

Efficacy of home healthcare on the management of tracheostomy patients

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ABSTRACT

الأهداف: تقييم مدى فعالية الرعاية الصحية المنزلية في علاج المرضى الذين أجريت لهم عملية ثقب القصبة الهوائية في مدينة الملك عبد العزيز الطبية التابعة لوزارة الحرس الوطني-الصحة.

المنهجية: أجريت هذه الدراسة الحشدية الرجعية في مدينة الرياض، المملكة العربية السعودية، بين يناير 2019 ويونيو 2022 لمجموعة منتقاة باستخدام عينة متتابعة لا احتمالية، شملت جميع المرضى ذوي ثقب القصبة الهوائية دون معايير استبعاد. تضمنت البيانات المجموعة المتغيرات الديموغرافية للمرضى وإعدادات التنفس (نوع التهوية، الحاجة اليومية للتهوية، المدة الزمنية منذ ثقب القصبة الهوائية، وإعدادات التهوية). النتائج المرجوة تمثلت بمعرفة معدل الوفيات والنتائج العلاجية لرعاية ثقب القصبة الهوائية لدى المرضى.

النتائج: من بين 183 مريض في الدراسة، كانت الالتهابات الرئوية هي الأكثر شيوعاً (53%). وعلى عكس الوفيات المرتبطة بالجهاز التنفسي، كان معدل وفيات المرضى الذين أدخلوا إلى وحدة العناية المركزة لأسباب غير مرتبطة بالجهاز التنفسي مرتفعاً بشكل ملحوظ (57%) ($p=0.003$). كان معدل وفيات المرضى الذين يعتمدون على أطواق التنفس الاصطناعي (34%) أعلى بشكل ملحوظ من المرضى الذين يعتمدون على التنفس الاصطناعي الميكانيكي (57%) ($p=0.004$). كان معدل الوفيات بعد الخروج من الرعاية الصحية المنزلية 40%، وكان المعدل أعلى بين المرضى الذين تزيد أعمارهم عن 70 عاماً (47%) ($p=0.04$).

الخلاصة: ارتبطت الالتهابات الرئوية بالعدوى المتعلقة بأجهزة التنفس الاصطناعي، وأدت كذلك إلى معدل أعلى فيما يتعلق بإعادة الدخول إلى المستشفى. ختاماً نشدد على أهمية ضمان الممارسات الصحيحة والحرص على تعليم مقدمي الرعاية من الأهل عن سبل تعلم هذه الممارسات والحفاظ عليها لتقليل نسب حدوث العدوى المتعلقة بأجهزة التنفس الاصطناعي.

Objectives: To evaluate the home healthcare efficacy in managing tracheostomy patients at King Abdulaziz Medical City under the Ministry of National Guard Health Affairs. Home healthcare is care provided to patients in the convenience of their homes to ensure high-quality care based on healthcare providers' supervision.

Methods: This retrospective cohort study utilizing a non-probability consecutive sampling technique, including all available tracheal patients with no exclusion criteria, was carried out in Riyadh, Saudi Arabia, between January 2019 and June 2022. The collected data included patient demographic variables and respiratory settings (ventilation type, daily ventilation need, tracheostomy

duration, and ventilator settings). The outcomes included mortality rate and therapeutic outcomes of tracheal management.

Results: Of the 183 patients in the study, the most common type of respiratory-related infection was pneumonia (53%). Unlike respiratory-related causes, The mortality rate of patients admitted to the intensive care unit that was unrelated to respiratory causes was statistically significant (57%) ($p=0.003$). The mortality rate of patients who used aerosol tracheal collars (34%) was markedly higher than mechanically ventilated patients (57%) ($p=0.004$). The mortality rate following discharge from HHC was 40%, and was higher among patients aged >70 years (47%) ($p=0.04$).

Conclusion: Pneumonia was associated with the majority of ventilator-related infections and resulted in hospital readmissions. Ensuring proper practices and caregiver education is crucial to decrease the incidence of ventilator-related infections.

