

---

# Interactive Journal of Medical Research

---

Impact Factor (2022): 2.0  
Volume 9 (2020), Issue 2 ISSN 1929-073X

---

## Contents

### Original Papers

- The Influence of Gender on the Choice of Radiology as a Specialty Among Medical Students in Saudi Arabia: Cross-Sectional Study ([e14666](#))  
Ahmed Abduljabbar, Sara Alnajjar, Hussein Alshamrani, Lujain Bashamakh, Hisham Alshehri, Waleed Alqulayti, Mohammad Wazzan. . . . . 2
- Health-Related Effects of Home Nebulization With Glycopyrronium on Difficult-to-Treat Asthma: Post-Hoc Analyses of an Observational Study ([e17863](#))  
Deepak Talwar, Saliil Bendre. . . . . 10
- Public Awareness of Sepsis Compared to Acute Myocardial Infarction and Stroke in Jeddah, Saudi Arabia: Questionnaire Study ([e16195](#))  
Nourah Al-Orainan, Adel EL-Shabasy, Khawlah Al-Shanqiti, Rawan Al-Harbi, Hadeel Alnashri, Raghad Rezqallah, Alanoud Mirghani. . . . . 19

Original Paper

# The Influence of Gender on the Choice of Radiology as a Specialty Among Medical Students in Saudi Arabia: Cross-Sectional Study

Ahmed H Abduljabbar<sup>1</sup>, MD; Sara F Alnajjar<sup>2</sup>, MBBS; Hussein Alshamrani<sup>2</sup>, MBBS; Lujain F Bashamakh<sup>2</sup>, MBBS; Hisham Z Alshehri<sup>2</sup>, MBBS; Waleed M Alqulayti<sup>2</sup>, MBBS; Mohammad A Wazzan<sup>1</sup>, MD

<sup>1</sup>Department of Radiology, King Abdulaziz University Hospital, Jeddah, Saudi Arabia

<sup>2</sup>College of Medicine, King Abdulaziz University, Jeddah, Saudi Arabia

**Corresponding Author:**

Hussein Alshamrani, MBBS

College of Medicine

King Abdulaziz University

Al Sulaymaniyah

Jeddah,

Saudi Arabia

Phone: 966 530204524

Email: [Hussein.m.edu@gmail.com](mailto:Hussein.m.edu@gmail.com)

## Abstract

**Background:** Medical undergraduates are the future doctors of the country. Therefore, determining how medical students choose their areas of specialty is essential to obtain a balanced distribution of physicians among all specialties. Although gender is a significant factor that affects specialty choice, the factors underlying gender differences in radiology are not fully elucidated.

**Objective:** This study examined the factors that attracted medical students to and discouraged them from selecting diagnostic radiology and analyzed whether these factors differed between female and male medical students.

**Methods:** This cross-sectional study conducted at King Abdulaziz University Hospital in Jeddah, Saudi Arabia, used an electronic questionnaire sent to medical students from all medical years during February 2018. Subgroup analyses for gender and radiology interest were performed using the chi-square test and Cramér's V test.

**Results:** In total, 539 students (276 women; 263 men) responded. The most common factor preventing students from choosing radiology as a career was the lack of direct patient contact, which deterred approximately 47% who decided against considering this specialty. Negative perceptions by other physicians ( $P<.001$ ), lack of acknowledgment by patients ( $P=.004$ ), and lack of structured radiology rotations ( $P=.007$ ) dissuaded significantly more male students than female students. Among those interested in radiology, more female students were attracted by job flexibility ( $P=.01$ ), while more male students were attracted by focused patient interactions with minimal paperwork ( $P<.001$ ).

**Conclusions:** No significant difference was found between the genders in terms of considering radiology as a specialty. Misconception plays a central role in students' judgment regarding radiology. Hence, early exposure to radiology, assuming a new teaching method, and using a curriculum that supports the active participation of students in a radiology rotation are needed to overcome this misconception.

(*Interact J Med Res* 2020;9(2):e14666) doi:[10.2196/14666](https://doi.org/10.2196/14666)

**KEYWORDS**

gender; radiology; specialty choice

## Introduction

According to the latest statistics from the Saudi Commission for Health Specialties, there are 37 medical colleges throughout Saudi Arabia, and 4042 students are expected to graduate in 2020. Among these students, 1781 are female, and 2261 are male [1]. Medical undergraduates are the future doctors of the

country; therefore, determining how medical students choose their areas of specialty is essential to obtain a balanced distribution of physicians among all specialties [2].

Factors including personal interactions, lifestyle choices, society's perception, high financial status, job opportunities, and interest in research have been found to influence the selection of a medical specialty [3-5]. In Saudi Arabia, previous

studies stated that medical students were influenced to choose a medical career mostly by a flexible lifestyle, high income, and prestige [6,7].

Gender is another significant factor that affects specialty choice. Female students are more likely to favor job flexibility (namely, the option to work part-time) and the lifestyle [8,9], while male students are more concerned about technical challenges, society's perception, and learning potential [10].

