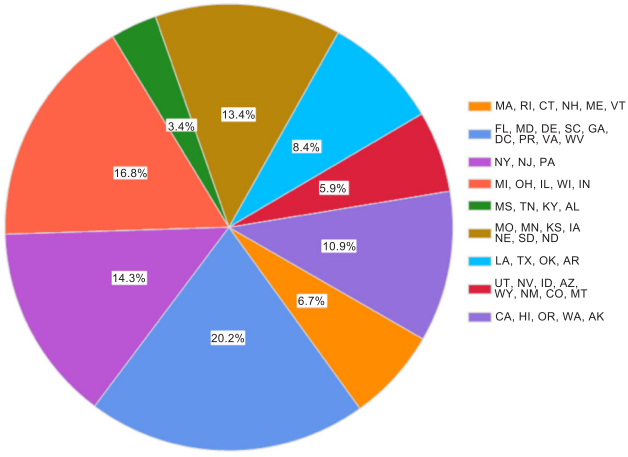
The survey was created in Survey Monkey under a Pro plan (www.surveymonkey.com), which allowed participants to log out and return to complete the survey at a later time. The survey was constructed to prevent subjects from responding to the survey more than one time. Informed consent was implied and obtained by virtue of the participant electing to respond to or complete the survey instrument.

A reminder email was built into the survey design to improve the response rate. The reminder was sent electronically approximately 1.5 weeks after the initial recruitment email. A sample size of 100 was targeted, with more being acceptable and any less than 50 considered insufficient. The survey did not allow participants to address any concerns or ask or clarify any questions. However contact numbers for the research team were provided in the recruitment letter to facilitate two-way communication and address concerns or provide clarification to those consenting to study participation.

Data Collection and Analysis

The introductory remarks and link to the survey tool were sent to the AARC's director of education and management services, who in turn informed the AARC specialty section chairs of the study purpose and survey dissemination process. The invitation to participate was distributed electronically through AARConnect to members of the adult acute care, education, and management specialty sections by the respective section chairs. Participants had three weeks to access and complete the survey.

Figure 1
Regional Distribution of Participants (n = 119)



Completed surveys were collected electronically through Survey Monkey Data and entered into SPSS Version 15 for Windows (SPSS Incorporated, Chicago, IL) for analysis. Descriptive statistics were used to report incidence and type of disruptive behavior as well as the main source of the disruptive behavior. The proportion of subjects experiencing disruptive behavior by job classification was compared using Chi-Square. An ANOVA was used to detect differences in the incidence of disruptive behavior among bedside caregivers, managers, and educators. Statistical significance was established at $p < 0.05$.

Results

Demographic Profile of the Sample Population

A total of 119 from a possible 3,961 participants (3%) consented to participate in this study. Regional distributions of study participants are listed in Figure 1. There were no incomplete surveys. Subjects were predominately female, n = 71(59.7%). Longevity in the field varied, with a majority of participants, 47.1%, having more than 30 years of experience in the field of respiratory care, Figure 2. The most responses were from department or technical directors of respiratory care departments (47.9%), Figure 3.

Nearly three quarters of participants (76%) worked in the acute care hospital. Educators represented 22% of the study population and worked either as a clinical educator within a

Figure 2
Longevity in the Field (n = 119)

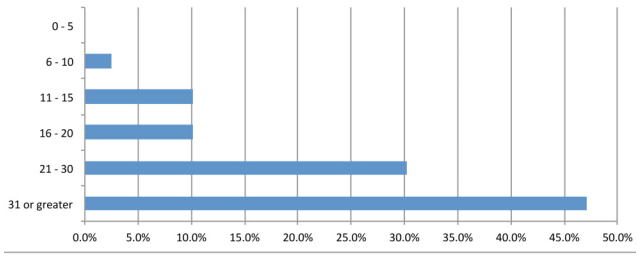


Figure 3
Percent of respondents stratified by their defined primary job function (n = 119). Staff respiratory therapists were defined as certified or registered respiratory therapists who function as primary bedside practitioners. The job category for supervisor or team leader also included responses from front line leadership roles such as quality specialist, manager, and clinical coordinator. The job category defined as "other" included charge or lead therapists who had a blended leadership and staff role.

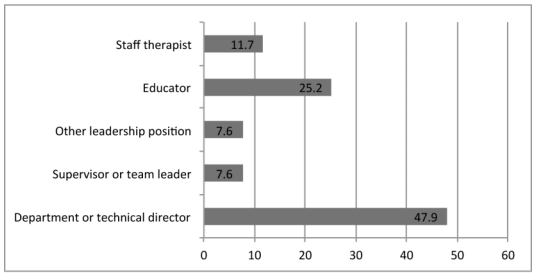
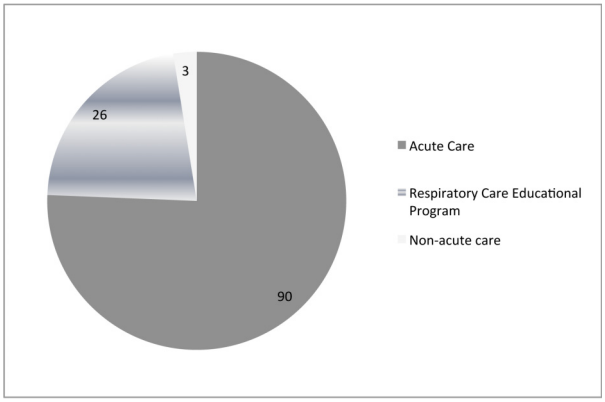


Figure 4
Primary Work Environment Reported by Study Participants (n = 119)



respiratory care department or faculty for a respiratory care program at a post-secondary institution. A minority of participants (3%) reported working in an area outside of acute care. Two reported working in the long term care setting (subacute care or skilled nursing facility) and one in a physician's office, Figure 4.

Prevalence of Disruptive Behavior

Ninety-six percent of individuals surveyed experienced a form of disruptive behavior. An equivalent percentage of individuals, 96%, witnessed a co-worker experiencing a disruptive event. The disruptive behavior manifested itself in multiple forms. More than one half (55.5%) experienced verbal disruptive behavior. A few (4.2%) experienced sexual harassment and physical imposition. No difference was found in the disruptive behavior manifestation by job classification, p = 0.29, Table 1.

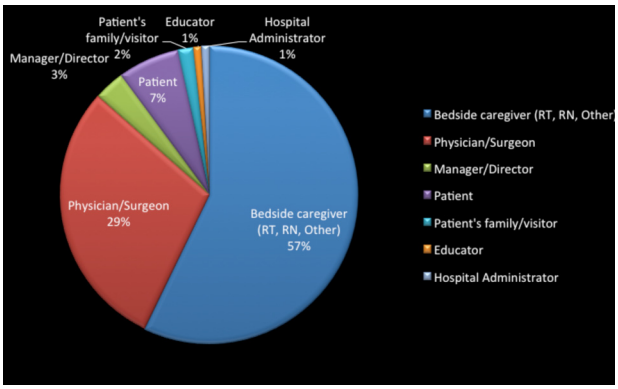
Bedside caregiver (57%), physician/surgeon (29%), and patient (7%) were identified as offenders, Figure 5. Males exhibited disruptive behavior (55.5%) more frequently than females (44.5%). Participants ranked peers (44.7%) as the most common offenders of disruptive behavior within the workplace, followed by a physician/surgeon (36%). Managers and supervisors were reported as the least common offenders (2%), Figure 6. Bedside caregivers did not experience disruptive behavior more often than department technical directors, supervisors, or educators, p = 0.78.

