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Research Article

Assessing respiratory therapists' compliance with cystic fibrosis guidelines in Saudi Arabia: A descriptive quantitative study

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Abstract

Introduction

Cystic fibrosis (CF) is a severe autosomal recessive disorder caused by mutations in the cystic fibrosis transmembrane conductance regulator (CFTR) gene. This condition disrupts chloride channels and leads to the production of thick, sticky mucus, affecting the respiratory and gastrointestinal systems. CF's prevalence is particularly high in Saudi Arabia, where the incidence has increased from 1 in 2,000 to 1 in 1,000 births. Effective management of CF is essential for improving patient outcomes, yet there is a notable lack of understanding regarding respiratory therapists' (RTs) adherence to established CF management protocols.

Methods

This descriptive quantitative study aimed to assess RTs' adherence to the Cystic Fibrosis Foundation's guidelines. Using a convenience sampling technique, a self-report survey was distributed to 750 members of the Saudi Society for Respiratory Care (SSRC), resulting in 351 responses, of which 166 were fully completed and met the inclusion criteria. The survey focused on RTs' knowledge and management practices related to CF. Data analysis was conducted using SPSS version 25, with descriptive statistics (mean, standard deviation, frequency, percentage, and mode) and non-parametric tests. The Kruskal-Wallis Test was employed to evaluate differences in adherence scores across demographic groups (e.g., education level, years of experience). Chi-square analysis was applied to examine relationships between categorical demographic variables (e.g., region of practice) and adherence to guidelines.

Results

The analysis revealed significant gaps in RTs' adherence to CF guidelines, with only 42.8% accurately identifying the sweat chloride threshold for CF diagnosis and a limited 36.1% recognizing Pseudomonas aeruginosa as a common CF pathogen. Additionally, just 56.6% correctly identified the gold-standard airway clearance therapy. The Wilcoxon signed-ranks test further highlighted a statistically significant disparity ($p = 0.00$) between RTs' theoretical knowledge and practical application of CF management techniques, emphasizing the need for improved training.

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Discussion

The findings suggest a need for enhanced training and resources to bridge the gap between theoretical knowledge and practical management of CF. The lack of adherence to clinical guidelines could impact patient outcomes and survival rates.

Conclusion

Improving RTs' adherence to CF management guidelines through ongoing education and updated clinical standards is essential. Addressing these gaps could elevate the standard of care and contribute to better patient outcomes and survival rates in Saudi Arabia.

INTRODUCTION

A complicated autosomal recessive disease known as cystic fibrosis (CF) occurs due to alterations in the gene that expresses the protein known as cystic fibrosis transmembrane conductance regulator (CFTR). The CFTR gene is encoded by ion channel protein, which has been related to more than 2000 identified mutations.[1] Individuals without CF possess two functional copies of this gene. CF reveals when one or both copies are nonfunctional.

Additionally, the CFTR protein regulates chloride channels, bicarbonate levels and the transport of chloride and sodium across various organs, including the lungs, pancreas, salivary glands and kidneys. Mutations in CFTR result in significant impacts on the lungs and gastrointestinal tract. The movement of chloride across airway epithelial cells and sodium retention are disrupted in the lungs due to CFTR failure. The increased water absorption caused by this disruption lowers airway surface fluid and produces thick, sticky mucus. Consequently, ciliary function in CF patients is compromised, creating an environment favourable for bacterial growth.[2]

The Cystic Fibrosis Foundation's annual reports estimate that approximately 60,000 to 70,000 people globally are affected by CF.[3] The incidence of CF varies by region. In Europe, the average prevalence is 0.737 per 10,000 individuals.[4] CF affects 1 out of every 4,000 babies born in the United States,[5] whereas in the Middle East, the incidence is 1 in 5,800 births.[6]