In fact, the total number of female medical students has increased to that of male medical students. However, there are fewer female students in some medical specialties, such as diagnostic radiology [11-13]. The factors discouraging female students from choosing diagnostic radiology are similar to those in other medical careers [14].

A previous study conducted to find the reasons for choosing radiology as a career among radiologists found 4 important factors: interest in diagnostic radiology, quality of life, variety of practice, and fixed work hours [11]. A greater proportion of female radiologists (60%) than male radiologists (43%) took into consideration the work hours and believed it was the main reason they decided to join the radiology field. These findings are understandable since women need more flexible working shifts than do men during their child-rearing years [15].

One study showed that indirect patient care and nonclinical work were the major factors that dissuaded American clerkship students from choosing diagnostic radiology as a career [16]. However, evidence suggests that good exposure during medical education may help students choose diagnostic radiology as a career in the future [11].

The factors underlying gender differences in radiology are not fully elucidated. The purpose of this research was to examine the factors that attract medical students to and discourage them from selecting diagnostic radiology as a specialty and to analyze whether these factors differ between female and male medical students in Saudi Arabia.

## Methods

This cross-sectional study was conducted at King Abdulaziz University Hospital (KAUH) in Jeddah, Saudi Arabia. Ethical approval for the study was provided by the Institutional Review Board of KAUH.

We included participants from all medical years. The study was conducted by sending an electronic questionnaire to the medical students of KAUH during February 2018. The students were given 1 month to return their reply after receiving the questionnaire. In the meantime, we sent 2 reminder emails about the questionnaire. The survey was sent to 1127 students, and only 539 (47.8%) answered the questionnaire.

The questionnaire was obtained from a previously published study [17]. It consisted of 4 sections. The first section collected

information about any previous radiology exposure or any mentorship the respondent had received in the radiology field. The second section collected information about any factors that affected their specialty choice. The third section collected information about the factors that discouraged them from choosing radiology as a career. This section was to be answered only by students who were not interested in radiology. The fourth section collected information about the factors that encouraged them to choose radiology as a career. This section was to be answered only by students who were considering radiology as a career. In the "previous radiology exposure" section, a preclinical observership, wherein a student attended radiology out of personal interest, was not a mandatory requirement before clerkship. An elective was defined as a rotation in which a student could select any specialty and he/she selected radiology. The answers were in a "select all that apply" format.

The data were entered into Microsoft Excel (Microsoft Corporation, Redmond, WA) and then transferred to IBM SPSS Statistics for Windows, Version 23.0 (IBM Corp, Armonk, NY) for further analysis. Categorical variables, including primary variables, were described using a frequency table and subsequently processed to calculate the statistical significance using the chi-square test and Cramér's V test. For all statistical tests,  $P$  values  $<0.05$  were considered significant.

## Results

A total of 539 students participated, resulting in a response rate of 47.8% (539/1127). Of these students, 276 were female (276/539, 51.2%), and 263 were male (263/539, 48.8%). In the total sample, 266 (266/539, 49.3%) students were in their pre-clerkship years, and 273 (273/539, 50.6%) students were in their clerkship years. No significant difference was observed between genders in the level of training. Students who were potentially considering radiology as a career numbered 83 (83/539, 15.4%), while 456 (456/539, 84.6%) were not interested in considering radiology as a career. Among the students interested in radiology, 40 were female (40/83, 48.2%), and 43 were male (43/83, 51.8%). No significant difference was found between genders regarding the consideration of radiology as a specialty.

### Radiology Exposure

Among the students considering radiology as a career, more men had a radiology mentor than did women ( $P<.001$ ). In addition, more male students conducted radiology-related research than did female students ( $P<.001$ ), but no gender-specific differences were observed in mentorship and research experience among those not interested in radiology. Among the students not interested in radiology, more men had received didactic lectures than did women ( $P=.01$ ; Table 1).

**Table 1.** Method of exposure to radiology, by gender and interest in the specialty.

Previous radiology exposure	Considering radiology, n (%)			Not considering radiology, n (%)		
	Female students (n=40)	Male students (n=43)	P value	Female students (n=236)	Male students (n=220)	P value
A. None	12 (30.0)	10 (23.3)	.65	99 (41.9)	104 (47.3)	.29
B. Preclinical observerships	7 (17.5)	5 (11.6)	.65	36 (15.2)	39 (17.7)	.58
C. Preclinical didactic lectures	11 (27.5)	10 (23.3)	.84	81 (34.3)	53 (24.0)	.01
D. Radiology research experience	6 (15.0)	22 (51.2)	<.001	3 (1.3)	5 (2.3)	.69
E. Core rotations in clerkship	7 (17.5)	12 (27.9)	.38	57 (24.2)	45 (20.5)	.19
F. Elective rotations in clerkship	12 (30.0)	8 (18.6)	.33	9 (3.8)	7 (3.2)	.91
G. Radiology mentor	0 (0)	10 (23.2)	.001	3 (1.3)	7 (3.2)	.20
H. Radiologist family member	4 (10.0)	5 (11.6)	>.99	14 (5.9)	9 (4.1)	.49
I. Attended a radiology conference	3 (7.5)	8 (18.6)	.24	7 (3.0)	11 (5.0)	.38

### Specialty Choice

More male students not considering radiology as a specialty rated direct patient contact ( $P=.003$ ) and impact on patient care ( $P=.01$ ) as important factors than did those interested in radiology. In contrast, more male students who were interested in radiology as a career were attracted by fewer working hours ( $P=.03$ ), job flexibility ( $P=.008$ ), and fewer years of training ( $P=.02$ ) than were those not interested in radiology.