Most participants (58%) indicated the disruptive event did not occur during or immediately following a high stress situation. The primary cause was one in which there was an innate need for the offender to be in control of a particular situation or event. Survey participants (73.9%) described the

Table 1
Comparison of Disruptive Behavior by Job Classification

Type of Disruptive Behavior	Job Function					
	Educator	Department or Technical Director	Staff Therapist	Other	Total	p Value
Psychological n (%)	11 (9)	30 (25)	3 (3)	4 (3)	48 (40)	
Verbal n (%)	16 (13)	35 (29)	9 (8)	6 (5)	66 (55)	
Physical n (%)	2 (2)	0 (0)	1 (1)	0 (0)	3 (3)	
Sexual harassment n (%)	1 (1)	1 (1)	0 (0)	0 (0)	2 (2)	
					119 (100)	0.29

Figure 5
Role of the Disruptive Behavior Offender (n = 119)



perpetrator as one who forced the respiratory therapist into a subordinate role.

Exposure to disruptive behavior elicited varied responses. Most participants felt angered (36.1%). The next most frequent response was embarrassment (21%), followed by powerlessness (10.1%), harassment (9.2%), fearfulness (5.9%), confusion (4.2%), and hostility (0.8%). The ability to report emotional responses was not displayed as a survey option. These data are reported in aggregate and categorized as "other." Approximately 12.6% of subjects added additional responses and reported feeling stressed, disappointed, anxious, annoyed, shocked, and frustrated.

Disruptive behavior reduced morale (100%) and productivity (93.8%); increased the propensity for medical error (87.6%); and reduced the quality of care delivered (75.6%). Respondents reported experiencing physical ailments such as depression, anxiety, and migraines (94.6%). A majority of participants (83.2%) disagreed with the statement, "Disruptive behavior occurs in health care. It is just something I must accept as a part of my job."

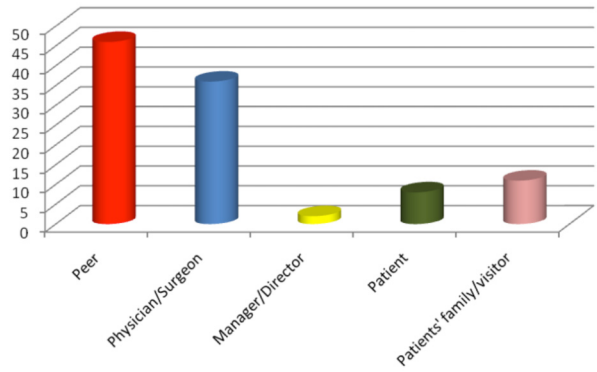
Most of those surveyed (87.4%) were aware of their institution's Workplace Violence or Corporate Code of Conduct policy. A few participants (4.2%) reported not having the aforementioned organizational policies, and 8.4% were unsure. Nearly 74% of participants reported the disruptive event to an organizational leader. Most participants (67.2%) agreed that a "Zero Tolerance" policy and structured discipline would eliminate or reduce disruptive behavior.

Discussion

Consistent with reports in the nursing literature, this survey confirmed that respiratory therapists experience disruptive behavior in the workplace. Verbal disruptive behavior was the most commonly experienced and was manifested as condescending, angry, accusatory, and/or vulgar comments.

Bedside caregivers were more likely to be offenders than

Figure 6
Frequency of Disruptive Behavior, Ranked by Frequency of Offense (n = 119)



individuals in a leadership role (supervisors, managers, educators). Respondents reported that this disruption compromised multidisciplinary teamwork, contributed to medical error, and reduced the delivery of safe and effective patient care. Our findings are consistent with reports in the literature describing how disruptive behavior undermines a collaborative work culture, especially when this behavior originates from the primary care team.[11] Hospitals with high teamwork ratings experience greater patient satisfaction, improved staff retention, and lower hospital costs.[12] Organizations in which disruptive behavior, aggression, and violence prevail accrue greater financial costs and lower quality of care ratings secondary to increased absences and turnover, as well as a reduction in employee morale, job satisfaction, and productivity.[13]

It is important to note that the survey participants did not feel that disruptive behavior was something that just happened and must be tolerated. A majority, 83.2%, acknowledged that disruptive behavior does occur in health care, but did not feel it is something the health care professional must merely accept as a part of the job. Respiratory therapists working in a disruptive environment show adaptive behaviors and possess significant coping skills. This is evidenced by the longevity in the field reported by the participants in this survey, with nearly one half (47%) documenting more than 30 years of work experience. Greater than 71% of participants reported they had never contemplated leaving their respective employment position after experiencing behavior that resulted in a disruptive event. Perhaps it is these individuals who face the challenge head on and try to redirect the aggressive behavior, thus deescalating the situation. Participants reported that it is important to encourage staff to document and report disruptive behavior immediately. Individuals need to know that they will be supported if they come forward with concerns about another's behavior.

There are respiratory therapists who, for reasons not assessed in this particular research endeavor, do not advocate for

themselves and succumb to the stress of the health care environment. This group of individuals may be among the nearly 29% who contemplated leaving health care. It is essential for those in leadership positions to develop a process to deal with disruptive behavior before it becomes an issue in the workplace. Educators play a significant role in improving the recognition and consequences of this type of behavior. Through education, policies, and administrative support, the incidence of disruptive behavior can be minimized.[1] Survey participants offered strategies to minimize and/or eliminate the occurrence of disruptive behavior similar to those reported in the literature. Increased awareness of the disruptive behaviors, developing a culture of respect, improved communication, and cooperation in the workplace were effective means of reducing disruptive behavior in the health care workplace.[14]

Limitations

The relatively small size of this convenience sample makes the results of this study difficult to generalize to the respiratory care profession. To illustrate this, our demographic profile did not match the demographic profile of respondents to the 2009 AARC Human Resource Study. Although members of the adult acute care section were recruited, the respondents to our survey were predominantly (63.1%) in leadership positions. Only 8% of those in leadership positions responded to the AARC Human Resource Survey. Recruiting from all AARC members, rather than those who also subscribe to a specialty section, may have improved our ability to generalize our results.

Our results may also have been impacted by the job classification of individuals who routinely utilize the section discussion lists. The Human Resource Study used postcards to recruit subjects, whereas our subjects were recruited by a posting on the respective section discussion lists. There were also disparities in the longevity in the profession. In our study population, 77.4% of participants had greater than or equal to 20 years of experience in respiratory care. Respondents to the AARC Human Resource Survey had on average less than 20 years in the field.

The increased awareness of organizational workplace disruption policies and/or Codes of Conduct may have been influenced by the fact that an overwhelming majority of participants were victims of or witnessed disruptive behavior in the workplace.

Conclusion

The causes of disruptive behavior are complex but can be identified within organizations that employ respiratory therapists. It was evident by the responses that disruptive behavior exists within the respiratory workplace and is experienced by those with different job classifications. An increased understanding of the causes and consequences of disruptive behavior will help members of the respiratory team effectively deal with disruptive events and high stress environments to help minimize displaced anger.

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APPENDIX A – Testing Instrument

Disruptive Behavior in the Respiratory Therapy Workplace

1. In what region do you work?
   - ❑ MA, RI, CT, NH, ME, VT
   - ❑ FL, MD, DE, SC, GA, DC, PR, VA, WV
   - ❑ NY, NJ, PA
   - ❑ MI, OH, IL, WI, IN
   - ❑ MS, TN, KY, AL
   - ❑ MO, MN, KS, IA, NE, SD, ND
   - ❑ LA, TX, OK, AR,
   - ❑ UT, NV, ID, AZ, WY, NM, CO, MT
   - ❑ CA, HI, OR, WA, AK

2. In what setting do you primarily work?
   - ❑ Acute care hospital
   - ❑ Home care
   - ❑ Subacute or long-term acute care
   - ❑ Skilled nursing facility
   - ❑ Respiratory care education program
   - ❑ Physician's office or clinic
   - ❑ Sleep Disorder Center

3. If you work in an acute care hospital, what is the bed capacity?
   - ❑ 1-100 beds
   - ❑ 101-200 beds
   - ❑ 201-400 beds
   - ❑ 401-or more beds

4. What is your primary job function?
   - ❑ Staff Respiratory Therapist
   - ❑ Pulmonary Function Technologist
   - ❑ Sleep Specialist
   - ❑ Neonatal or Pediatric Specialist
   - ❑ Supervisor or Team Leader
   - ❑ Department or Technical Director
   - ❑ Educator
   - ❑ Other_____