Keywords: tracheostomy, home health care, Tracheal patients

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Home healthcare (HHC) has played a vital role in health approaches with rapid epidemiological changes in the last decade. Owing to accelerated longevity rates and technological advancements, extending the arms of care beyond the walls of hospitals has become necessary. Consequently, home-care services have become increasingly available and in demand.¹ Home healthcare is care provided by home healthcare practitioners based on a physician's directions and supervision to patients in the convenience of their homes.² Home-based care has also proven beneficial for health organizations by providing low-cost health services that, in comparison with facility-based care, are of equal or higher quality.³ Telehealth and other home-based services have helped overcome the barriers to delivering care by facilitating access to patient's medical information and patients themselves when needed, despite being in separate locations.⁴ For these reasons, resorting to home healthcare is beneficial for patients and their families regarding cost and safety, according to Al-Khashan et al.¹

The purpose of HHC is to assist patients in achieving optimal health and avoid readmission and hospitalization.² In particular, chronic conditions require long-term management, such as cases that require airway management. Airway management means evaluating, constructing, and utilizing several procedures and devices for maintaining patient ventilation, such as mechanical ventilation.⁵ In Saudi Arabia and internationally, the increased utilization of home mechanical ventilation is because of the great advantage of a better lifestyle.^{6,7} However, patients undergoing tracheostomy and home mechanical ventilation encounter numerous challenges that affect recovery. Consequently, HHC is essential to assist the patient and caregiver in coping with these hardships to ensure the continuation of their care and well-being.

Avoiding hospital readmission, reducing mortality rates, and discharging patients to their care facilities are the main reasons for home healthcare. Causes of unplanned hospital readmissions are classified as avoidable and unavoidable. Even though unplanned readmission is an undesirable occurrence for home healthcare providers and patients, it is often due to unavoidable causes such as traumatic events, severely declining health, or unavoidable adverse effects

of treatments, as stated by Donzé.⁸ According to Harrison et al,⁹ immediate access to investigations and the availability of specialists' opinions are concerns regarding home healthcare and are considered risk factors for unscheduled readmissions. Preventable unplanned rehospitalizations are costly, frequent, and require healthcare resources. In addition, they pose a threat to patient safety, including healthcare-associated infections, procedural complications, and adverse drug events. Whether the reasons for readmission are avoidable or unavoidable, unexpected hospitalization is an unfavorable outcome of home-based care and can potentially cause issues for patients, caregivers, and care providers. Therefore, assessing the frequency of patient readmission is imperative for evaluating the effectiveness and quality of home healthcare systems.

According to Shah et al,¹⁰ in home healthcare settings, mortality rates among patients requiring chronic ventilation can be influenced by a range of factors, including underlying illnesses, associated cardiovascular conditions, infections, and financial inability. Infections in HHC patients are due to their environment, higher use of indwelling tools and devices, and the severity of their conditions.¹¹ For example, mechanically ventilated patients are prone to pneumonia, associated with ventilator management, and deteriorate their recovery course.¹²

As indicated by Lehmann et al,¹³ better HHC outcomes are possible. However, certain criteria must be established to guarantee compliance. Care delivered to mechanically ventilated tracheal patients, both invasively and noninvasively, under the Ministry of National Guard-Health Affairs (MNGHA) has not been thoroughly explored. Therefore, this study evaluated the efficacy of home healthcare in the management of tracheal patients under MNGHA by measuring readmission, mortality, and infection rates. It also aimed to conduct a retrospective cohort study of the present care and its association with mortality and morbidity.

Methods. This retrospective cohort study aimed to evaluate the efficacy of HHC in the management of tracheal cancer patients at King Abdulaziz Medical City (KAMC), under MNGHA in Riyadh, from January 2019 to June 2022. The criteria included all recorded cases of tracheal patients of both genders above 18 years who were registered under the HHC department of MNGHA in Riyadh from January 2019 to June 2022 with no exclusion criteria. The sample size was selected using a non-probability consecutive sampling technique to include all available enrolled tracheal patients. Medical

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record numbers (MRNs) were obtained from the daily log sheet of the Respiratory Therapy Department of the HHC in MNGHA. Duplicates were removed, and the remaining 183 MRNs were retrieved.

