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Respiratory-tract infections among geriatrics: prevalence and factors associated with the treatment outcomes

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Abstract

Background: Geriatric individuals are more susceptible to different infections, especially respiratory-tract infections (RTIs) due to their compromised immune system. Hence, the objectives of the present study were to evaluate the prevalence, medication regimen complexity and factors associated with the treatment outcomes of different RTIs among geriatrics.

Methods: A retrospective cross-sectional study (5 years) was conducted at the respiratory department, Hospital Pulau Pinang. Patients aged ⩾65 years with confirmed diagnosis of RTI were included in the study.

Results: A total of 474 patients were included, and the most prevalent RTIs were community-acquired pneumonia (65.6%) followed by chronic obstructive pulmonary disease (20.7%), bronchitis (8.2%) and hospital-acquired pneumonia (5.5%). Amoxicillin/clavulanate (69.8%), ampicillin/sulbactam (9.1%) and cefuroxime (6.5%) are the most common antibiotics prescribed to treat RTIs among geriatrics. Smoking, alcohol consumption, polypharmacy and presence of other co-morbidities are statistically significant factors associated with treatment outcomes of RTIs among geriatrics.

Conclusion: Prevalence of community-acquired pneumonia (65.6%) among older patients aged 65 years and older higher than other RTIs. Smoking, alcohol use, presence of polypharmacy and other co-morbidities are important factors associated with the treatment outcomes of RTIs.

The reviews of this paper are available via the supplemental material section.

Keywords: geriatrics, outcome research, pneumonia, prevalence, RTIs

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Introduction

Respiratory-tract infections (RTIs) are very common in all ages but most particularly, it affects elderly individuals due to their weaker immune system, along with the presence of other co-morbidities.[1] The burden of RTIs among the elderly population significantly contributes to increased risk of mortality, morbidity and costs throughout the world.[2] Around 85% of deaths among the elderly population were recorded in the United States due to RTIs; moreover, over 16.1 billion dollars were spent on RTIs in 2013.[3] One fifth of the total population in Europe is more than 65 years of age and that proportion may increase up to 25% in 2030.[4] The incidence of RTIs is higher in elderly individuals as compared with young ones,[5,6] as the susceptibility to infections increases with increase in age.[7–9] The mortality rate in individuals over 65 years of age increases approximately 6–7% with the presence of RTIs [10] because of other co-morbidities, weak immune system and poor response to respiratory vaccines.[11,12]

In developed countries, pneumonia is one of the major causes of death among the elderly population. Moreover, approximately 200 million cases of community-acquired pneumonia (CAP) were reported every year, with equal distribution among young children and adults;

however, elderly individuals were the most affected group among the adult population.[13] With presence of other co-morbidities and/or polypharmacy, occurrence of adverse drug reactions and drug–drug interactions also reduces the treatment outcomes of RTIs among elderly individuals.[4]

As the occurrence of chronic diseases increases with age, so does the number of medications.[14,15] A serious problem arising in pharmacotherapy of the elderly population is the consumption of several medications simultaneously, leading to polypharmacy. Polypharmacy is defined as concurrent consumption of five or more medications regardless of duration of consumption and dosage format.[16–18] In older individuals, polypharmacy leads to many significant problems which include: drug–drug interactions, adverse effects, decreased quality of life and other medical problems.[19,20] In addition, polypharmacy also increases the rate of hospital admissions, length of stay, repeated hospitalisations and even death among the elderly population.[21] Therefore, appropriate medications should be prescribed to the elderly according to their disease history, mental and physical health, drug resistance, memory, physical ability and support of their family members.[22]

In the elderly population, rate of mortality caused by RTIs increased up to 6–7% with increase in age.[10] Other risk factors among older people with RTIs were underlying co-morbidities and poor response towards their treatment.[12] Elderly individuals having mixed infections with RTIs and other bacterial pathogens could develop severe pneumonia and have longer length of stay in hospitals.[23,24] The aetiology of RTIs among older individuals could be different as compared with the younger population, which may require adjusted empirical therapy of antimicrobials. Moreover, the diagnosis of RTIs might be more challenging in the elderly population, which could lower the threshold for prescribing the antimicrobials. In addition, with increase in age, changes in the human body might alter the pharmacodynamics and pharmacokinetics of antimicrobials.[25] Hence, the objectives of current study are to determine the prevalence of different RTIs, medication regimen complexity and different factors involved in the treatment outcomes of RTIs among the elderly population.