5. How many years have you been in healthcare? (Check one)
   - ❑ 0-5 years
   - ❑ 6-10 years
   - ❑ 11-15 years
   - ❑ 16-20 years
   - ❑ 21-30 years
   - ❑ 31 and over

6. Gender (check one)
   - ❑ Male ❑ Female

7. In your work experience in the hospital setting have you ever experienced a disruptive event? (Check one)
   - ❑ Yes ❑ No

8. In your work experience in the hospital setting have you ever witnessed a co-worker experiencing a disruptive event? (Check one)

❑ Yes ❑ No

9. Which type of disruptive behavior have you experienced or witnessed the most? (Check one)

❑ Verbal (examples: verbal outbursts, yelling, cursing)
❑ Physical (examples: hitting, pushing, shoving, striking, throwing objects)
❑ Sexual harassment (unwanted sexual advances, verbal or physical)
❑ Psychological (examples: uncooperative attitudes, impatience with questions)

10. What role was the disruptive behavior offender functioning in? (Check only one)

❑ Bedside Caregiver (RT, RN, Other)
❑ Physician/Surgeon
❑ Manager/Director
❑ Patient
❑ Patient's family/visitor
❑ Educator
❑ Hospital Administrator

11. What was the gender of the person(s) who most frequently performs these disruptive behaviors? (Check one)

❑ Male ❑ Female

12. Of the events you witnessed or experienced which of the following have been sources of disruptive behavior or unprofessional conduct? (Rank on frequency of offense)
(1 = most common and 5=least or never)

Peer	1	2	3	4	5
Physician/Surgeon	1	2	3	4	5
Manager/Director	1	2	3	4	5
Patient	1	2	3	4	5
Patients' family/visitor	1	2	3	4	5

13. Which of the following best describes your feelings following a disruptive event? (Please check only one)

❑ Powerless
❑ Fearful
❑ Hostile
❑ Harassed
❑ Embarrassed
❑ Angry
❑ Confused
❑ Other: _____

14. Did the event occur during or immediately after a high stress situation (example: trauma teams, intensive care teams) for either you or the disruptive individual? (Check one)

❑ Yes ❑ No

15. Certain situations have been shown to trigger stress and possible disruptive behavior. Please indicate all that you feel would trigger these behaviors. (Check all that apply).

- ❑ Equipment needed for a procedure is malfunctioning.
- ❑ Equipment needed for a procedure is not immediately available.
- ❑ The disruptive individual feels the need to be in control so he/she forces the therapist into a subordinate role.
- ❑ The disruptive individual is angry at another department.
- ❑ The disruptive individual feels there is a time delay.
- ❑ The disruptive individuals order is questioned.
- ❑ A sudden change happens in the patient's status
- ❑ Other: _____

16. Have you ever contemplated leaving healthcare due to a disruptive event or behavior? (Check One)

❑ Yes ❑ No

17. Based on your experience with disruptive behavior, respond to the questions below based on what you believe to be true.

a. The incident can have a negative effect on morale? (Check one)

❑ Yes ❑ No

b. The incident can decrease the victim's level of productivity for a period of time? (Check one)

❑ Yes ❑ No

c. The incident could lead to an increase in medical errors? (Check one)

❑ Yes ❑ No

d. Repeated exposure will influence the caregivers or providers in a negative way? (Example: depression, anxiety, migraines)

❑ Yes ❑ No

18. Do you believe that quality patient care provided by the victim is affected by disruptive behavior?

- ❑ No
- ❑ Yes, please explain: _____

_____

19. Disruptive behavior occurs in healthcare. It is just something I must accept as a part of my job.

- ❑ agree with the statement
- ❑ disagree with the statement

20. Does your institution have a Workplace Violence Policy or Code of Conduct? (Check one)

❑ Yes ❑ No ❑ Unsure

21. Have you ever reported a disruptive incident? (Check one)

❑ Yes ❑ No

22. Do you feel that a policy of zero tolerance for disruptive behavior and a structured discipline process for offenders would help to reduce or eliminate the use of disruptiveness? (Check one)

❑ Yes ❑ No ❑ Uncertain

23. What do you feel would help to reduce or eliminate the disruptive behavior?

_____

_____

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The Use of the Asthma Blues© Educational Program and Device Teaching to Improve Asthma Knowledge and Self-Management Skills

Kaynat Saiyed, MS, RRT

David L. Vines, MHS, RRT, FAARC

Brian Stein, MD, MS

Giselle S. Mosnaim, MD, MS

Abstract

Background: Empowering patients with asthma knowledge and self-management skills is critical to their achievement of asthma control. The purpose of this study was to determine if asthma knowledge could be increased using the Asthma Blues© Educational Program and asthma self-management skills could be improved by the teaching of proper use of a nebulizer machine, peak flow meter, and spacer with metered-dose inhaler (MDI). **Method:** Ten patients > 18 years of age admitted to the hospital with a documented physician diagnosis of asthma were recruited by a respiratory therapist to participate in this pilot study. During their hospitalization, patients received one-on-one teaching by a respiratory therapist on both the Asthma Blues© educational program and training on how to use a nebulizer machine, peak flow meter, and spacer with metered-dose inhaler (MDI). The Asthma Blues© educational program is an innovative and powerful way to improve the quality and efficiency of asthma education. Patients were asked to complete the Asthma Blues© educational program and to demonstrate proper nebulizer machine, peak flow meter, and spacer with metered-dose inhaler (MDI) technique pre- and post-intervention. **Results:** Asthma knowledge, assessed using the 15-item Asthma Blues Test, improved by 58% after receiving the Asthma Blues© educational program. All participants scored 100% on the nebulizer machine, peak flow meter, and spacer with metered-dose inhaler checklists after receiving training on proper use of each of these devices. The mean score improved from 44.5% pre-intervention assessment of asthma knowledge to 70.8% post-intervention. Patients scored 100% in device(s) knowledge and use following the instructions. **Conclusions:** Respiratory therapist delivery of asthma education using the Asthma Blues© educational program and asthma self-management training by demonstration of proper nebulizer machine, peak flow meter, and spacer with metered-dose inhaler (MDI) use was well received by patients and achieved improvements in both asthma knowledge and self-management skills.

Key Words: asthma, adult asthma, asthma education, asthma knowledge, asthma self-management, peak flow meter

Kaynat Saiyed, MS, RRT
Respiratory Therapist
Rush University Medical Center
Department of Respiratory Care
Chicago, IL

David L. Vines, MHS, RRT, FAARC
Chair and Program Director, Associate Professor of Respiratory Care
Rush University Medical Center
College of Health Sciences
Department of Respiratory Care
Chicago, IL

Brian Stein, MD, MS
Assistant Professor of Pulmonary and Critical Care Medicine
Rush University Medical Center
Rush Medical College
Department of Medicine
Division of Pulmonary and Critical Care Medicine
Chicago, IL

Giselle S. Mosnaim, MD, MS
Assistant Professor of Preventive Medicine, Immunology/Microbiology, Medicine, and Pediatrics
Rush University Medical Center
Rush Medical College
Departments of Preventive Medicine, Immunology/Microbiology, Medicine, and Pediatrics
Chicago, IL

Correspondence and Request for Reprints:
Giselle S. Mosnaim, MD, MS
Rush University Medical Center
Department of Preventive Medicine
1700 West Van Buren, Suite 470
Triangle Office Building
Chicago, IL 60612

Introduction

Asthma self-management, including use of controller medications and routine monitoring of symptoms, has proven helpful in minimizing symptoms of asthma as well as lessening the severity of asthma attacks when they do occur.[1] Studies show that many patients have a high frequency of emergency department visits due to poor asthma knowledge and self-management skills.[2,3] Hence, patients who are admitted to the hospital for asthma exacerbations represent a key opportunity for respiratory therapists to provide asthma education and self-management training. A previous randomized controlled trial was done to test whether an intensive asthma intervention program led by specially trained nurses could prevent readmissions of adult patients who were noted to be high users of health care. The multi-component intervention included asthma education, a written asthma action plan, social support, and telephone follow up calls after discharge. The combination of all of these components produced a significant decrease in asthma readmissions as well as total hospitalizations compared to patients receiving usual care.[4]

In 2005, *Asthma Blues*©, an interactive and easy-to use asthma educational tool, was released.[5] The musical CD consists of seven songs and an educational booklet that delivers clinical concepts key to successful asthma self-management. The *Asthma Blues*© educational program reinforces and expands key messages from the 2008 Guidelines Implementation Panel (GIP) Report.[5] The purpose of this study was to determine if respiratory therapist delivery of the *Asthma Blues*© educational program, as well as training in proper use of a nebulizer machine, peak flow meter, and spacer with metered-dose inhaler (MDI), could improve asthma knowledge and self-management skills, respectively.