A greater proportion of female students interested in radiology as a career (23/40, 57.5%) were attracted by high income than female students not interested in the specialty (92/236, 38.9%;  $P=.02$ ). In addition, more female students not interested in radiology rated the impact on patient care (116/236, 49.1%;  $P=.008$ ), job opportunities (98/236, 41.5%;  $P=.04$ ), and use of emerging technology (64/236, 27.1%;  $P=.005$ ) as important than did female students interested in radiology. Factors that influenced the choice of a medical specialty are shown in [Table 2](#).

**Table 2.** Factors affecting specialty choice, by gender and interest in radiology.

Factor	Female students, n (%)			Male students, n (%)		
	Not considering radiology (n=236)	Considering radiology (n=40)	P value	Not considering radiology (n=220)	Considering radiology (n=43)	P value
A. High income	92 (38.9)	23 (57.5)	.02	127 (57.7)	28 (65.1)	.46
B. Fewer working hours	61 (25.8)	16 (40.0)	.09	71 (32.2)	21 (48.8)	.03
C. Job flexibility	90 (38.1)	19 (47.5)	.34	80 (36.0)	25 (58.0)	.008
D. Intellectual stimulation	58 (24.5)	5 (12.5)	.13	59 (26.8)	9 (20.9)	.53
E. Use of emerging technology	64 (27.1)	2 (5.0)	.005	43 (19.5)	12 (27.9)	.30
F. Direct patient contact	102 (43.2)	13 (32.5)	.27	82 (37.0)	6 (13.9)	.003
G. Impact on patient care	116 (49.1)	10 (25.0)	.008	82 (37.3)	7 (16.3)	.01
H. Perception by others	14 (5.9)	2 (5.0)	>.99	30 (13.6)	5 (11.6)	.91
I. Job satisfaction	140 (59.3)	20 (50.0)	.35	132 (60.5)	22 (51.2)	.33
J. Available job opportunities	98 (41.5)	10 (25.0)	.04	84 (38.2)	16 (37.2)	>.99
K. Fewer years of residency	34 (14.4)	2 (5.0)	.16	23 (10.4)	10 (23.3)	.02
L. Research opportunities	41 (17.3)	3 (7.5)	.16	40 (18.2)	6 (14.0)	.65
M. Positive training experience	70 (29.6)	11 (27.5)	.92	44 (20.0)	6 (14.0)	.47
N. Positive mentorship experience	50 (21.1)	5 (12.5)	.29	44 (20.0)	4 (9.3)	.14
O. Favorable to having children	45 (19.0)	7 (17.5)	.98	33 (15.0)	9 (20.9)	.40

### Factors Attracting Students to Radiology

The top factors attracting medical students to radiology as a career included focused patient interactions with minimal paperwork, interest in anatomy, and job flexibility ([Table 3](#)).

More female students (Cramér's  $V=0.12$ ,  $P=.01$ ) were attracted by the option to work part-time (namely, job flexibility), while more male students were attracted by focused patient interactions with minimal paperwork (Cramér's  $V=0.4$ ,  $P<.001$ ).

**Table 3.** Factors enticing medical students to radiology, among those considering radiology as a career.

Factor	Male students (n=43), n (%)	Female students (n=40), n (%)	P value
A. Physics knowledge	12 (27.9)	13 (32.5)	.83
B. Interest in anatomy	13 (30.2)	19 (47.5)	.17
C. Wide range of medical knowledge	13 (30.2)	14 (35.0)	.82
D. Role as a consultant to other doctors	7 (16.2)	10 (25.0)	.48
E. Having a task-based workday	13 (30.2)	14 (35.0)	.82
F. Focused patient interactions with minimal paperwork	28 (65.1)	1 (2.5)	<.001
G. Impact on patient care	9 (20.9)	10 (25.0)	.86
H. High income	15 (34.9)	13 (32.5)	>.99
I. Positive perception of radiology by others	4 (9.3)	2 (5.0)	.67
J. Positive prior exposure to radiology as a specialty	5 (11.6)	9 (22.5)	.30
K. Positive radiology mentorship experience	4 (9.3)	3 (7.5)	>.99
L. Job flexibility (ie, opportunity to work part-time)	12 (27.9)	23 (57.5)	.01
M. Passionate to be an interventional radiologist	9 (20.9)	10 (25.0)	.86
N. Intellectual stimulation	8 (18.6)	7 (17.5)	>.99
O. Interest in radiology research	5 (11.6)	5 (12.5)	>.99
P. Perceived availability of job opportunities	12 (27.9)	16 (40.0)	.35

### Factors Dissuading Students From Radiology

The most common factor that dissuaded students from choosing radiology as a career was the lack of direct patient contact, which deterred 43.2% (95/220) of male students and 50.8% (120/236) of female students who had decided not to consider radiology as a specialty (Table 4). For each gender, among female students, the second most common factor was potential

exposure to radiation (88/236, 37.7%), while among males, the second most common factor was a negative perception by other physicians (71/220, 32.1%).