For the literature review, PubMed and Google scholar were used to review all previous studies on the subjects of home healthcare, mechanical ventilation, and outcomes associated with them. All referenced researches that included human subjects followed the Helsinki Declaration principles.

This study was approved by the Institutional Review Board of King Abdullah International Medical Research Center, Riyadh, Saudi Arabia. This was a chart review study; therefore, informed consent was not required, and confidentiality was ensured by not collecting the personal information of the patients.

After reviewing the literature, a collection sheet was created using Excel, comprising 25 parameters, including patient demographics and respiratory settings (type of ventilation, daily ventilation needs, duration of tracheostomy, and ventilator settings). The outcome variables were mortality rate and therapeutic outcomes of tracheal management. Co-authors collected data from King Abdullah Specialized Children's Hospital (KASCH) through the BESTCare system.

Statistical analysis. After data entry, data were checked for correctness, and incorrect entries were resolved. Data was analyzed using the Statistical Package for the Social Sciences, software Statistics for Windows, version 26 (IBM Corp., Armonk, N.Y., USA). Categorical variables were presented as frequencies and percentages, whereas numerical variables were presented as means and standard deviations. The Chi-square test was used to determine the association between mortality after HHC admission and the basic demographic and outcome variable characteristics of the patients, such as the reason for readmission and infection. Multivariate logistic regression analysis of the prognostic factors of mortality rates after HHC admission was also conducted. The confidence interval was maintained at 95%, and the significance level was set at 0.05.

Results. The study included all 183 available Saudi tracheostomy the aerosol tracheal collar (74%). The most common cause of admission was cerebrovascular accidents (CVA) (28%), and the most common reason for respiratory therapy-related readmission was pneumonia (61%), while gastrotomy-related (28%) was most common for respiratory-related cases. Noninvasive ventilation was administered to 71% of patients. The mortality rate after discharge from HHC was 40%, which mostly consisted of patients above 70

Table 1 - Basic demographic characteristics of the patients (N=183).

Study data	n (%)
<i>Age group</i>	
18 – 40 years	34 (19%)
41 – 60 years	24 (13%)
61 – 70 years	34 (19%)
71 – 80 years	48 (26%)
>80 years	43 (23%)
<i>Gender</i>	
Male	87 (48%)
Female	96 (52%)
<i>Chronic comorbidity</i>	
Yes	181 (99%)
No	02 (01%)

Table 2 - Characteristics during admission and outcome of the patients (N=183).

Variables	n (%)
<i>Daily ventilation needs</i>	
None	1 (01)
24 hours	165 (90)
PRN	9 (05)
Others	8 (04)
<i>Type of ventilation</i>	
Aerosol trach collar	135 (74)
Chronic ventilation	48 (26)
<i>Reason for admission</i>	
CVA	52 (28)
Multiple comorbidities	33 (18)
Mental disorders	33 (18)
Cancer-related disease	9 (05)
Respiratory disease	10 (06)
Post-operation complication	6 (03)
Infection	21 (12)
Others	19 (10)
<i>Reason for readmission (respiratory related)</i>	
No admission	55 (30)
Pneumonia-related cases	112 (61)
Non-pneumonia-related cases	16 (09)
<i>Reason for readmission (respiratory unrelated)</i>	
No admission	60 (33)
Gastrotomy related issues	51 (28)
UTI	33 (18)
AKI	8 (04)
Infection	14 (08)
Others	17 (09)
<i>Ventilator</i>	
None	3 (02)
Non-invasive	130 (71)
Invasive	50 (27)
<i>HHC program discharge status</i>	
Deceased	72 (40)
Alive	109 (60)

PRN: Pro re nata (as needed), CVA: cerebrovascular Accident, UTI: urinary tract infection, AKI: acute kidney Injury, HMV: home mechanical ventilation, ATC: aerosol trach collar, HHC: Home Healthcare

Table 3 - Frequency of emergency room (ER) and intensive care unit admissions (ICU) (N=183).