Methods

This study was approved by the Rush University Medical Center Institutional Review Board. Patients > 18 years of age admitted to the hospital with asthma listed as one of their diagnoses were approached by a treating clinician to participate in the study. If the patient expressed interest and gave permission to be contacted by study staff, then the treating clinician gave the patient's contact information to the principal investigator, a respiratory therapist. Exclusion criteria included candidate refusal to participate in the study.

Study Design and Intervention

After obtaining written informed consent, patients were asked to complete a demographics questionnaire and the *Asthma Blues*© pre-test, as well as demonstrate proper use of a nebulizer machine, peak flow meter, and spacer with MDI. Following completion of the questionnaires, patients listened to five out of seven songs on the *Asthma Blues*© CD and read through educational modules accompanying these songs. The respiratory therapist then demonstrated proper use of a nebulizer machine, peak flow meter, and spacer. At the conclusion of the visit, patients were asked to complete the *Asthma Blues*© post-test and to demonstrate proper nebulizer machine, peak flow meter, and spacer technique. Variance in instrument administration and teaching of procedures was minimized by: 1) having only one respiratory therapist for all study participants; 2) the respiratory therapist strictly adhering to the *Asthma Blues*© Educational Self-Study Guide;[5] and 3) the respiratory therapist strictly adhering to the American College of Chest Physicians Patient Education Guide for teaching and evaluating proper use of a nebulizer machine, peak flow meter, and spacer with MDI.[6,7]

Measurement Tools

In this study, we used the following instruments to assess the patient's knowledge of asthma and asthma self-management skills: *Asthma Blues*©Educational Program,[5] *Asthma Blues*© Pre-Test and Post-Test,[5] and Device Knowledge Questionnaires.[6,7]

Asthma Blues© Educational Program and *Asthma Blues*© Pre-Test and Post-Test

Asthma Blues© communicates the goals of the National Heart, Lung and Blood Institute's Expert Panel Report 3 through the use of songs about asthma and delivers five of six messages from the 2008 GIP report.[5] The *Asthma Blues*©educational program pre-test and post-test are the same instrument. It is referred to as the pre-test when administered before the participant completes the *Asthma Blues*© educational program and the post-test after program completion. It consists of 15 items. Some of the items require multiple fill-in-the-blank answers, for a total of 23 possible correct answers.[5]

Device Knowledge Questionnaire

The Device Knowledge Questionnaire consists of three individual competency checklists to test patients' knowledge on the use of a nebulizer machine (8 steps), a peak flow meter (7 steps), and a spacer with a MDI medication (6 steps).[6,7] To receive credit for completing each step correctly, the participant had to perform the step correctly and complete each step in the proper order. A passing score equaled 100% (i.e. all items performed correctly and in the correct order).

Table 1
Demographics and Baseline Measurements

	Treatment (n = 10)
Age in yrs, mean (range)	54 (27-77)
Gender, Female	7 (70%)
Race/Ethnicity	
American/Alaskan Indian	1 (10%)
Black/African American	5 (50%)
Hispanic/Latino	2 (20%)
White	2 (20%)
Highest Education Level	
< High school diploma	2 (20%)
High school graduate/GED	4 (40%)
Some college/college graduate	4 (40%)
Age of Asthma Diagnosis	
0-≤1 yrs	2 (20%)
≥1-18 yrs	3 (30%)
>18 yrs	5 (50%)
Daily Controller Medications (Prior to hospital admission)	
Oral corticosteroid	2 (20%)
Inhaled corticosteroid plus LABA	7 (70%)
Long-acting anticholinergic	2 (20%)

Table 2
Asthma Blues© Score Pre-Post Intervention

	Treatment (n = 10)
Pre-intervention score (% items correct, mean, range)	45 (9-74)
Post-intervention score (% items correct, mean, range)	71 (43-91)
% Change (mean, range)	58 (4-65)

Table 3
Device Knowledge Assessment

	Nebulizer Machine (n=10)	Peak Flow Meter (n=10)
Pre-intervention (% Passed)	50	20
Post-intervention (% Passed)	100	100
% Change	100	400

Results

Participants

Ten patients were recruited for the study. Table 1 represents the patients' demographic and baseline characteristics. The mean age was 54 years with a range of 27-77 years. Seventy percent were female. The most common racial/ethnic group among patients was Black/African American (50%), followed by Hispanic/Latino (20%), White (20%), and American/Alaskan Indian (10%). Forty percent reported at least some college and/or had graduated college, while 60% had a high school diploma/GED or less. Fifty percent of the patients reported having been diagnosed with asthma by a physician at > 18 years of age, 30% between the ages of 1-18 years, and 20% before their first birthday. Seventy percent of the patients were on an inhaled corticosteroid long-acting bronchodilator combination medicine, 20% were on oral corticosteroids, and 20% were on a long-acting anticholinergic medication prior to admission to the hospital.

Asthma Knowledge and Self-Management Assessments

Table 2 represents *Asthma Blues*© pre-intervention and post-intervention asthma knowledge test scores.[5] The mean pre-test score was 45%, and the mean post-test score was 71%, with a 58% mean percent change. Table 3 represents summary asthma self-management scores pre- and post- intervention, which were calculated based on the patients' demonstration of proper technique according to nebulizer machine, peak flow meter, and spacer with MDI competency checklists.[6,7] Mean percent improvement for nebulizer machine, peak flow meter, and spacer technique were 100%, 400%, and 67% respectively.

Discussion

This is the first study to demonstrate improvement in asthma knowledge and self-management skills by a respiratory therapist: 1) in the inpatient setting; and 2) using music as the vehicle for delivery of the education. The respiratory therapist delivered the *Asthma Blues*© educational program[5] and one-on-one education on proper nebulizer machine, peak flow meter, and spacer technique during patients' hospitalization for asthma.[6,7] *Asthma Blues*© delivered key concepts to help persons to take control of their asthma through the use of music, songs, and accompanying educational modules.[8] Respiratory therapists caring for inpatients with asthma are uniquely positioned to deliver effective asthma self-management training on proper delivery of medications and self-monitoring of lung function.

This study had several limitations. The sample size (n=10) was small and there was no control group. Although the investigators were able to demonstrate improvements in both asthma knowledge and self-management skills, the study did not evaluate whether these improvements could be sustained over time. The promising results in this pilot study warrant a future, randomized clinical trial with a larger sample size and six month follow up period in order to evaluate for sus-

tained change. This study used asthma lyrics to increase asthma knowledge, laying the foundation for improving the patient's understanding of asthma, empowering him to become more active in disease management, and promoting the patient-clinician relationship.[5]

In summary, this pilot study demonstrated an improvement in asthma knowledge and asthma self-management skills by respiratory therapist delivery of the *Asthma Blues*© educational program and the teaching of proper device technique. Our educational intervention focused on the pathophysiology of asthma, function and appropriate use of medications, monitoring of asthma symptoms, assessment of asthma triggers, and proper use of medication delivery devices in order to empower patients to take better control of and manage their asthma.

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The Effect of Stethoscope Chest Piece on Sound Transmission and the Relationship of Stethoscope Price to Sound Transmission

Tadashia J. Cooper, BS, RRT

Jon R. Marstrander, MSEE, P.E.