A negative perception by other physicians (Cramér's  $V=0.8$ ,  $P<.001$ ), lack of acknowledgment by patients (Cramér's  $V=0.13$ ,  $P=.004$ ), and lack of structured radiology rotations (Cramér's  $V=0.12$ ,  $P=.007$ ) dissuaded significantly more male students than female students, as shown in Table 4.

**Table 4.** Factors dissuading medical students from radiology among those not considering radiology, by gender.

Factor	Male students (n=220), n (%)	Female students (n=236), n (%)	P value
A. Physics knowledge	43 (19.5)	55 (23.3)	.39
B. Role as a consultant to other doctors	16 (7.2)	24 (10.2)	.35
C. Lack of direct patient contact	95 (43.2)	120 (50.8)	.12
D. Negative perception by other doctors	71 (32.1)	8 (3.3)	<.001
E. Lack of acknowledgment by patients	52 (23.6)	30 (12.7)	.004
F. Possible exposure to radiation	65 (29.5)	88 (37.7)	.09
G. Competitiveness in attaining a residency position	14 (6.3)	19 (8.0)	.61
H. Lack of prior exposure to radiology as a specialty	32 (14.5)	28 (11.9)	.48
I. Lack of structured radiology rotations and courses	32 (14.5)	15 (6.4)	.007
J. Lack of radiology mentorship	15 (6.8)	16 (6.8)	>.99
K. Perceived lack of working part-time	8 (3.6)	7 (3.0)	.89
L. Perceived lack of job satisfaction	34 (15.3)	36 (15.3)	>.99
M. Perceived lack of job opportunities	18 (8.1)	13 (5.5)	.34
N. Already pursuing another specialty	65 (29.5)	78 (33.1)	.48
O. Bad personal experience in radiology	18 (8.1)	9 (3.8)	.07
P. Working in a dark environment	34 (15.5)	52 (22.0)	.09
Q. Perception as a male-dominated career	4 (1.8)	7 (3.0)	.62
R. Lack of research support or opportunities	11 (5.0)	16 (6.8)	.45
S. Lack of procedures performed by non-interventional radiologists	12 (5.5)	14 (5.9)	.99

## Discussion

The aim of this study was to scrutinize the factors that attracted medical students to and deterred them from selecting diagnostic radiology as a specialty and to analyze whether these factors vary between male and female students. In this survey, compared with the percentage of male students, the percentage of female students considering radiology as a specialty was inconsistent with that in the literature. In this study, the numbers of female and male participants interested in radiology were almost the same, while the literature suggests that female participants consider radiology less frequently than do male participants [17-20]. The female lifestyle in Saudi Arabia and the great attention they pay to child rearing, with considerable concern for their family in general, could be the cause for this disparity. Our finding agrees with that in a previous survey carried out in Saudi Arabia, which concluded that marital status, which is an important part of social life, was a considerable predictor for job selection among female participants [21].

Of the 16 attractive factors that we studied, the most important factor that attracted female participants to radiology was job flexibility. This was emphasized by another study conducted in Canada [17]. In the SwissMedCareer Study, the percentage of female physicians who had children and worked full-time was only 18.3% [22]. Furthermore, when radiology residents were asked about the factors they think would attract medical students to consider radiology, they reported the ability to work part-time and maintain work-family harmony as the 2 most important factors [23]. An American study demonstrated that

60% of women and only 7% of men were working part-time ( $P<.01$ ) [24]. This result is unsurprising as women seek more balance between work and life, including child-care, which is considered the main reason women consider part-time work [23,25]. In summary, a controllable lifestyle has a remarkable influence on medical students' specialty preferences and, therefore, has the potential to attract female students towards radiology [11,26]. However, women in diagnostic radiology are unequally represented within radiology residency training programs compared with other residency training programs [27]. For male students, the most attractive part of radiology is the focused patient interaction with minimal paperwork. This could be because male students prefer performing a focused task rather than being responsible for multiple tasks.