Variables	n (%)
<i>ER visit (Respiratory related and unrelated)</i>	
Yes	27 (15)
No	156 (85)
<i>Number of ER visits respiratory-related (n=173)</i>	
None	33 (19)
1 – 2	69 (40)
3 – 5	33 (19)
>5	38 (22)
<i>Number of ER visits respiratory unrelated (n=177)</i>	
None	33 (19)
1 – 2	40 (23)
3 – 5	47 (26)
>5	57 (32)
<i>ICU visit respiratory-related (n=167)</i>	
Yes	69 (41)
No	98 (59)
<i>ICU visit respiratory unrelated (n=166)</i>	
Yes	46 (28)
No	120 (72)
<i>Number of infections respiratory-related</i>	
None	58 (32)
One	42 (23)
2 – 4	53 (29)
5 or more	30 (16)
<i>Number of infections respiratory unrelated</i>	
None	92 (50)
One	26 (14)
2 – 4	45 (25)
5 or more	20 (11)

(47%) years. Also, a majority of 41% of the deceased cases following discharge were males.

Table 3 shows that 15% of patients had both respiratory-related and respiratory-unrelated emergency room (ER) visits. Also, 40% of the patients visited the ER for respiratory-related cases once or twice, while 32% of patients visited the ER for respiratory-unrelated cases more than 5 times.

Table 4 shows that the most frequent organism during HHC admission for respiratory-unrelated cases was *Staphylococcus* (15%), whereas for respiratory-related cases, it was *Pseudomonas aeruginosa* (37%). The most common cause of infection in respiratory-related cases was pneumonia (53%), whereas in respiratory-unrelated cases, it was UTI (34%).

Table 5 demonstrates the results of the chi-square that the mortality among the older age group (>70 years) was 47% compared to 32% for those ≤70 years ($p=0.04$). Similarly, the mortality rate of patients admitted to the ICU for respiratory-unrelated reasons was 57%, while for those unadmitted, it was 32% ($p=0.003$). Furthermore, the death rate among patients

Table 4 - Frequency of organisms during home healthcare admission (N=183).

Parameters	n (%)
<i>Name of the organism (respiratory unrelated)</i>	
None	74 (40)
<i>Candida Albicans</i>	7 (04)
<i>Escherichia coli</i>	17 (09)
<i>Enterococcus faecalis</i>	8 (04)
<i>Klebsiella pneumoniae</i>	20 (11)
<i>Pseudomonas aeruginosa</i>	14 (08)
<i>Staphylococcus</i>	27 (15)
<i>Acinetobacter</i>	4 (02)
<i>Yeast</i>	5 (03)
Other	7 (04)
<i>Name of the organism (respiratory related)</i>	
None	68 (37)
<i>Pseudomonas aeruginosa</i>	68 (37)
<i>Klebsiella pneumonia</i>	5 (03)
<i>Staphylococcus aureus</i>	22 (12)
<i>Stenotrophomonas maltophilia</i>	4 (02)
Methicillin-resistant <i>Staphylococcus aureus</i>	3 (02)
Others	13 (07)
<i>Causes of infection (respiratory related)</i>	
None	58 (32)
Pneumonia	96 (53)
<i>Pseudomonas aeruginosa</i>	18 (09)
Respiratory failure	8 (04)
Other	3 (02)
<i>Causes of infection (respiratory unrelated)</i>	
None	90 (49)
Infection of gastrostomy	9 (05)
Urinary tract infection	63 (34)
Other infection	12 (07)
<i>Candida auris</i> and other organisms	9 (05)

treated with invasive ventilation was 57%, whereas those treated with non-invasive ventilation had a mortality rate of 33% ($p=0.003$). In addition, the type of ventilator was significantly associated ($p=0.004$) with (ATC non-abbreviated form)ATC-related mortality of 34% and chronic ventilation-related mortality of 57%.¹⁴ Regarding the reason for admission, those admitted for CVA had a mortality rate of 48%. Mortality rates varied based on the the cause of admission, with psychological disorders having a mortality rate of (36%), multiple comorbidities (24%), with infection having the highest mortality rate reaching to (38%). Cancer-related diseases, respiratory diseases, and postoperative complications collectively result in a mortality rate of 45% ($p=0.24$). Readmission was either respiratory therapy-related or respiratory therapy-unrelated. Among respiratory-related causes, those who had never been readmitted for respiratory-related causes had a mortality rate of 35%. Patients readmitted because of pneumonia had a mortality rate of 43%, while those

Table 5 - Relationship between the outcome after Home Healthcare admission according to the basic demographic and intensive care unit admission characteristics of the patients.