Jonathan B. Waugh, PhD, RRT, RPFT, CTTS, FAARC

Abstract

Background: The stethoscope is a routinely used diagnostic/patient assessment instrument. However there is little information available for clinicians to utilize when selecting a stethoscope. Often only price and manufacturer descriptions are used when choosing a stethoscope. In this study, several types of stethoscopes were selected for testing to determine how much sound intensity is lost from the patient interface (chest piece) to the earpieces. The aim of this study was to provide an objective basis for comparing stethoscope performance and determine if a relationship between price and performance exists. **Methods:** Twelve models of stethoscopes were tested using computerized audio capture equipment (UA−1G interface with Cakewalk software by Roland Corp., Los Angeles, CA). A speaker (sonitor) designed specifically for interfacing with a stethoscope chest piece was used to send a sinusoidal sound sweep from 40 to 4000 Hz through the bell and diaphragm of each stethoscope chest piece. The stethoscope and sonitor/microphone apparatus were placed within an anechoic chamber for measurement in a room with low background noise. The difference between the sound input and output equals the amount of sound that is lost for each stethoscope (greater average area under the curve (AUC) value means less sound loss/better sound transmission). **Results:** Several of the nine models with bell chest pieces were different ($p=0.009$) as measured by One−Way ANOVA between Means, and the Prestige model S125 was different than all of the other models in that it had the least sound loss as tested by the Tukey−Kramer Multiple−Comparison test. The same analyses also showed a difference in the 12 models with diaphragm chest pieces ($p=0.002$), with the model Prestige S107 having the least sound loss value and being different from eight of the other models. The average AUC for all bell chest piece models was greater than that of the diaphragm models ($p<0.001$) for the full frequency range tested and the upper frequency range (1500−4000 Hz) using the Pooled t−test. Likewise correlation and linear regression showed no significant relationship between price and performance as measured by sound loss ($r = -0.406$ for bell and $r = 0.246$ for diaphragm). **Conclusions:** The findings from this small number of stethoscopes indicate some models do perform better than others based on this type of controlled measurement, but a higher price does not ensure better performance. Additional analyses may identify that certain models are better for specific frequency sub−ranges (low, medium, high), which could be useful for recommending certain models for specific applications.

Tadashia J. Cooper, BS, RRT
Teacher, Clinical and Diagnostic Sciences Dept.
University of Alabama at Birmingham
School of Health Professions, Respiratory Therapy Program
Birmingham, AL

Jon R. Marstrander, MSEE, P.E.
Instructor, Electrical and Computer Engineering
University of Alabama at Birmingham
School of Engineering, Dept. of Electrical
and Computer Engineering
Birmingham, AL

Jonathan B. Waugh, PhD, RRT, RPFT, CTTS, FAARC
Professor, Clinical and Diagnostic Sciences Dept.
University of Alabama at Birmingham
School of Health Professions, Respiratory Therapy Program
Birmingham, AL

Introduction

The ubiquitous stethoscope used by multiple health professions is of relatively simple design, but misconceptions about what attributes enhance performance persist and surprisingly little ongoing evaluation of the device is performed. Stethoscopes are used to listen to a variety of thoracic and abdominal sounds to confirm the presence of normal sounds and detect the presence of abnormal additional sounds. Mechanical stethoscopes simply transmit sounds from the body surface to the ears of the clinician. The sound waves from the patient are transmitted via direct contact with the bell or diaphragm interface of the stethoscope chest piece. The sounds are then transmitted down the tubing of the scope and into the binaural earpieces and into the ear. Electronic stethoscopes use a microphone element to directly convey an electronic signal for real-time listening or record it for later playback, or both. While it can be helpful for the user to have the ability to amplify electronic signals to varying degrees, this also introduces some distortion, as do the sample rate and signal conditioning selected by the manufacturer.

Stethoscopes are most thoroughly used for assessing the subtle qualities of cardiac and lung sounds but are commonly used to determine the presence of bowel sounds and detect vital signs as well. Examples of frequency ranges for particular adult chest sounds include: Low heart sounds (including 1st, 2nd, and 3rd heart sounds) 20-115 Hz, medium/high heart sounds (including systolic and diastolic murmurs) 200-660 Hz, vesicular (normal) breathing 150-1000 Hz, bronchial breathing 240-1000 Hz, and crepitations (crackles) ≥ 750 Hz.[1] Wilkins et al., describe the many factors that affect the transmission of sound through body tissues.[2] These factors include tissue density, reflectance/absorbance, and travel distance.

The different uses for stethoscopes have led to a wide variety of models. There is no official taxonomy for classification of stethoscopes, but a reasonable approach could be to base it upon intended use. This could include categories such as basic assessment, physical assessment, cardiology, high-end cardiology (suitable for assessing fine cardiac sounds), and even disposable. Like many other devices, stethoscopes come in different colors, shapes, and sizes; offer different features; and are made of different types of materials. They also vary considerably in price, costing as little as a few dollars to several hundred dollars. Given the wide price range of stethoscopes, objective evidence on performance characteristics needs to be available for determining the relative value of different models.

Previous studies have indicated that stethoscope qualities such as tubing length and diameter, single vs. double channel, type of chest piece, and materials may make a measurable difference in sound transmission.[3-4] While this may be true, it is generally accepted that differences due to tubing length and diameter are minor enough that they are not detected by adult hearing. Chest piece shape, angularity of the conducting channel, and especially fit of the ear pieces have greater bearing on the sound transmission differences in stethoscopes.[3-4]

Clinicians and students typically have little objective testing information to guide stethoscope purchases. Our goal was to assess several models intended for a variety of use categories and determine if there was a relationship between price and performance. A second goal was to provide an educational component on stethoscope features related to performance.

The Study

Audio performance can be measured in many ways and with many possible standards. We focused on the relatively simple approach of measuring sound loss over a defined spectrum and hypothesized that the more expensive the stethoscope, the less sound loss. Twelve models of stethoscopes were tested using three units of each model. All models had diaphragm chest pieces and nine models had bell chest pieces. A special speaker (sonitor) designed for use with a stethoscope was used in an engineering lab with low background noise (measured to confirm that it was below the test signal level) to transmit a sinusoidal sound sweep from 40-4000 Hz into the chest piece. The sound transmitted through each stethoscope was measured by a microphone attached to the earpiece using an anatomically correct ear canal volume. The microphone frequency response was verified by the manufacturer (Radio Shack, Fort Worth, TX) to be flat for the range tested in this experiment. The difference between the sound input and output equals the amount of sound that is lost for each stethoscope. The area under the curve (AUC) for the plot of this net sound level vs. frequency for the range measured yields an overall average of the sound transmission of each stethoscope (greater average AUC value means less sound loss). Therefore the best performing stethoscope would have the largest AUC value.

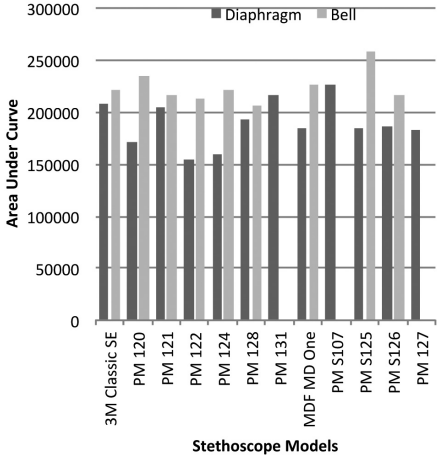
Results

Several of the nine models with bell chest pieces were different based on AUC plots ($p=0.009$) as measured by a one-way ANOVA, and the Prestige model S125 was different than all of the other models in that it had the least sound loss as verified by the Tukey-Kramer Multiple-Comparison test. The same analyses also showed a difference among the 12 models with diaphragm chest pieces ($p=0.002$); the model Prestige S107 had the least sound loss value of the eight tested models. Figure 1 shows the diaphragm versus bell chest piece AUC mean values for each model of stethoscope tested. The average AUC for all bell chest piece models was greater than that of the diaphragm models ($p<0.001$) for the full frequency range tested and the upper frequency range (1500-4000 Hz) using the Pooled t-test. Likewise correlation and linear regression

showed no significant relationship between price and performance as measured by sound loss (r = -0.406 for bell and r = 0.246 for diaphragm).