The most crucial factor that dissuaded both male and female students from considering radiology as a specialty was the lack of direct patient contact. This is concordant with the findings of other studies that confirmed this as the most significant factor [18,19,28,29]. However, female students concentrate on some subspecialties and overlook others, including interventional radiology, that enable the most patient contact [11,17,30]. There are two probable explanations for this. First, female students have insufficient information about interventional radiology; a Saudi study emphasized that more than half of respondents believed that they had poor or no information about this subspecialty [31]. Second, female students avoid this subspecialty because it is less flexible, lacks the opportunity to work part-time, and is associated with long hours and physically demanding work [17], which they considered an extremely

important characteristic when selecting radiology as a career. To solve the issue of women not considering a subspecialty such as interventional radiology, a program should be initiated that encourages the early exposure of students to subspecialties that involve direct contact with patients, and the available opportunities for patient contact in these subspecialties should be highlighted [18,28]. For male students specifically, the lack of acknowledgement by patients was ranked fourth among the choices. This outcome can be interpreted based on the lack of direct contact with the patient, which obviates patient appreciation. Nevertheless, highlighting the significant role of radiology in treating patients and improving their health could help overcome this notion.

The second most common factor that dissuaded female students from selecting radiology as a specialty was potential exposure to radiation. A fear of cancer, specifically breast cancer, could account for this; breast cancer is the most common cancer in women, and radiation exposure is a risk factor [32,33]. For male students, the second factor was a negative perception by other physicians. Notably, this specific reason was also the second most important deterrent among male participants in another study [28]. Many reasons could inculcate this thought, including that the decision to pursue radiology can be influenced by intensive radiology exposure [27]. We think that limited exposure to radiology may have a role in the development of this negative perception among students. Compared with other specialties that are studied in detail and over a long period of time, students of radiology are involved in a very short rotation with only a few scattered lectures throughout the 6 academic years and few available courses. This concept supports another of our findings, namely that a lack of structured rotations and selective courses dissuaded more male students from this specialty. Furthermore, as a result of limited exposure, radiologists will not have enough time to wholly and effectively display their expertise. The manner in which doctors from different specialties introduce radiology to students during classes and rounds could perhaps have an effect. However, it is unclear why this factor was specifically mentioned by male students.

Having a passion for another specialty was one of the top 3 dissuading factors among students of both genders. At our institution, the radiology rotation is presented to the students in the fourth year, a time at which most are already passionate about another specialty [20] and a short rotation will probably not change their choice. Therefore, radiology should be introduced to medical students in their first years, and it must be taught in a way that encourages active participation rather than just observing.

Overall, specialty choice was more affected by direct patient contact and impact on patient care for male respondents preferring non-radiology specialties. Students who are concerned about patient contact and patient care seem less interested in radiology and vice versa [34]. It must be emphasized that radiology has a prominent role in patient care since most patients

undergo radiological imaging as a part of their diagnostic journey [28]. Further, the process of image interpretation is not a separate process from patient care, and in fact, it is influenced by the patient's history and presentation [18]. Therefore, patient care is an integrated system where success depends on the contribution of many physicians from different specialties with a final goal of saving patients' lives. Among students interested in radiology as a career, when compared with students not interested, the male students' choices were more affected by fewer working hours, job flexibility, and fewer years of training, while the female students' choices were influenced by a high income. These findings are supported by those of another study, which showed that specialty choice has recently been influenced by many factors, including a controllable lifestyle and high income [26].

Male students interested in radiology also conducted more research activities in radiology than did female students. This finding is consistent with that of a Canadian study [17]. Additionally, more male students interested in radiology had a radiology mentor than did female students. In fact, the presence of a mentor is considered an essential factor that affects specialty choice [18,35].

Although the aim of the study was achieved, there were some limitations. Since the main topic of the study was the specialty of radiology, bias may be present because students who are considering radiology as a career may be more interested than other students in answering the questionnaire. Furthermore, almost half of the students were in the pre-clerkship years. As a result, their exposure and knowledge about radiology and other specialties could be restricted. In fact, we did not assess the students' career choice after graduation, and we only assessed their interest in radiology in general. Moreover, this survey did not illustrate whether exposure to radiology would markedly increase the students' interest in radiology. Thus, a study analyzing the students' opinion before and after exposure to the specialty of radiology is warranted. Finally, this was a cross-sectional study that cannot determine causality between the studied factors and the choice of the radiology specialty.

## Conclusion

Many factors could influence the decision of medical students to consider diagnostic radiology as a career in the future. The present work has shown that the most discouraging factor is the lack of direct patient contact, whereas the most encouraging factor is job flexibility for female students and focused patient interactions with minimal paperwork for male students. Furthermore, no significant difference was found between the genders related to considering radiology as a specialty. We observed that misconception plays a central role in students' judgments regarding radiology specialties. Hence, early exposure to radiology, assuming a new teaching method, and using a curriculum that supports the active participation of students in a radiology rotation are needed to overcome this misconception.

## Acknowledgments

We would like to show our gratitude to the following medical students for their considerable contributions to data collection: Mada Barashid, Nusaiba Khayyat, Raghad Bishnaq, Ghadeer Alotaibi, and Lujain Alghamdi.

## Conflicts of Interest

None declared.