Factor	Deceased (n=72) n (%)	Alive (n=109) n (%)	P-value [§]
<i>Age group</i>			
≤70 years	29 (32)	61 (68)	0.04 **
>70 years	43 (47)	48 (53)	
<i>Gender</i>			
Male	35 (41)	50 (59)	0.72
Female	37 (39)	59 (61)	
<i>ICU visit respiratory-related</i>			
Yes	31 (46)	36 (54)	0.14
No	34 (35)	64 (65)	
<i>ICU visit respiratory unrelated</i>			
Yes	25 (57)	19 (43)	0.003 **
No	38 (32)	82 (68)	
<i>Reason for admission</i>			
Cerebrovascular accident	24 (48)	26 (252)	0.24
Multiple comorbidities	8 (24)	25 (76)	
Psychological disorders	12 (36)	21 (64)	
Infection	8 (38)	13 (63)	
Others (cancer-related disease, respiratory disease, post-op complication, et cetera)	20 (45)	24 (55)	
<i>Reason for readmission (respiratory related)</i>			
No admission	19 (35)	36 (65)	0.59
Pneumonia-related disease	47 (43)	63 (57)	
Non-pneumonia-related diseases	6 (38)	10 (63)	
<i>Reason for readmission (respiratory unrelated)</i>			
No admission	17 (28)	43 (72)	0.03 **
Gastrostomy related issues	18 (35)	33 (65)	
Urinary tract infection	16 (52)	15 (48)	
Others (acute kidney injury, infection, et cetera)	21 (54)	18 (46)	
<i>Ventilator</i>			
Non-invasive	43 (33)	87 (67)	0.003 **
Invasive	28 (57)	21 (43)	
<i>Type of ventilation</i>			
Aerosol trach collar	45 (34)	89 (68)	0.004 **
Chronic ventilation	27 (57)	20 (43)	

[§]P-value has been calculated using Chi-square test. **Significant at $p < 0.05$ level. ICU: intensive care unit

Table 6 - Multivariable logistic regression analysis for the prognostic factor of mortality rates after home healthcare admission (N=181).

Factor	AOR	95% CI	P-value
<i>Age group</i>			
≤70 years	Ref		0.046**
>70 years	1.995	1.012-3.933	
<i>ICU visit (respiratory unrelated)</i>			
Yes	Ref		0.39
No	0.743	0.376-1.470	
<i>Ventilator</i>			
Non-invasive	Ref		0.43
Invasive	2.710	0.226-32.527	
<i>Type of ventilation</i>			
Aerosol trach collar	Ref		0.90
Chronic ventilation	1.186	0.095-14.867	

**Significant at $p < 0.05$ level. AOR: adjusted odds ratio, CI: confidence interval, ICU: intensive care unit

readmitted because of non-pneumonia causes had a mortality rate of 38% ($p=0.59$). In contrast, the mortality rates of patients readmitted for respiratory-unrelated causes, such as gastrostomy issues, UTI, AKI, infections, and other problems, were 35%, 52%, and 54%, respectively, while those who were not readmitted for respiratory-unrelated causes had a mortality rate of 28% ($p=0.03$).

A multivariable logistic regression model was conducted to assess the association between different variables in **Table 6** for all the variables was found to have a p -value < 0.20 on bivariate analysis. Naturally, age, a non-modifiable factor, had the greatest influence on patient mortality after admission for HCC ($p=0.046$). People aged >70 years were twice as likely to die compared to those 70 years of age (AOR=1.995;

95% CI=1.012, 3.933; $p=0.046$). Unrelated ICU respiratory visits ($p=0.39$), ventilator use ($p=0.43$), and type of ventilation ($p=0.90$) did not significantly affect mortality rates after adjustment for the regression model ($p>0.05$). These findings emphasize the impact of age on the other variables evaluated in this study.