Moreover, the prevalence of CF has increased drastically in Saudi Arabia, from 1 in 2000 births to 18 in 1000 births.[7] Patients with CF have a 20-year average survival rate across the country, which is lower compared to other countries with similar healthcare systems.[8] For instance, the median age of survival for cystic fibrosis patients in France is 65.9 years, while in Australia, it is 53.3 years, 55.4 years in Canada, and 54.8 years in New Zealand.[9] This discrepancy emphasizes the urgent need to improve clinical practices and adherence to established treatment protocols in Saudi Arabia. Studies indicate that early diagnosis and comprehensive disease management by multidisciplinary teams, along with effective therapeutic interventions, contribute to the increased survival rates among CF patients.[10]

Effective management of respiratory complications is essential in the treatment of CF. Airway clearance drugs such as bronchodilators, Pulmozyme, and hypertonic saline are used in conjunction with exercises for the chest and antibiotics. To provide the best possible care for patients, respiratory therapists (RTs) must adhere to the most recent CF recommendations and stay current on available treatments.[11]

Furthermore, RTs are essential for the management of patients with CF and associated comorbidities, focusing on treatments such as gene replacement therapy, airway clearance and aerosol drugs.[12] RTs play an essential role in improving oxygen intake and maintaining clear airways for CF patients by delivering aerosol treatments and performing airway clearance, all while adhering to CF pulmonary guidelines. Also, they teach patients and their family members how to prepare and administer required therapies and clear the airways. When lung function declines, experienced RTs play a major role in guiding patients from primary oxygen therapy to recurring oxygen use, mild ventilation or intensive ventilation, particularly for those awaiting lung transplants. In addition to this, RTs may conduct pulmonary function tests to evaluate the patient's baseline lung function.[11]

CF's prevalence and patient distribution vary in Saudi Arabia, with 37% of cases originating from the East. Most patients have CFTR mutations, with 67% from Saudi Arabia and 13% non-natives. A study in Saudi Arabia revealed that 1234V and 1548deIG are the most prevalent CFTR mutations.[10] Additionally, the condition's magnitude is still noteworthy as CF has been linked to other medical conditions such as tuberculosis, diarrheal diseases and malnutrition, emphasizing the need for specialized management strategies. Moreover, RTs are integral to implementing airway clearance therapy (ACT), including cough and huff technique, autogenic drainage (AD), oscillating positive expiratory pressure (OPEP), active cycle of breathing technique and chest physiotherapy (CPT), which are essential for reducing airway obstruction and managing lung infections.[10]

CF airway clearance therapy (ACT) is a basic intervention for managing CF, as lung infections cause 85% of total deaths. ACT helps reduce air obstruction and minimize lung infections. Lung function has been reported to improve, and exacerbations have decreased with ACT.[13] However, ACT alone is often insufficient, requiring adjunct therapies such as antibiotics, especially inhaled tobramycin, to target pathogens such as *Pseudomonas aeruginosa*, a common cause of respiratory infections in CF patients.[10] ACT is another alternative and chest physiotherapy is essential for CF treatment. This method involves postural drainage, deep breathing exercises, chest percussion, vibration and coughing to reduce secretion in the lungs and respiratory tract.[14]

The study holds significance as it can improve RT's understanding and compliance with CF clinical standards. The research intends to evaluate RTs' adherence to international CF guidelines and identify areas requiring additional training and instruction to enhance adherence. Furthermore, the study will also evaluate the extent to which RTs currently follow published criteria. By identifying areas where RTs may benefit from enhanced training, this research will help to improve the standard of care for CF patients, ultimately contributing to better long-term patient outcomes.

Pulmonary exacerbations are the main cause of hospital admissions and occurrences of CF fatality.[15] Given that RTs play an essential role in managing pulmonary complications in CF, it is mandatory that they possess adequate knowledge about the disease and its management. Yet, the current study revealed gaps in the literature regarding the overall compliance of RTs to the CF clinical standards, especially in the KSA.

This descriptive quantitative research aims to assess RTs' degree of adherence to CF criteria and assess whether RTs in Saudi Arabia are managing respiratory complications in CF in compliance with the recommendations published by the CF Foundation. Additionally, the research aims to identify gaps in CF awareness and management practices to inform targeted improvements in healthcare strategies.