Figure 1

Diaphragm versus bell AUC means. The AUC values represent the cumulative AUC generated by net sound level vs. frequency for the range tested. The greater the AUC value, the greater the sound transmission.



Interpretation

The findings for this limited group of stethoscopes indicate some models do perform better than others based on this type of controlled measurement, but a higher price does not ensure better performance (Table 1). Additional analyses may identify models that are best for specific frequency sub-ranges (low, medium, high), which could be useful for the recommendation of certain models for specific applications.

Table 1

Price-Performance Comparison.

Model	Price	Combined Bell-Diaphragm AUC
Prestige - S126	$59.95	200920
Prestige - 127	$99.95	183438
Prestige - 121	$27.95	210321
Prestige - 128	$119.95	199438
Prestige - 120	$62.95	202582
Prestige - 122	$24.95	183308
Prestige - 124	$24.95	190618
Prestige - 131	$64.95	216655
Prestige - S125	$22.95	221412
Prestige - S107	$39.95	226149
3M Littmann Classic S.E.	$94.45	214622
MDF MD One	$65.00	205431

One important finding was that in all cases, bell chest pieces performed better than diaphragms. It is a common perception that the bell chest piece should only be used to listen to low frequency heart sounds and the diaphragm should be used to listen to lung sounds. It is believed that the diaphragm attenuates low frequency (heart) sounds and enables the listener to better appreciate the lung sounds. However, our findings indicate that while the diaphragm does have a greater limiting effect on low frequency sounds it reduces all frequencies measured. Therefore the bell chest piece would likely be best for listening to all thoracoabdominal sounds.

Limitations

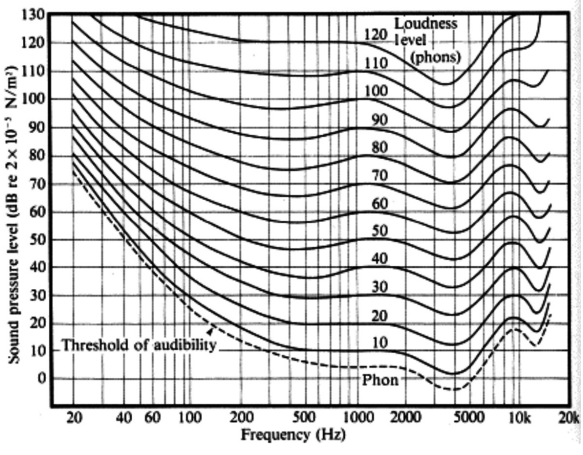
This investigation tested a small percentage of the total number of stethoscopes commercially available. There is a need for more of the models that are currently being sold to be objectively compared in order to draw confident conclusions. There is no accepted standard methodology for stethoscope testing. It would be useful to have a standard that allows comparison of studies as well as data pooling and secondary analyses.

Implications for Clinical Practice

The human ear does not perceive all frequencies at the same loudness. The often cited Flethcher-Munson curves show plots of equal loudness as a function of frequency, as shown in Figure 2. It is more difficult to hear sounds at the low and high extremes of the audible frequency range. With the onset of middle age, the maximum audible frequency decreases to around 16 KHz. The age-related hearing loss does not present an auscultation problem for most clinicians because most chest sounds of interest are still well within the hearing range of mature adults. Therefore clinicians of all ages can benefit from data on the performance of stethoscopes over the "functional" frequency range.

Figure 2

Fletcher-Munson plots of equal loudness as a function of frequency (from http://hyperphysics.phy-astr.gsu.edu/hbase/sound/eqloud.html with permission).



So what should one look for when purchasing a stethoscope? As previously indicated, higher price does not ensure better performance. There are many factors that affect the performance of the stethoscope; type and fit of earpieces, and the stethoscope material and tubing type (single or double) are all important factors. When purchasing a stethoscope, one can choose between models that have only a diaphragm, only a bell, or both. Just because a manufacturer says a feature functions like a bell or diaphragm does not guarantee it does. In this study, the bell had the least amount of sound loss in all models tested. Perhaps it should be the interface of choice for all diagnostic purposes.

Conclusions

The findings from this small number of stethoscopes indicate some models do perform better than others based on this type of controlled measurement, but a higher price does not ensure better performance. Additional analyses may identify the models that are best suited for listening to specific frequency sub-ranges (low, medium, high), which could be useful for making recommendations.

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Tools for Practice: Information Resources for the Respiratory Therapy Student

Kimberly Pullen, MLIS

Julia M. Esparza, MLS, AHIP

Introduction

The Transitioning the Respiratory Therapy Work force for 2015 and Beyond conference report, released in 2011, calls for several initiatives to better prepare the respiratory therapist for the future. A major goal is to transition associate degree programs to the baccalaureate level by 2020.With this transition comes a need to expand current curricula to include preparing students to embrace evidence-based medicine (EBM) and critical analysis of the literature. The report found that 22% of baccalaureateRT programs did not teach EBM and 20% failed to teach critical appraisal of the scientific literature, which is a necessary skill for EBM.[1] Since EBM is the integration of best research evidence with clinical expertise[2], respiratory therapists should be equipped with use of this information to better care for their patients.

So how does one find this evidence? While many individuals use general web search engines to seek information, there are several flaws that should discourage students from relying on these resources. First, thousands of citations are typically retrieved when completing most searches in a generic web search engine. This can lead to wasted time searching for a clinical answer. Second, a student may feel over confident with the results because he believes the citations are in relevancy order. While there is some relevancy used in many of the search engines, completing a systematic review of the literature using multiple databases to explore a specific topic is a better method of gathering quality information.[3-7]

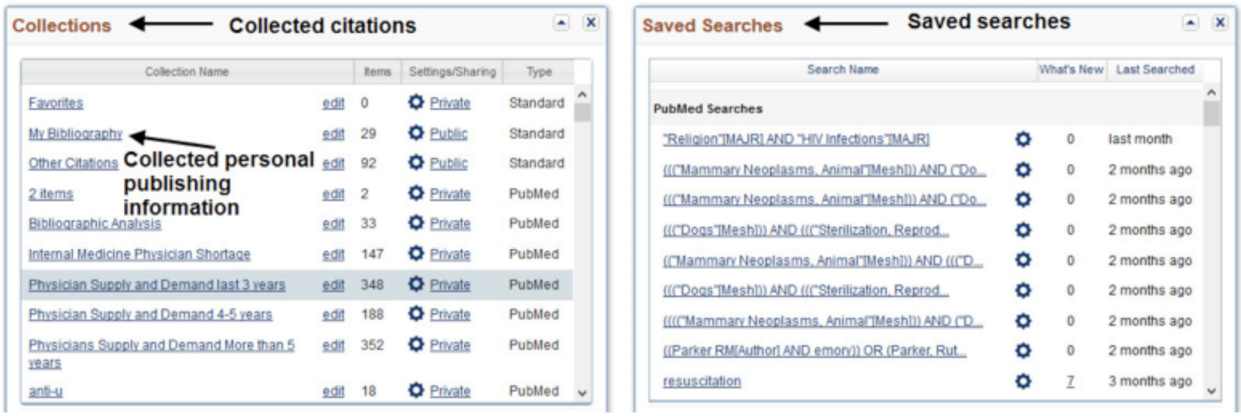
There are a number of search tools and databases that students need to be aware of to learn and utilize EBM and critical analysis of the literature. While information resources are an important part of the EBM process, the librarian plays a key role in optimizing EBM resources. First, a librarian is trained to efficiently find information from a variety of electronic resources. Second, librarians are trained in critical journal analysis and can assist practitioners in understanding the strengths and weaknesses of research articles. As a result, the librarian can assist faculty and students in finding relevant scientific literature and analyzing the literature to determine the quality.