## References

1. Saudi Commission for Health Specialties. 2018. The reality of the Saudi health workforce over the next ten years Internet URL: <https://www.scfhs.org.sa/Media/DigitalLibrary/DocumentLibrary/OtherPublications/Pages/default.aspx>
2. Mehmood SI, Kumar A, Al-Binali A, Borleffs JCC. Specialty preferences: trends and perceptions among Saudi undergraduate medical students. *Med Teach* 2012;34 Suppl 1:S51-S60. [doi: [10.3109/0142159X.2012.656753](https://doi.org/10.3109/0142159X.2012.656753)] [Medline: [22409192](https://pubmed.ncbi.nlm.nih.gov/22409192/)]
3. She L, Wu B, Xu L, Wu J, Zhang P, Li E. Determinants of career aspirations of medical students in southern China. *BMC Med Educ* 2008 Dec 11;8:59 [FREE Full text] [doi: [10.1186/1472-6920-8-59](https://doi.org/10.1186/1472-6920-8-59)] [Medline: [19077214](https://pubmed.ncbi.nlm.nih.gov/19077214/)]
4. Lefèvre JH, Karila L, Kerneis S, Rouprêt M. Motivation of French medical students to pursue surgical careers: results of national survey of 1742 students. *J Visc Surg* 2010 Jul;147(3):e181-e186. [doi: [10.1016/j.jviscsurg.2010.08.004](https://doi.org/10.1016/j.jviscsurg.2010.08.004)] [Medline: [20800566](https://pubmed.ncbi.nlm.nih.gov/20800566/)]
5. Akpayak IC, Okonta KE, Ekpe EE. Medical students' preference for choice of clinical specialties: A multicentre survey in Nigeria. *Jos Journal of Medicine* 2014;8(3):49-52.
6. Alshahrani M, Dhafery B, Al Mulhim M, Alkhadra F, Al Bagshi D, Bukhamsin N. Factors influencing Saudi medical students and interns' choice of future specialty: a self-administered questionnaire. *Adv Med Educ Pract* 2014;5:397-402 [FREE Full text] [doi: [10.2147/AMEPS.69152](https://doi.org/10.2147/AMEPS.69152)] [Medline: [25368542](https://pubmed.ncbi.nlm.nih.gov/25368542/)]
7. Huneif M. Factors influencing in the selection of specialty among the student of College of Medicine, Najran university, KSA. *Glo. Adv. Res. J. Med. Med. Sci* 2017;6(2):028-033.
8. Ek EW, Ek ET, Mackay SD. Undergraduate experience of surgical teaching and its influence and its influence on career choice. *ANZ J Surg* 2005 Aug;75(8):713-718. [doi: [10.1111/j.1445-2197.2005.03500.x](https://doi.org/10.1111/j.1445-2197.2005.03500.x)] [Medline: [16076339](https://pubmed.ncbi.nlm.nih.gov/16076339/)]
9. Gorenflo DW, Ruffin MT, Sheets KJ. A multivariate model for specialty preference by medical students. *J Fam Pract* 1994 Dec;39(6):570-576. [Medline: [7798861](https://pubmed.ncbi.nlm.nih.gov/7798861/)]
10. Baxter N, Cohen R, McLeod R. The impact of gender on the choice of surgery as a career. *The American Journal of Surgery* 1996 Oct;172(4):373-376. [doi: [10.1016/S0002-9610\(96\)00185-7](https://doi.org/10.1016/S0002-9610(96)00185-7)] [Medline: [8873533](https://pubmed.ncbi.nlm.nih.gov/8873533/)]
11. Potterton VK, Ruan S, Sunshine JH, Applegate K, Cypel Y, Forman HP. Why don't female medical students choose diagnostic radiology? A review of the current literature. *J Am Coll Radiol* 2004 Aug;1(8):583-590. [doi: [10.1016/j.jacr.2004.02.023](https://doi.org/10.1016/j.jacr.2004.02.023)] [Medline: [17411657](https://pubmed.ncbi.nlm.nih.gov/17411657/)]