HYPOTHESIS

This research hypothesizes that RTs in Saudi Arabia exhibit varying levels of adherence to CF clinical guidelines, with significant variation in compliance based on factors such as educational background, experience level and regional differences. We hypothesize that gaps exist in both awareness and practical management of CF care among RTs, potentially leading to variability in adherence to established guidelines. The null hypothesis states that there is no significant difference in CF clinical guideline adherence among RTs in Saudi Arabia based on educational background, experience, or region.

METHODOLOGY

DATA COLLECTION

The data was collected using a self-reporting survey based on the Cystic Fibrosis Foundation's published guidelines. The survey, distributed electronically between January 2018 and March 2018, included 33 multiple-choice questions, each structured to provide one correct answer alongside incorrect options and an "I don't know" response to measure participants' knowledge and confidence level. The survey questions were divided as follows:

- Demographic Questions: 13 questions gathered demographic information, such as age, gender, years of experience, education level and familiarity with CF guidelines.
- Knowledge Assessment on CF: 6 questions tested participants' understanding of CF disease characteristics, clinical presentations and diagnostic criteria. To measure foundational CF knowledge, these questions focused on important CF indicators, such as chloride concentration levels and lung function expectations in CF patients.
- Adherence to Clinical Guidelines: The remaining 14 questions assessed adherence to the Cystic Fibrosis Foundation's guidelines for CF management. These questions covered recommended practices, including airway clearance therapies, use of mucoactive agents and antibiotic protocols for specific pathogens prevalent in CF.

To ensure content validity, the survey instrument was refined using a modified Q-sort method and reviewed by a committee of respiratory therapy education experts. The survey was then distributed electronically to the Saudi Society for Respiratory Care (SSRC) members. Participants received a cover letter explaining the purpose of the study, confidentiality assurances and detailed instructions. Survey questions are included in the Appendix.

SAMPLE SIZE

Utilizing a convenience sampling technique, 750 surveys were emailed to SSRC members, and 351 responses were obtained. Of these 351 responses, 166 were completed in full and met the inclusion criteria. Responses with missing data were excluded to ensure the reliability of the findings, resulting in a final sample size of 166 complete surveys. This sample size was determined by the availability and willingness of SSRC members to participate in the survey.

INCLUSION AND EXCLUSION CRITERIA

The study included respiratory therapists who are members of the Saudi Society for Respiratory Care (SSRC) and are either currently practicing respiratory care in Saudi Arabia or have previously practiced in the country, regardless of their country of origin or familiarity with CF foundation clinical guidelines. Respiratory therapists who have never practiced in Saudi Arabia were excluded from the study, even if they are members of the SSRC.

STUDY VARIABLES

The study included both demographic and dependent variables. Demographic variables were gender, age, country and region of residence, highest level of education, age at the start of working as a respiratory therapist, years of experience in respiratory care, clinical experience with CF patients and guidelines, current position and National Board for Respiratory Care (NBRC) accreditation. Dependent variables focused on the RTs' perception and knowledge of CF disease and their perception of CF disease management. These dependent variables were measured through responses to 20 questions (6 on CF disease knowledge and 14 on CF disease management).

DATA ANALYSIS

A descriptive exploratory approach was applied to analyze the data collected from the survey. The analysis used the Statistical Package for the Social Sciences (SPSS) version 25. Variables were categorized based on their measurement levels to ensure the application of appropriate statistical techniques.

Descriptive statistics were calculated to summarize demographic and dependent variables. The mean and standard deviation were reported for interval/ratio variables (e.g., age, years of experience, starting age in the respiratory therapy profession). For nominal and ordinal variables (e.g., gender, region of practice, education levels, familiarity with CF treatment guidelines, and NBRC accreditation), frequencies, percentages, and mode were used.