Discussion. The study found a mortality rate of 40% among tracheal patients under the HHC program of MNGHA. Age, a non-modifiable factor, was the main factor related to mortality, which is not related to the care provided. The demand for 24-hour ventilation in patients was high, which might explain the increased pneumonia-related readmissions. This is supported by data found in a study suggesting that the daily duration of ventilation is a predisposing factor for ventilator-associated pneumonia.¹⁵ Furthermore, after examining the risk factors for nonspecific infections in HHC patients, 3 studies found that indwelling devices were a routinely reported risk factor for infection.¹⁶⁻¹⁸ Moreover, a previously reported nationwide American study indicated that pneumonia rates were 21-fold higher in patients receiving continuous ventilatory support than in those not requiring mechanical ventilation.¹⁹

Patients admitted to the ER were less likely to have respiratory-related conditions than those who were not. Researchers have reported similar findings, in which respiratory admissions to the ER were significantly low. Emergency room admissions unrelated to respiratory causes were due to improper care, damage, or caregiver tampering with ventilators.²⁰ Numerous patients were admitted to the ICU, regardless of whether they were respiratory-related or respiratory-unrelated. A study conducted in Thailand investigated whether intensive care unit (ICU) admission was related to the respiratory system. This was mainly due to a lack of resources, which resulted in many ICU admissions.²¹ Compared to other studies conducted in other parts of the world, the patients in our study had high rates of respiratory-related infections. Different studies have suggested that the lack of guidelines for monitoring infections in home care settings could contribute to the high rates of respiratory infections.^{17,18} These findings demonstrate the complex nature of managing respiratory-related conditions and the need for ongoing medical attention and infection management. Pneumonia is the cause of most respiratory admissions. A similar study conducted in a nursing home reported similar problems as pneumonia. As some hospitals have implemented formal and organized programs to reduce ventilator-associated pneumonia in high-risk patients, other hospitals should

consider doing the same to minimize the incidence of infection.²²

The type and invasiveness of the ventilator modality also play a role in patient outcomes, with higher mortality rates in those using aerosol trach collar/noninvasive ventilators, in contrast to the findings of other studies.¹⁸ Furthermore, respiratory-related readmissions and ICU admissions had higher mortality rates than respiratory-unrelated readmissions and ICU admissions. This study concluded that among all the significant variables that increased mortality, age had the greatest impact on the patient's death rate after admission to HHC. The findings of this study suggest that healthcare providers should prioritize early intervention and comprehensive care for patients with respiratory-related readmissions and ICU admissions, particularly among older individuals. It is crucial to implement measures that address the specific needs and vulnerabilities of this population in order to reduce mortality rates and improve patient outcomes. This result suggests that HHC, if implemented with appropriate guidelines and had continuous monitoring, then it would help achieve optimal health. This study had a few limitations. First, this was a single-center study, so the statistical findings might not be generalized to a larger population. Second, the relatively small sample size and consecutive sampling technique lack patient randomization and affect the generalizability of the study findings, as well. Also, there was a lack of prior research studies on the topic, which gave the opportunity to identify literature gaps to present the need for further development.

In conclusion, HHC had a significant effect on the management of patients with tracheostomy in MNGHA. Approximately 40% of patients who were discharged from HHC died. Age, a non-modifiable factor, was the most significant factor contributing to death. The number of ICU visits and readmissions was associated with patient mortality rates. Therefore, it is critical to explore ways to prevent frequent ICU visits and readmissions to improve patient outcomes. Considering the high mortality rates of patients who were readmitted because of pneumonia-related infections, further awareness of prevention, implementation of educational programs for proper device care, and the establishment of strict guidelines to decrease the incidence of ventilator-related infections in patients' residences are warranted. Similar studies at multiple centers are recommended to include a larger and more generalizable sample size.

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