Methods

Location, design and duration of study

The current study (retrospective cross-sectional) was carried out in the Respiratory Department, Hospital Pulau Pinang, Malaysia, between June 2019 and October 2019. The present study was conducted following approval from National Institute of Health and Medical Research and Ethics Committee, Malaysia (NMRR-19-1037-46721).

Sample size and study population

By evaluating the medical records of all geriatric patients who visited or were admitted to the Respiratory Department, Hospital Pulau Pinang, Malaysia, from January 2014 to December 2018, a convenience sampling method was used to include the patients in the current study. Patients aged $\geqslant$65 years with confirmed diagnosis of RTIs having complete medical records were included in present study.

Data collection

A comprehensive data collection form has been developed to collect all socio-demographic and medical profiles of the included study population from the medical record room of Respiratory Department, Hospital Pulau Pinang, Malaysia. Socio-demographic and infection-related data included age, race, sex, marital status, alcohol consumption, smoking, current residence, polypharmacy and presence of co-morbidities. Information on prescribed medications were also collected to evaluate the presence of polypharmacy ($\leqslant$5 medicines and $>$5 medicines)[24] among the included study population.

Improvement in the status of RTIs is defined in current study as 'improvement in their medical reports observed by the physicians working in the respiratory department after completing their course of therapy'.

Medication Regimen Complexity Index (MRCI) scores were measured from the medications prescribed.[25] MRCI has 3 sections with 65 items which include: 'Different dosage forms', 'Frequencies of the dosage' and 'Other additional instructions'. This index provides limitless entry of prescribed medications to a single patient. The minimum score of MRCI for one patient is 1.5, which represents one tablet or capsule once in a day, whereas,

there is no maximum score because as the number of medicines increases, so will the score.

Data analysis

The Statistical Package for the Social Sciences version 24.0 was used to perform the data analyses. Treatment outcomes of RTIs were compared with categorical variables using the Chi-square test, and a p value was considered significant at <0.05. Continuous variables were reported as frequencies (percentages). The association between the improvement in treatment outcomes and each independent variable were investigated using binary and multiple logistic regression with adjusted odds ratio (OR), 95% confidence interval and p values ($p<0.05$). MRCI scores were analysed as continuous variables.

Results

A total of 474 elderly patients with RTIs were included in the current study, from which 256 (54.0%) were males and 218 (46.0%) were females with the mean age of 75 ± 8 years. The majority of the included population ($n=257$; 54.2%) were in the age group of 65–75 years of age and 217 (45.8%) were above 75 years of age. Table 1 describes the association between socio-demographic variables and the treatment outcomes (improved or not improved) of the RTI-studied population.

The most commonly observed RTIs in the study population were CAP ($n=311$; 65.6%), chronic obstructive pulmonary disease (COPD; $n=98$; 20.7%), bronchitis ($n=39$; 8.2%) and hospital-acquired pneumonia (HAP; $n=26$; 5.5%). Hypertension ($n=196$; 41.4%), diabetes mellitus ($n=145$; 30.6%) and dyslipidaemia ($n=123$; 25.9%) were the most common co-morbidities seen in the study population. Detailed presentation of RTIs along with co-morbidities are shown in Table 2.

Amoxicillin clavulanate ($n=331$; 69.8%), ampicillin and sulbactam ($n=43$; 9.1%) and cefuroxime ($n=31$; 6.5%) were the common oral antibiotics used to treat RTIs among the studied elderly population. Inhaled medications include salbutamol ($n=81$; 17.1%), ipratropium bromide ($n=58$; 12.2%), and ipratropium bromide and albuterol sulfate ($n=32$; 6.8%) for the treatment of RTIs (Table 3).