To investigate relationships and differences between variables:

- Spearman's Rank Correlation: Used to analyze correlations between ordinal/ratio variables, such as current age and total correct responses. The strength of correlations was interpreted following Davis conventions.
- Mann-Whitney U-Test: Applied to compare differences in adherence scores between groups (e.g., those with vs. without NBRC accreditation).
- Kruskal-Wallis Test: This test compares adherence scores across multiple groups (e.g., education levels, years of experience categories) to identify significant differences based on demographics. The results of the Kruskal-Wallis Test are reported in terms of the H statistic and degrees of freedom (df).
- Chi-Square Analysis: Applied to examine relationships between categorical demographic variables (e.g., region of practice, education level) and adherence to CF clinical guidelines.

ETHICAL CONSIDERATION

This study was approved by the Institutional Review Board (IRB) at Georgia State University and granted approval under Exempt Protocol Category 2 (IRB Number: H18241). To protect participant anonymity and prevent multiple submissions from the same individual, the survey was designed to include IP address tracking and session-based authentication, which ensured each participant could submit the survey only once. Additionally, no personally identifiable information was collected, ensuring participants remained anonymous. Missing or incomplete responses were handled through a pairwise deletion approach for quantitative variables, ensuring that incomplete data did not significantly bias the results. For qualitative responses, missing data was coded as 'not provided,' and where applicable, these entries were excluded from analysis.

RESULTS

We found that 94% of surveyed RTs in Saudi Arabia are Saudi citizens, with a majority being male (69.9%). The workforce is predominantly well-educated, with 73.5% holding bachelor's degrees. Most therapists work in central Saudi Arabia (51.8%), followed by the Eastern region (24.1%). While 63.9% have experience with CF patients and 53.6% are familiar with the CF Foundation's guidelines, only 33.1% have NBRC credentialing. Further demographic details are outlined in Table 1, providing insights into the professional landscape of RTs involved in CF care in Saudi Arabia.

Regarding professional experience, respiratory therapists in this sample are relatively young, with a mean age of 29.2 years (SD = 5.5). They began their careers at an average age of 24.2 years (SD = 2.6) and have an average of 4.93 years of experience (SD = 4.9), indicating a varied range of professional experience. This range suggests a mix of early-career professionals and more seasoned practitioners, contributing to diverse perspectives on guideline adherence. For a full descriptive summary of age, starting age, and experience levels, please refer to Table 2.

In examining the knowledge and management practices related to CF among RTs, only 42.8% could accurately identify the sweat chloride threshold for diagnosing CF, with a notable proportion mistakenly assuming predicted FEV1 values in adults with CF would remain normal. Recognition of typical CF-related chest x-ray findings was also low, with only 28.3% answering correctly. Knowledge about CF's inflammatory response was higher, with 67.5% of respondents recognizing the link between CF inflammation and infection burden, yet knowledge of *Pseudomonas aeruginosa* and its associated antibiotic treatment was limited, with only 36.1% and 36.7% accuracy, respectively. Table 3 provides a detailed breakdown of these knowledge and management responses, demonstrating areas where RTs may benefit from targeted educational resources to improve CF patient care.

Further analysis using the Wilcoxon signed-rank test revealed a statistically significant difference (p = 0.00) between total correct responses for the management and awareness and knowledge sections. Specifically, 144 participants had higher scores in the management section compared to the awareness and knowledge section, while only 7 participants scored higher in the awareness and knowledge section. The test results confirm that RTs demonstrated better adherence and accuracy in management practices compared to their awareness and knowledge of CF guidelines. This suggests that practical implementation of management strategies is stronger than theoretical knowledge among RTs. The complete test results are detailed in Table 4.

Spearman's rank-order correlation indicated a weak positive association (0.264) between years of experience and correct responses, while a negative correlation (-0.303) was observed with "I don't know" responses, both statistically significant ($p < 0.01$). Although experience correlates with accuracy and decreased uncertainty, this correlation is not strong, emphasizing the need for continuous education and knowledge updates for RTs to stay current on best practices. Detailed results are presented in Table 5.

Table 1. Demographic Characteristics of Surveyed Respiratory Therapists (Current or Formerly Practicing in Saudi Arabia, N=166).