Kimberly Pullen, MLIS
Head, Liaison Librarian
LSU Health
Health Sciences Library
1501 Kings Hwy, PO BOX 33932
Shreveport, LA 71130-3932

Julia Esparza, MLS, AHIP
Clinical Medical Librarian
LSU Health
Health Sciences Library
1501 Kings Hwy, PO BOX 33932
Shreveport, LA 71130-3932

Correspondence and Request for Reprints:
Julia M. Esparza, MLS, AHIP
LSU Health
Health Sciences Library
1501 Kings Hwy, PO BOX 33932
Shreveport, LA 71130-3932

Figure 1
Screen shot of My NCBI personal account interface



When librarians are incorporated into training, student learning and comfort with searching or information literacy are enhanced. While many programs include an orientation to the library, the involvement of a librarian in more in-depth search training benefits the students in the development of lifelong skills. Searching, as with other clinical skills, must be practiced frequently. As a result, the inclusion of the librarian into the curriculum through interactive searching with the students is crucial. In addition, librarians are often able to assist a student in critical analysis by working one-on-one with a student or small group of students to analyze a scientific article for presentation in a journal club type setting.[8-11] Teaching respiratory therapy students to search, analyze, and communicate the scientific literature is important because of the role they will play on patient care teams. While many respiratory care school faculty have limited time to devote to these enhanced learning experiences, librarians can often assist students in gaining competency.

The librarian should have a range of resources to help students find the relevant literature to practice EBM. Given the diverse environment, from small community hospitals to large academic centers, where respiratory therapists may practice, it is important that students be exposed to wide list of resources during their education. There are a number of key resources that should be emphasized since they are available at no cost to the student and can be beneficial in any clinical practice environment. These resources will be discussed below.

Citation Databases – The Primary Literature

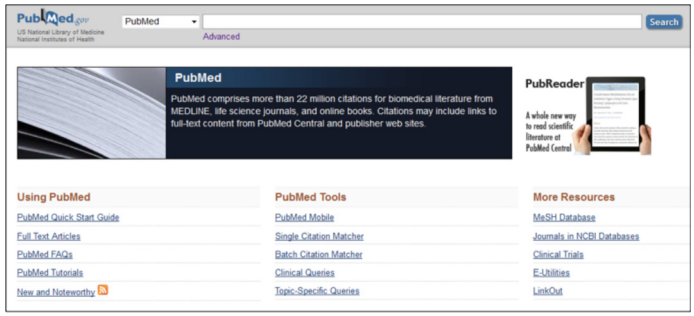
Free Databases

The National Library of Medicine (NLM) has been a leader in collecting medical information for clinical use since 1836.[12] Originally, the NLM maintained a physical library with employees indexing citations from scientific articles into the *Index Medicus* (a paper index). With the advent of computer systems, the NLM began to provide information in electronic format for searching in databases. The first database was MEDLINE® through MEDLARS® Online; later MEDLINE access came through Grateful Med, then with the World Wide Web, in the form of Internet Grateful Med® and then finally PubMed®.[13] For the creation of PubMed, the National Center for Biotechnology created an interface called NCBI to house databases to collect data. While the MEDLINE database is a large part of the interface, there are many other government databases within the system.[14]

NCBI contains a personal data management system called My NCBI. While several databases allow customization of data results through the use of My NCBI, in PubMed My NCBI allows a researcher to collect citations, save searches, and collect personal publishing information to be saved within the system (see Figure 1). A respiratory therapist may work in an institution that offers limited information resources. If the institution has a library, it may set up a system called LinkOut. LinkOut works with PubMed by identifying the journals that the institution pays for and then providing access to those journals.[15] Ensuring students are familiar with My NCBI would be a necessary learning outcome for RC programs that include EBM in their curriculum.

PubMed provides access to 22 million citations from over 5,600 worldwide journals making up the MEDLINE database (see Figure 2). A unique feature of MEDLINE is the ability to search this database using the NLM's Medical Subject Headings (MeSH®).Using MeSH allows focused search-

Figure 2
A screen shot of PubMed's main screen.



ing for quick retrieval of the information most relevant to the clinical need. MeSH is a controlled vocabulary that is applied to each article citation in the MEDLINE database. Sometimes referred to as the MeSH Tree, the hierarchical system allows browsing, which can provide a quick view of terms that may be relevant to a broader term.[16] For example, searching the term "artificial respiration" will yeild this MeSH Tree:

All MeSH Categories
- Analytical, Diagnostic and Therapeutic Techniques and Equipment Category
  - Therapeutics
    - Airway Management
      - **Respiration, Artificial**
        - High-Frequency Ventilation
          - High-Frequency Jet Ventilation
        - Interactive Ventilatory Support
        - Liquid Ventilation
        - Noninvasive Ventilation
        - One-Lung Ventilation
        - Positive-Pressure Respiration
          - Continuous Positive Airway Pressure
          - Intermittent Positive-Pressure Breathing
          - Intermittent Positive-Pressure Ventilation
        - Ventilator Weaning

To illustrate the power of MeSH, in a search of the PubMed database on 2/17/2013 when "high-frequency ventilation" (HFV) was entered in the PubMed database 4,924 citations were retrieved. Many of the citations were irrelevant. If "HFV" is searched in the MeSH database the phrase „high-frequency ventilation"[Mesh] comes up. Searching that phrase in PubMed retrieves 2,356 citations that are more relevant. Combining those 2,356 citations with PubMed filters such as "English language" and "human studies" results in 1,630 citations. PubMed also allows a researcher to filter by publication type such as meta-analysis, review article, clinical trial, or randomized clinical trial. When adding the filter "clinical trial" the search becomes very specific, with only 201 citations to review on HFV. After conducting the search, the respiratory therapist can save the search in My NCBI to create an ongoing search for information that may be relevant to clinical practice.

PubMed also contains citations for which various publishers provide full-text articles. Of the full-text articles, a subset is also in PubMed Central® (PMC).PMC is an archive of free articles. A search in PubMed on 2/17/2013 listed almost four million articles available for free in full-text, with over 700,000 from PMC. It will be tempting for students to only use free full-text articles. However, instructors should emphasize to students that they should utilize both those articles freely available and those purchased by their institution to adequately evaluate the literature on a research topic. Limiting the search to only free articles could result in an erroneous conclusion and jeopardize their clinical practice.

While PubMed and My NCBI are essential resources that respiratory therapy students should be familiar with, there are other citation databases that academic institutions or large health systems may provide. A number of these databases may be available through state consortium agreements and are available through public library systems. Many small community colleges may lack the funds to purchase these additional databases as they are expensive.

While in school, students ideally should have access to more than just the commonly used free databases. Accessing paid subscriptions to databases requires Internet access and computer use. Access is usually provided by the program or institution using secured passwords and user IDs.

Subscription Databases

When looking for full-text, peer-reviewed respiratory therapy related articles library subscription databases are a good place to start. While there are a number of other databases, the following are commonly held by academic institutions.

CINAHL® Plus with full text

EBSCO's database CINAHL is a research tool for allied health related literature. It provides full-text journals, plus legal cases, clinical innovations, critical paths, drug records, research instruments, and clinical trials. Additional material includes Evidence-Based Care Sheets and Quick Lessons, which provide concise overviews of diseases and conditions along with outlines of the most effective treatment options. CINAHL Subject Headings follow the structure of the MeSH subject headings used by the NLM, which reflects the vocabulary used by health professionals.[17]

Nursing@Ovid

Nursing@Ovid, from Ovid, indexes 400 journals and provides some full-text content. The focus is on nursing but allied health literature is included.[18]

Nursing & Allied Health Source

ProQuest'sNursing & Allied Health Source database also functions as a tool for research for those in nursing and allied health. The database includes over 715 titles in full-text and provides citations to over 850 titles. The database also includes dissertations from allied health and nursing.[19]

Other database resources that can be beneficial to search

EBM but have limited availability through some institutions due to their cost as subscription services include:

EMBASE™

EMBASE, from Elsevier, is a citation database containing records from over 7,500 medical journals. While there is overlap with MEDLINE, this database concentrates mostly on European literature. Elsevier is a world leader in scientific and medical journal publishing and most of any peer-reviewed journals in that area are indexed in the database. Most major academic institutions purchase this database as it is an expensive resource.[20]