Number of medications per patient ranging from 1 to 20 with a median of 4 medications per patient. Over 297 (62.7%) patients were prescribed no more than 5 medications and 177 (37.3%) were having over 5 prescribed medicines simultaneously. Total score of MRCI ranged from 2 to 42 medications per patient, with a median of 11. MRCI detailed scores of each section are presented in Table 4.

Binary logistic regression has been used to predict different factors contributing to RTI improvement among the study population. Nine independent variables (sex, marital status, age, race, smoking status, alcohol consumption, home, polypharmacy and presence of co-morbidities) were evaluated using binary logistic regression analysis to examine their association with treatment outcomes of RTIs. Five variables have significant association with the treatment outcomes which include: sex (OR = 0.645; $p=0.024$); alcohol consumption (OR = 0.427; $p<0.001$); smoking status (OR = 0.463; $p<0.001$); polypharmacy (OR = 2.083; $p<0.001$); and presence of co-morbidities (OR = 0.608; $p=0.012$). When these variables were tested in multiple logistic regression, all of them showed statistically significant association except one variable (sex; OR = 1.784; $p=0.105$) which showed no significant association with treatment outcomes. Detailed presentation of binary and multiple logistic regression is presented in Table 5.

Discussion

In geriatrics, RTIs are the most common cause of mortality among infectious diseases; moreover, the rate of mortality is higher in geriatrics as compared with young adults infected with RTIs.[26] A recent study reported 10–30% increase in mortality rate in geriatrics.[27] The current study shows high prevalence of CAP (65.6%) among the older population. The increased prevalence of RTIs in geriatrics may be due to defects in cell-mediated and humoral immunity, alcohol and smoking consumption, presence of polypharmacy and other co-morbidities along with their treatments.

Results of the current study showed relatively high prevalence of polypharmacy (37.3%) among individuals above age 65 years; moreover, polypharmacy has a statistically significant association with the treatment outcomes of RTIs among the study population (OR = 2.083; $p<0.001$). Some

Table 1. Socio-demographic characteristics of the study population.

Characteristics	*n* (%)	Treatment outcomes		*p* value
		Improved	Not improved	
Sex				**0.024***
Male	256 (54.0)	153 (32.3)	103 (21.7)	
Female	218 (46.0)	152 (32.1)	66 (13.9)	
Age (years)				0.202
65–75	257 (54.2)	172 (36.3)	85 (17.9)	
>75	217 (45.8)	133 (28.1)	84 (17.7)	
Marital status				0.624
Single	19 (4.0)	10 (2.1)	9 (1.9)	
Married	278 (58.6)	184 (38.8)	94 (19.8)	
Divorced	29 (6.1)	18 (3.8)	11 (2.3)	
Widow	148 (31.2)	93 (19.6)	55 (11.6)	
Race				0.594
Malay	133 (28.1)	90 (19.0)	43 (9.1)	
Chinese	253 (53.4)	158 (33.3)	95 (20.0)	
Indian	88 (18.6)	57 (12.0)	31 (6.5)	
Residence location				0.427
Own home	456 (96.2)	295 (62.2)	161 (34.0)	
Nursing home	18 (3.8)	10 (2.1)	8 (1.7)	
Smoking				**<0.001***
Smoker	231 (48.7)	128 (27.0)	103 (21.7)	
Non-smoker	243 (51.3)	177 (37.3)	66 (13.9)	
Alcohol				**<0.001***
Alcoholic	127 (26.8)	63 (13.3)	64 (13.5)	
Non-alcoholic	347 (73.2)	242 (51.1)	105 (22.2)	
Polypharmacy (number of medications)				**<0.001***
⩽5	297 (62.7)	210 (44.3)	87 (18.4)	
>5	177 (37.3)	95 (20.0)	82 (17.3)	
Co-morbidities				**0.012***
Yes	272 (57.4)	162 (34.2)	110 (23.2)	
No	202 (42.6)	143 (30.2)	59 (12.4)	

*Using Chi-square.
Bold numerals indicate statistical significance.