Characteristic	N	%
Country of Citizenship		
Canada	3	1.8
Philippines	4	2.4
Saudi Arabia	156	94.0
United States of America.	2	1.2
Yemen	1	0.6
Gender		
Male	116	69.9
Female	50	30.1
Practicing Respiratory Care in Saudi Arabia		
Yes	132	79.5
No	34	20.5
Region of Practice		
Centre	86	51.8
East	40	24.1
North	2	1.2
South	8	4.8
West	30	18.1
Level of Respiratory Therapy Education		
Associate degree	11	6.6
Bachelor's degree	122	73.5
Master's degree	33	19.9
Overall level of Education		
Associate degree	9	5.4
Bachelor's degree	115	69.3
Master's degree	34	20.5
Doctorate (PhD, EdD, ScD, etc.)	6	3.6
Doctor of Medicine	2	1.2
Position		
Technician	14	8.4
Specialist	100	60.2
Supervisor	14	8.4
Director or Manager	8	4.8
Clinical Educator	7	4.2
Participant treated CF patient in the past		
Yes	106	63.9
No	60	36.1
Familiarity with CF Foundation clinical guidelines		
Yes	89	53.6
No	77	46.4
Credentialed RRT from NBRC		
Yes	55	33.1
No	111	66.9

Table 2. Demographic Characteristics of Respiratory therapists in Saudi Arabia, N=166.

Characteristic	M	SD	Minimum	Maximum
Current age	29.2	±5.5	23	51
Age when started respiratory care profession (years)	24.2	±2.6	20	39
Years of experience	4.9	±4.9	0	22

Regarding experience, our data revealed that RTs with more than five years of experience performed better, as indicated by higher correct response rates. This relationship was confirmed by a Mann-Whitney U test, with a Z-score of -4.028 and a significance level of $p < 0.001$. Table 6 provides a summary of these results, highlighting the correlation between years of experience and adherence proficiency.

The Kruskal-Wallis Test was applied to compare adherence scores across multiple demographic groups, including regions of practice, education levels, and professional roles. The results, presented in Table 7, show no significant differences between adherence scores based on practice region ($H = 2.5$, $p = 0.645$) or respiratory therapy education level ($H = 2.7$, $p = 0.255$). However, borderline significance was observed for overall educational attainment ($H = 9.1$, $p = 0.053$) and current professional roles ($H = 12.1$, $p = 0.050$), suggesting these variables may warrant further investigation.

Finally, chi-square tests were conducted to evaluate relationships between categorical variables, such as education level, practice region, and adherence scores. These tests revealed no statistically significant associations ($p > 0.05$), further confirming the results of the Kruskal-Wallis Test for certain demographic factors.

DISCUSSION

This study highlights important findings on the adherence of RTs in Saudi Arabia to clinical standards for managing CF, providing insight into gaps in both knowledge and practice. The implications of these findings emphasize the need for curriculum improvements, enhanced practical training and tailored interventions in healthcare settings to bridge observed knowledge-practice gaps. The findings, as demonstrated in Table 4, indicate that around 35% of RTs in Saudi Arabia do not adhere to established standards for managing respiratory problems in patients with CF. This lack of adherence may reflect an underlying ambiguity in specific recommendations within the clinical guidelines, making it challenging for practitioners to apply them consistently in diverse clinical settings.[16] Non-compliance may also reflect a need for clearer guidelines and more rigorous integration of these standards into educational programs, as suggested by past research that advocated curriculum incorporation of clinical guidelines to enhance adherence among healthcare practitioners.[17]

Similarly, Hurst et al. revealed that physicians holding accreditation-certification status exhibited higher adherence to clinical guidelines, superior patient education, elevated patient satisfaction and improved timeliness of care.[18] Accreditation and certification in the field of respiratory therapy, similar to the medical profession, may promote higher adherence to clinical standards and better patient outcomes. In Saudi Arabia, where CF is a significant health concern, ensuring that RTs are adequately accredited could result in improved care delivery, including better adherence to evidence-based guidelines for CF management. This could, in turn, lead to improved patient education, satisfaction, and overall care quality. Therefore, it is important for policymakers and educators to consider strengthening the accreditation and certification frameworks for RTs in Saudi Arabia to align with international best practices and improve the quality of care for CF patients.