12. Sunshine JH, Cypel YS, Schepps B. Diagnostic radiologists in 2000: basic characteristics, practices, and issues related to the radiologist shortage. *AJR Am J Roentgenol* 2002 Mar;178(2):291-301. [doi: [10.2214/ajr.178.2.1780291](https://doi.org/10.2214/ajr.178.2.1780291)] [Medline: [11804882](https://pubmed.ncbi.nlm.nih.gov/11804882/)]
13. Baker SR, Barry M, Chaudhry H, Hubbi B. Women as radiologists: are there barriers to entry and advancement? *J Am Coll Radiol* 2006 Mar;3(2):131-134. [doi: [10.1016/j.jacr.2005.10.001](https://doi.org/10.1016/j.jacr.2005.10.001)] [Medline: [17412023](https://pubmed.ncbi.nlm.nih.gov/17412023/)]
14. Martin CA, Woodring JH. Attitudes toward women in radiology. *J Am Med Womens Assoc* (1972) 1986;41(2):50-53. [Medline: [3700943](https://pubmed.ncbi.nlm.nih.gov/3700943/)]
15. Chertoff JD, Bird CE, Amick BC. Career paths in diagnostic radiology: scope and effect of part-time work. *Radiology* 2001 Dec;221(2):485-494. [doi: [10.1148/radiol.2212000788](https://doi.org/10.1148/radiol.2212000788)] [Medline: [11687694](https://pubmed.ncbi.nlm.nih.gov/11687694/)]
16. Kazerooni EA, Blane CE, Schlesinger AE, Vydareny KH. Medical students' attitudes toward radiology: Comparison of matriculating and graduating students. *Academic Radiology* 1997 Jul;4(8):601-607. [doi: [10.1016/s1076-6332\(97\)80211-5](https://doi.org/10.1016/s1076-6332(97)80211-5)] [Medline: [9261460](https://pubmed.ncbi.nlm.nih.gov/9261460/)]
17. Zener R, Lee SY, Visscher KL, Ricketts M, Speer S, Wiseman D. Women in Radiology: Exploring the Gender Disparity. *J Am Coll Radiol* 2016 Mar;13(3):344-50.e1. [doi: [10.1016/j.jacr.2015.10.019](https://doi.org/10.1016/j.jacr.2015.10.019)] [Medline: [26774885](https://pubmed.ncbi.nlm.nih.gov/26774885/)]
18. Arleo EK, Bluth E, Francavilla M, Straus CM, Reddy S, Recht M. Surveying Fourth-Year Medical Students Regarding the Choice of Diagnostic Radiology as a Specialty. *J Am Coll Radiol* 2016 Mar;13(2):188-195. [doi: [10.1016/j.jacr.2015.08.005](https://doi.org/10.1016/j.jacr.2015.08.005)] [Medline: [26499162](https://pubmed.ncbi.nlm.nih.gov/26499162/)]
19. Bluth EI, Bansal S, Macura KJ, Fielding J, Truong H. Gender and the radiology workforce: results of the 2014 ACR workforce survey. *J Am Coll Radiol* 2015 Mar;12(2):155-157. [doi: [10.1016/j.jacr.2014.07.040](https://doi.org/10.1016/j.jacr.2014.07.040)] [Medline: [25652301](https://pubmed.ncbi.nlm.nih.gov/25652301/)]
20. Taylor CS, Weatherly B, Farley EP, Clemons MP, Watts J, Vijayakumar V. Generating Medical Student Interest in the Field of Radiology. *J Am Coll Radiol* 2018 Feb;15(2):340-342. [doi: [10.1016/j.jacr.2017.08.018](https://doi.org/10.1016/j.jacr.2017.08.018)] [Medline: [29079247](https://pubmed.ncbi.nlm.nih.gov/29079247/)]
21. Zolaly MA, Kasim K, Mahmoud MI. Medical career selection among newly graduated physicians in Madinah, KSA. *Med Teach* 2013;35 Suppl 1:S63-S67. [doi: [10.3109/0142159X.2013.765541](https://doi.org/10.3109/0142159X.2013.765541)] [Medline: [23581898](https://pubmed.ncbi.nlm.nih.gov/23581898/)]
22. Stamm M, Buddeberg-Fischer B. How do physicians and their partners coordinate their careers and private lives? *Swiss Med Wkly* 2011;141:w13179 [FREE Full text] [doi: [10.4414/smw.2011.13179](https://doi.org/10.4414/smw.2011.13179)] [Medline: [21437817](https://pubmed.ncbi.nlm.nih.gov/21437817/)]