MEDLINE through EBSCO, OVID, or ProQuest

Many academic institutions pay to access MEDLINE through a variety of paid vendors. While some researchers prefer a specific database's searching or saving features, it is important to remember that respiratory therapy students may lack access to these paid databases when going into actual practice. So the time spent learning these resources may not carry forward unless they obtain work at a large academic center.[21-23]

Web of Science®

Web of Science, available through Web of Knowledge from Thomson Reuters, is a citation database covering a wide range of research disciplines. With over 12,000 journals indexed, this database may not be a specific research tool for the respiratory therapist. However, this is one of the few databases that index conference proceedings. Web of Knowledge also contains ENDNOTE Web, which allows for easy citation management and paper formatting. This can be an extremely useful resource for students and researchers.[24]

Systematic Review or Meta-Analyses Resources

Since clinical trials (in many cases well conducted randomized controlled trials) are considered the basis for making many clinical decisions it reasons that researchers have determined ways to summarize the evidence for quick evaluation by healthcare professionals. At times the groupings of literature on a topic may have different names, such as comparative effectiveness research, technological assessment, or EBM. Each of these processes utilizes the framework of systematic reviews or meta-analyses to report the literature.[25] While systematic reviews and meta-analyses may contain bias they are normally considered a higher level of evidence since they can show trends of success or failure of treatments or diagnostic tests, or they can determine that additional research is needed due to inadequate study design in most studies or that there is limited literature available.

Cochrane Library

In 1971, *Effectiveness and Efficiency*, written by Archibald Cochrane, was published and changed the way medical research was evaluated. As a strong advocate for research involving randomized controlled trials, he often found conflicting results from papers studying the same question. He encouraged researchers to evaluate all of the randomized controlled trials together to see the overall results of research on a specific topic.[26] In 1993, the Cochrane Collaboration began to provide a framework for pursing this type of systematic analysis of randomized controlled trials.[27] Today, with over 53 research centers, the Cochrane Collaboration publishes research through the Cochrane Library. The Cochrane Library is offered through John Wiley & Sons and is a reliable online collection of six EBM databases that contain high quality research on healthcare treatments, interventions, methodology, and diagnostic tests. Citations of the Cochrane Collaboration reports are indexed in MEDLINE but a paid subscription is needed to access the full-text.[28]

Point-of-Care Resources

Resources used by clinicians during patient care are called point-of-care (POC) resources. One of the oldest and the most common POC resource is testing of medical equipment. However, since the late 1990s information found in POC resources has become a useful tool for answering clinical questions.[29] These resources are available through licenses purchased by a health system or academic center. With the explosion of smart phones, many POC resources are available as applications on these devices. The following are examples of POC resources that may be available through institutional access.

ACP PIER®: Physicians' Information and Education Resource

ACP PIER is a collection of evidence-based summaries on common diseases, procedures, and screening methods. Maintained by the American College of Physicians this resource is updated when new literature is published. This resource provides rankings on the quality of the evidence on a particular topic. The resource is meant to provide quick answers for the busy clinician.[30]

DynaMed

DynaMed®is a clinical reference tool created by physicians for health care professionals to use at the point-of-care. A product of EBSCO Industries, summaries are clinically organized to provide the most current content and resources, making DynaMed an excellent resource for answering clinical questions. The summaries are evidence-based and the relevant literature is ranked to help the clinician understand the importance of a particular study.[31]

GIDEON (Global Infectious Diseases and Epidemiology Online Network)

GIDEON, from GIDEON Informatics, is a differential diagnosis tool meant to be used by the clinician evaluating patients for infectious diseases. The material in the database is evidence-based and also updated weekly with the latest epidemiologic information from the World Health Organization, Centers for Disease Control and Prevention in the United States, and other agencies collecting infectious disease information. The database contains appropriate treatment strategies for each infectious disease.[32]

Isabel

Isabel was established when Jason and Charlotte Maude almost lost their daughter Isabel to severe complications from chicken pox. A part of Isabel Healthcare, Isabel is a diagnostic tool that helps physicians determine differential diagnosis and to assist with an accurate diagnosis. The system can be used with an electronic health record and may be seen by students or practicing respiratory therapists.[33]

UpToDate

UpToDate® is probably the most widely used POC information resource. A product of Wolters Kluwer, it provides evidence-based summaries written by medical professionals. The database contains over 10,000 summaries covering 20 different specialties.[34] This resource is typically very expensive.

Multi-collection Resources

Multi-collection resources such as bundled textbooks, multimedia resources, and online assessments often contain products or portions that can serve as POC resources providing quick answers.

McGraw-Hill

McGraw-Hill has a group of resources named AccessEmergencyMedicine, AccessMedicine, and AccessSurgery. They include textbooks; multimedia learning resources such as lung sounds, echocardiography videos, and images and procedures; and differential diagnosis tools and knowledge assessments or self-examinations to prepare students and clinicians for credentialing examinations.[35-37]

Elsevier

Elsevier provides several multi-collection resources. MDConsult offers comprehensive information available in an online resource. The resource provides information from textbooks published by Elsevier and provides full-text articles from many Elsevier published journals. The resource also provides patient education material that can be useful to students or practicing respiratory therapists as they educate patients on their diseases and therapy.[38] In 2012, Elsevier brought out ClinicalKey, which is an updated multi-collection resource with additional journals, textbooks, and other features. ClinicalKey will take the place of MDConsult in 2014.[39]

Stat!Ref

Unlike the multi-collection resources from McGraw-Hill and Elsevier, Stat!Ref is a healthcare e-resource that provides access to textbooks and other resources. The interface is like using online textbooks and the resource allows for searching within a particular resource. Institutions can customize resources in the database based on the clinical care they provide. The resource is one of the few databases that contains CPT with RVUs Data File from INGENIX®, HCPCS - Level II – the Healthcare Common Procedure Coding System, and ICD-9-CM (soon to be ICD-10-CM) resources in a searchable format. STAT!Ref also provides access to a collection of medical reference books, including a medical dictionary, and is accessible by desktop, laptop, and wireless or web-enabled mobile devices.[40]

Journal Resources

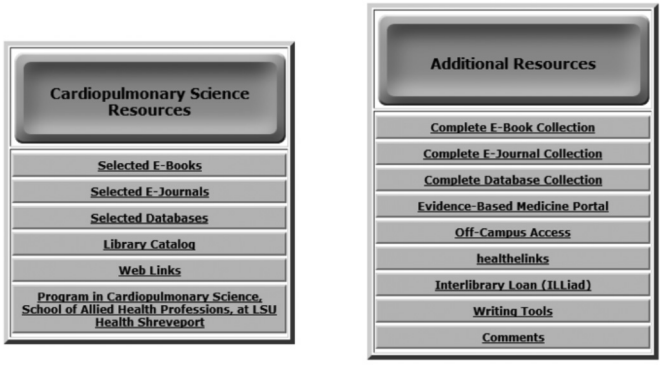
There are many respiratory therapy related journals, and depending on faculty interest, those can change with institutions. Providing a list of core journals available to the student can be useful. One such list of resources is a subject portal.

Subject Portals

As seen in Figure 3, librarians often develop subject portals or web pages to organize resources for educational programs or clinical departments. Typically, a subject portal contains lists of relevant databases, electronic books, electronic journals, and useful websites. The portal can be set up in a number of different ways to meet the needs of a particular set of students.

As the next generation of respiratory therapists is educated, it is important to realize the role they will play in the future

Figure 3
An example screenshot of a Cardiopulmonary Science Subject Portal



of patient care. Providing students with the ability to search and analyze the literature is critically important to their future ongoing education. Instruction on the practice and evaluation of the literature needs to comprise more than a one hour library orientation. Training should be embedded into the curriculum so students are comfortable evaluating the literature and then presenting the evidence from the literature to physicians, hospital administrators, and other therapists. By partnering with libraries and librarians, faculty can give students the skills they need to be leaders in their field.

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