Additionally, the respondents have higher accuracy in the management section than in the knowledge section, which further suggests that they have inadequate expertise regarding CF. This highlights a gap between theoretical knowledge and practical application. Similar findings of a knowledge-practice gap were found in a similar study conducted in Nigeria to evaluate healthcare practitioners' knowledge and practices for the management of uncomplicated malaria.[19] According to a 2021 study, the observed variation between knowledge and practice in disease management could be attributed to a number of factors, including inadequate self-efficacy, lack of motivation and awareness, conflict with guidelines and an excessive emphasis on potential side effects. These factors may similarly influence RTs' adherence to CF management guidelines.[20]

Moreover, adherence to CF clinical standards was not impacted by the associate, bachelor's, or master's degree level of respiratory therapy education ($p = 0.255$). This homogeneity in adherence might be due to the consistent curriculum followed across RT programs in Saudi Arabia, yet findings from other healthcare fields revealed that higher educational levels can correlate with improved clinical outcomes.[21] Haegdorens et al. found that nurses with bachelor's degrees or higher education had lower death rates than those nurses with associate degrees.[22] This suggests that increased educational attainment correlates with improved disease management and reduced mortality.

Also, the findings from Table 5 indicated that respondents with over five years of experience correctly answered more questions than those with less experience. This indicates that therapists with more than five years of expertise have demonstrated greater levels of adherence and management proficiency. These findings align with a study conducted in 2018 highlighting that nurses with five years or more of experience exhibit fewer clinical errors, such as lower rates of prescription errors and patient falls, reinforcing the value of experience in clinical proficiency.[23]

Table 3. Descriptive statistics for knowledge and management section, N=166.

Question	Correct % (n)	Wrong % (n)	I don't know % (n)
Awareness and knowledge of CF			
From my experience as a respiratory therapist, sweat chloride of … mmol/l or more can indicate the presence of CF.	42.8 (71)	17.5 (29)	39.8 (66)
From my experience as a Respiratory Therapist, performing direct spirometry test for an adult patient with CF disease, the predicted value for forced exhaled volume in 1 second (FEV1) will be ……	10.8 (18)	71.1 (118)	18.1 (30)
From my experience as a Respiratory Therapist, most CF chest x-ray demonstrate …… ….. lungs.	28.3 (47)	59.6 (99)	12.0 (12)
From my experience as a Respiratory Therapist, CF inflammatory response is ….relative to the burden of infection.	67.5 (112)	12.0 (20)	20.5 (34)
From my experience as a Respiratory Therapist, …….. is the most common destructive airway pathogen present in CF patients.	36.1 (60)	22.9 (38)	41.0 (68)
According to my answer to the previous question, in my experience as a Respiratory Therapist, the use of ……. antibiotic is prescribed for the pathogen selected in question nine-tee.	36.7 (61)	16.9 (28)	46.4 (77)
Management of CF			
From my experience as a Respiratory Therapist, the gold standard for airway clearance therapy in a CF patient is:	56.6 (94)	39.2 (65)	4.2 (7)
From my experience as a Respiratory Therapist, the Mucoactive agent used most often with a CF patient is:	35.5 (59)	46.4 (77)	18.1 (30)
From my experience as a Respiratory Therapist, ... reduces the viscosity of airway secretion in general.	26.5 (44)	51.2 (85)	22.3 (37)
From my experience as a Respiratory Therapist, the administration of Mucoactive agent should occur:	62.7 (104)	25.3 (42)	12.0 (20)
From my experience as a Respiratory Therapist, airway clearance therapy should be performed for:	22.9 (38)	77.1 (128)	--
From my experience as a Respiratory Therapist, airway clearance therapy in a CF patient with a small pneumothorax (≤3 cm) should be:	25.3 (42)	38.6 (64)	36.1 (60)
From my experience as a Respiratory Therapist, airway clearance therapy in a CF patient with scant hemoptysis should be:	14.5 (24)	57.8 (96)	27.7 (46)
From my experience as a Respiratory Therapist, aerosol therapy that induces a cough (hypertonic saline >0.9%) a with CF patient who has a pneumothorax should be:	20.5 (34)	41.6 (69)	38.063)
From my experience as a Respiratory Therapist, BiPAP in a CF patient with scant hemoptysis should be:	18.7 (31)	45.8 (76)	35.5 (59)
From my experience as a Respiratory Therapist, the use of hypertonic saline (>.9%) twice a day to reduce the chance of lung infection in a CF patient is:	39.8 (66)	26.5 (44)	33.7 (56)
From my experience as a Respiratory Therapist, PEP therapy in a CF patient with an ear infection is:	42.2 (70)	19.3 (32)	38.6 (64)
From my experience as a Respiratory Therapist, the airway clearance regimen AFTER lung transplant in a CF patient is:	24.1 (40)	24.1 (40)	51.8 (86)
From my experience as a Respiratory Therapist, the long-term use of Dornase Alpha demonstrates better outcome compared to short-term use in a CF patient.	69.9 (116)	30.1 (50)	--
From my experience as a Respiratory Therapist, the long-term use of an anti-inflammatory like inhaled corticosteroids to increase forced exhaled volume in 1 second (FEV1) in a CF patient is:	45.2 (75)	15.7 (26)	39.2 (65)