Table 2. List of respiratory tract infections and other co-morbidities among the study population.

Respiratory tract infections	*n* (%)	Co-morbidities	*n* (%)
Community-acquired pneumonia	311 (65.6)	Hypertension	196 (41.4)
		Diabetes mellitus	145 (30.6)
Chronic obstructive pulmonary disease	98 (20.7)	Dyslipidaemia	123 (25.9)
Bronchitis	39 (8.2)	Ischaemic heart disease	61 (12.9)
Hospital-acquired pneumonia	26 (5.5)	Hypothyroidism	25 (5.3)
		Chronic kidney disease	13 (2.7)

Table 3. List of antibiotics and inhaled medications among study population.

Antibiotics	*n* (%)	Inhaled medications	*n* (%)
Amoxicillin clavulanate	331 (69.8)	Salbutamol	81 (17.1)
Ampicillin and sulbactam	43 (9.1)	Ipratropium bromide	58 (12.2)
Cefuroxime	31 (6.5)	Ipratropium bromide and albuterol sulfate	32 (6.8)
Azithromycin	20 (4.2)		
Cloxacillin	8 (1.7)		

previous cross-sectional studies also indicated high prevalence of polypharmacy to be 39.4% in Italy,[28] 29.5% in New Zealand[29] and 32.5% in Taiwan.[30] Higher prevalence of polypharmacy among the elderly population is due to the presence of different co-morbidities because of a weaker immune system that leads to possible drug–drug interactions and inappropriate use of medications. Pharmacists play a huge role in reviewing the medications of the patients, and regular support for elderly patients infected with RTIs prove beneficial in improving their quality of life.[31]

Many studies reported that infection rate is higher in patients with diabetes mellitus, most particularly in the elderly population.[32–34] In this current study, 30.6% of diabetic patients have RTIs, which supports the findings of a Dutch study, which reported that patients with type 2 diabetes have higher risk of developing RTIs as compared with patients with hypertension.[33] In the elderly population, presence of co-morbidities with RTIs worsens the condition of patients because their immune system is already compromised, and these co-morbidities may decrease their quality of life and affect their treatment outcomes.

Table 4. Medication regimen complexity index by sections.

MRCI total score	Mean (SD)	Minimum	Maximum
MRCI section A score	4.90 (3.101)	01	20
MRCI section B score	6.35 (3.019)	01	19
MRCI section C score	0.54 (0.666)	00	03
MRCI total score	11.79 (6.166)	02	42

Section A: number of medications prescribed; section B: frequency of prescribed medicines; section C: additional instructions of prescribed medicines.
SD, standard deviation.

Amoxicillin/clavulanate has been used over the past 2 decades for the treatment of different infections, most in RTIs. In the present study, amoxicillin/clavulanate (69.8%) is the most common antibiotic prescribed by physicians for the treatment of RTIs among the elderly. Several studies included in a review suggested the clinical success rate of amoxicillin/clavulanate among RTIs.[35] Amoxicillin/clavulanate is prescribed particularly in RTIs because often, the causative agents of these infections were not detected; therefore, empirical therapy is required.[35]

Table 5. Predictors affecting the respiratory tract infections improvement among study population.