Furthermore, the study revealed significant differences in the number of accurate answers amongst individuals occupying various current positions. Particularly, the unemployed and those in clinical instructor and managerial professions answered most of the questions correctly. The requirement to work a specific amount of hours at the bedside in Saudi Arabian hospitals to advance to a supervisory position may explain the supervisors' improved accuracy and management abilities.[24] The role of a clinical educator requires staying current with new clinical guidelines, which most probably contributes to the superior performance of clinical educators compared to other positions.[25] In addition, the high number of correct responses among the unemployed RTs, possibly recent graduates, could indicate retained knowledge from recent training, suggesting that

Table 4. Comparison of the level of adherence to cystic fibrosis clinical guidelines between awareness and knowledge, and management among respiratory therapists in Saudi Arabia. N=166.

	Negative ranks			Positive ranks			Test statistic		
	n	Mean rank	Sum of ranks	n	Mean rank	Sum of ranks	Ties	Z	*p*
Total correct responses for management -Total correct responses for awareness & knowledge	7^a	19.86	139	144^b	78.73	11337	15^c	-10.45^*	.00

a. Total Correct Responses Management section < Total Correct Responses Awareness and knowledge section
b. Total Correct Responses Management section > Total Correct Responses Awareness and knowledge section
c. Total Correct Responses Management section = Total Correct Responses Awareness and knowledge section
* Based on negative ranks.

Table 5. Spearman's rank-order correlation between years of experience and participant responses, N=166.

	How many years of experience do you have in the field of RT?	Overall correct responses	Overall wrong responses	Overall *I don't know* responses
How many years of experience do you have in the field of RT?	1.000	.264**	.163*	-.303**
Overall correct responses	.264**			
Overall wrong responses	.163*			
Overall, I don't know responses	-.303**			

Table 6. Comparison of overall correct responses between respiratory therapists with> 5 years of experience and those with < 5 years of experience, N=166.

Factor	Overall
Mann-Whitney U	2056
Z-score	-4.028
Significance *p*-value	.000

ongoing professional development could sustain high knowledge retention over time.[26]

Lastly, Table 7 indicates that the region of practice did not significantly impact the total number of correct responses among RTs. These results suggest that geographical location does not affect Saudi Arabian RT adherence rates. According to the Saudi Commission for Health Specialties (SCFHS), students must finish their externship in authorized facilities. Standardized externship requirements across authorized facilities may facilitate this uniformity in training quality, supporting consistent professional development across the country.[27] As reported by Hampton et al., nurses who participated in externship programs demonstrated greater "professionalism and role socialization" than those not subject to such responsibilities.[28]

Furthermore, the guidelines emphasize the importance of tailored pulmonary management strategies for individuals with advanced cystic fibrosis lung disease (ACFLD). They recommend regular monitoring, proactive treatment of respiratory infections and noninvasive ventilation for respiratory failure. They also suggest high-flow nasal oxygen for acute hypoxemic respiratory failure. Prompt treatment of exacerbations with antibiotics, bronchodilators and corticosteroids is recommended. A multidisciplinary approach is advocated for comprehensive management and regular guideline updates to ensure RTs and healthcare providers remain equipped with the latest evidence-based practices for CF management.[29]

CONCLUSION

The study highlighted essential knowledge gaps and investigated Saudi Arabian RTs' compliance with clinical guidelines for CF. Although 53.6% of RTs were familiar with CF guidelines, many lacked important knowledge about CF management, especially in recognizing proper therapies and antibiotic selections. Most RTs demonstrated good understanding of airway clearance therapy but misinterpreted its frequency and application. Enhancing RTs' education and adherence to guidelines could enhance CF management and potentially increase patient survival rates in Saudi Arabia.

LIMITATIONS AND FUTURE IMPLICATIONS

The study's limitations include potential bias due to convenience sampling, limited generalizability beyond Saudi Arabia and reliance on self-reported data, which may not accurately reflect actual adherence or knowledge levels among respiratory therapists. Another limitation to consider is the potential impact of question-wording on par-

Table 7. Comparison of the overall number of correct responses between highest levels of respiratory therapist's education, between the regions and current position, N=166.

Questions	Overall *n*	H(df)	*p*
Region of Practice		2.5(4)	.645
Center region	86		
East region	40		
North region	2		
South region	8		
West region	30		
Highest level of respiratory therapy education		2.7(2)	.255
Associate degree	11		
Bachelor degree	122		
Master degree	33		
Highest completed overall level of education		9.1(4)	.053
Associate degree	9		
Bachelor degree	115		
Master degree	34		
Doctorate (PhD, EdD, ScD, etc.)	6		
Doctor of Medicine	2		
Current position		12.1(6)	.050
Respiratory therapist - Technician	14		
Respiratory therapist - Specialist	100		
Respiratory therapist - Supervisor	14		
Respiratory therapist - Director or Manger	8		
Respiratory therapist – Clinical Educator	7		
Respiratory therapist – Faculty member	18		
Unemployed	5		

ticipants' responses, as the phrasing of questions may have led to varying interpretations, potentially influencing the consistency of responses with established best practices. Future research should focus on enhancing training programs and resources for RTs in Saudi Arabia to address identified gaps in CF management. Given the significant difference in adherence levels between CF knowledge and management practices, targeted educational interventions and workshops could improve patient care quality. Building an educational framework that incorporates evidence-based CF management guidelines, continuous professional development, and assessments of RT knowledge and skills would support adherence to best practices.

Furthermore, a quality improvement project could be implemented to track adherence to CF management guidelines in clinical settings, assessing its impact on patient outcomes over time. Investigating the effects of such initiatives on long-term patient outcomes, such as survival rates and quality of life, would provide valuable insights into the potential benefits of increasing adherence to CF management protocols. Special attention should be given to regions with high CF prevalence, where improved treatment strategies could significantly improve patient care, particularly in terms of survival rates and overall health outcomes.

In addition to these practical applications, future studies could explore innovative strategies such as telemedicine or mobile health interventions to support ongoing CF management, especially in remote areas. This approach could also contribute to optimizing care continuity and patient monitoring.

CONTRIBUTORS

All authors contributed to the conception or design of the work, the acquisition, analysis, or interpretation of the data. All authors were involved in drafting and commenting on the paper and have approved the final version.

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COMPETING INTERESTS

All authors have completed the ICMJE uniform disclosure form and declare no conflict of interest.

ETHICAL APPROVAL

This study was approved by the Institutional Review Board (IRB) at Georgia State University and granted approval under Exempt Protocol Category 2 (IRB Number: H18241).

AI STATEMENT

The authors confirm no generative AI or AI-assisted technology was used to generate content.

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SUPPLEMENTARY MATERIALS

Appendix

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