Variables	*n* (%)	Binary logistic regression				Multiple logistic regression			
				95% CI				95% CI	
		Odds ratio	*p* value	Lower	Upper	Odds ratio	*p* value	Lower	Upper
Sex									
Male	256 (54.0)	Reference				Reference			
Female	218 (46.0)	0.645	**0.024***	0.440	0.945	1.784	0.105	0.886	3.592
Age (years)									
65–75	257 (54.2)	Reference							
>75	217 (45.8)	1.278	0.202	0.877	1.863				
Marital status									
Single	19 (4.0)	Reference							
Married	278 (58.6)	0.568	0.235	0.223	1.445				
Divorced	29 (6.1)	0.679	0.517	0.210	2.192				
Widow	148 (31.2)	0.657	0.391	0.252	1.717				
Race									
Malay	133 (28.1)	Reference							
Chinese	253 (53.4)	1.258	0.310	0.808	1.961				
Indian	88 (18.6)	1.138	0.655	0.645	2.010				
Home									
Own home	456 (96.2)	Reference							
Old care home	18 (3.8)	1.466	0.430	0.567	3.788				
Smoking									
Smoker	231 (48.7)	Reference				Reference			
Non-smoker	243 (51.3)	0.463	<**0.001***	0.316	0.680	0.383	**0.009***	0.186	0.787
Alcohol									
Alcoholic	127 (26.8)	Reference				Reference			
Non-alcoholic	347 (73.2)	0.427	<**0.001***	0.282	0.648	0.583	**0.031***	0.357	0.951
Polypharmacy									
⩽5	297 (62.7)	Reference				Reference			
>5	177 (37.3)	2.083	<**0.001***	1.415	3.068	1.858	**0.002***	1.245	2.774
Co-morbidities									
Yes	272 (57.4)	Reference				Reference			
No	202 (42.6)	0.608	**0.012***	0.412	0.896	0.643	**0.032***	0.429	0.964

*$p < 0.05$.
CI, confidence interval.

Consumption of alcohol is the major and avoidable risk factor for a wide range of different diseases, including cardiovascular and gastrointestinal diseases, violence, cancer, suicide and RTIs.[36] Use of alcohol among the studied elderly population infected with RTIs shows strong association with the treatment outcomes (OR = 0.583; $p = 0.031$) in the present study. A recent meta-analysis shows that there is 1.8-fold increased risk of RTIs among those who consume alcohol as compared with non-alcoholic individuals. In addition, there is an 8% increase of acquiring RTIs in those who consume 10–20 g of alcohol per day.[36]

Cigarette smoking has a statistically strong association with the treatment outcomes of elderly individuals infected with RTIs in the current study (OR = 0.383; $p = 0.009$). Various studies reported that smokers have a high risk of developing RTIs as compared with non-smokers, particularly in the elderly population.[37–39] A case-control study showed that there is twofold high risk of CAP among active smokers (OR = 1.88; 95% confidence interval 1.11–3.19) and there is 50% reduction in OR after 5 years of smoking cessation.[40]

Strengths and limitations

Precise measurement (pulmonary exacerbations) of RTIs is not possible due to the retrospective design of the study. However, the current study investigated the use of different antibiotics along with other medications prescribed by the physicians for the treatment of RTIs and other co-morbidities present in elderly individuals. Prescription of antibiotics along with the regular medications of the elderly population led to polypharmacy which increases the burden of medications. Appropriateness of multiple medications prescribed (polypharmacy) is not considered in the current study and it is very important to explore the appropriateness of different medications among older people infected with RTIs. As it is a single-centred study, and a convenience sampling technique was used, generalizability of the study is not feasible. Nevertheless, it gives a snapshot of the problems faced by geriatrics with RTI.

Several assumptions regarding the prescription of antibiotics and other medications were made. Adherence to medications by the elderly population, which is a high-risk factor to treatment outcome [41] was not considered. There is a limitation regarding the information of oral antibiotics prescribed by physicians in the patient medical records. Only the past 6 months of the prescribed oral antibiotics were available in the medical records. In addition, medications other than those for RTIs may be missed during the collection of data.

Conclusion

In conclusion, there is a high prevalence of CAP (65.6%) and COPD (20.7%) among the elderly population in the current study. Factors that affect the treatment outcomes of older people infected with RTIs were being a smoker (OR = 0.383, $p = 0.009$), being an alcoholic (OR = 0.583, $p = 0.031$), polypharmacy (OR = 1.858, $p = 0.002$) and presence of other co-morbidities (OR = 0.643, $p = 0.032$). The regular management of elderly patients infected with RTIs should be initiated to lower the treatment burden when evaluating the outcomes.

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Conflict of interest statement

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Supplemental material

The reviews of this paper are available via the supplemental material section.

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