23. Buddeberg-Fischer B, Hoffmann A, Christen S, Weishaupt D, Kubik-Huch RA. Specialising in radiology in Switzerland: still attractive for medical school graduates? *Eur J Radiol* 2012 Jul;81(7):1644-1651. [doi: [10.1016/j.ejrad.2011.03.011](https://doi.org/10.1016/j.ejrad.2011.03.011)] [Medline: [21458185](https://pubmed.ncbi.nlm.nih.gov/21458185/)]
24. Owen JB, Chan WC, Sunshine JH, Shaffer KA. The sex ratio of American radiologists: comparison and implications by age, subspecialty, and type of practice. *AJR Am J Roentgenol* 1995 Dec;165(6):1337-1341. [doi: [10.2214/ajr.165.6.7484559](https://doi.org/10.2214/ajr.165.6.7484559)] [Medline: [7484559](https://pubmed.ncbi.nlm.nih.gov/7484559/)]
25. Buddeberg-Fischer B, Stamm M, Buddeberg C, Bauer G, Häemmig O, Knecht M, et al. The impact of gender and parenthood on physicians' careers--professional and personal situation seven years after graduation. *BMC Health Serv Res* 2010 Mar 18;10:40 [FREE Full text] [doi: [10.1186/1472-6963-10-40](https://doi.org/10.1186/1472-6963-10-40)] [Medline: [20167075](https://pubmed.ncbi.nlm.nih.gov/20167075/)]
26. Dorsey ER, Jarjoura D, Rutecki GW. Influence of controllable lifestyle on recent trends in specialty choice by US medical students. *JAMA* 2003 Oct 03;290(9):1173-1178. [doi: [10.1001/jama.290.9.1173](https://doi.org/10.1001/jama.290.9.1173)] [Medline: [12952999](https://pubmed.ncbi.nlm.nih.gov/12952999/)]
27. Campbell JC, Yoon SC, Cater SW, Grimm LJ. Factors Influencing the Gender Breakdown of Academic Radiology Residency Programs. *J Am Coll Radiol* 2017 Jul;14(7):958-962. [doi: [10.1016/j.jacr.2017.02.045](https://doi.org/10.1016/j.jacr.2017.02.045)] [Medline: [28427906](https://pubmed.ncbi.nlm.nih.gov/28427906/)]
28. Fielding JR, Major NM, Mullan BF, Neutze JA, Shaffer K, Wilcox CB, et al. Choosing a specialty in medicine: female medical students and radiology. *AJR Am J Roentgenol* 2007 May;188(4):897-900. [doi: [10.2214/AJR.06.0539](https://doi.org/10.2214/AJR.06.0539)] [Medline: [17377020](https://pubmed.ncbi.nlm.nih.gov/17377020/)]
29. Grimm LJ, Lowell DA, Cater SW, Yoon SC. Differential Motivations for Pursuing Diagnostic Radiology by Gender: Implications for Residency Recruitment. *Acad Radiol* 2017 Oct;24(10):1312-1317. [doi: [10.1016/j.acra.2017.03.023](https://doi.org/10.1016/j.acra.2017.03.023)] [Medline: [28552374](https://pubmed.ncbi.nlm.nih.gov/28552374/)]
30. Collins J. Residency training data: what do the numbers tell us? *J Am Coll Radiol* 2004 Oct;1(9):685-688. [doi: [10.1016/j.jacr.2004.03.004](https://doi.org/10.1016/j.jacr.2004.03.004)] [Medline: [17411679](https://pubmed.ncbi.nlm.nih.gov/17411679/)]
31. Alshumrani GA. Awareness of interventional radiology among final-year medical students and medical interns at a university in Southwestern Saudi Arabia. *Saudi Med J* 2013 Aug;34(8):841-847. [Medline: [23974457](https://pubmed.ncbi.nlm.nih.gov/23974457/)]
32. Tarver T. Cancer Facts & Figures 2012. American Cancer Society (ACS). *Journal of Consumer Health On the Internet* 2012 Jul;16(3):366-367. [doi: [10.1080/15398285.2012.701177](https://doi.org/10.1080/15398285.2012.701177)]
33. International Agency for Research on Cancer. IARC Monographs on the Evaluation of Carcinogenic Risk to Humans Vol. In: Ionizing Radiation: Part 1: X- And Gamma (γ)-radiation, And Neutrons (medicine). France: World Health Organization; 2020.
34. Roubidoux MA, Packer MM, Applegate KE, Aben G. Female medical students' interest in radiology careers. *J Am Coll Radiol* 2009 May;6(4):246-253. [doi: [10.1016/j.jacr.2008.11.014](https://doi.org/10.1016/j.jacr.2008.11.014)] [Medline: [19327657](https://pubmed.ncbi.nlm.nih.gov/19327657/)]
35. Wright S, Wong A, Newill C. The impact of role models on medical students. *J Gen Intern Med* 1997 Jan;12(1):53-56 [FREE Full text] [doi: [10.1046/j.1525-1497.1997.12109.x](https://doi.org/10.1046/j.1525-1497.1997.12109.x)] [Medline: [9034946](https://pubmed.ncbi.nlm.nih.gov/9034946/)]

## Abbreviations

**KAUH:** King Abdulaziz University Hospital

*Edited by G Eysenbach; submitted 09.05.19; peer-reviewed by IV George, S Purkayastha, F Sendra-Portero; comments to author 14.12.19; revised version received 06.02.20; accepted 02.03.20; published 28.04.20.*

*Please cite as:*

Abduljabbar AH, Alnajjar SF, Alshamrani H, Bashamakh LF, Alshehri HZ, Alqulayti WM, Wazzan MA

*The Influence of Gender on the Choice of Radiology as a Specialty Among Medical Students in Saudi Arabia: Cross-Sectional Study* *Interact J Med Res* 2020;9(2):e14666

URL: <http://www.i-jmr.org/2020/2/e14666/>

doi: [10.2196/14666](https://doi.org/10.2196/14666)

PMID: [32141832](https://pubmed.ncbi.nlm.nih.gov/32141832/)

©Ahmed H Abduljabbar, Sara F Alnajjar, Hussein Alshamrani, Lujain F Bashamakh, Hisham Z Alshehri, Waleed M Alqulayti, Mohammad A Wazzan. Originally published in the Interactive Journal of Medical Research (<http://www.i-jmr.org/>), 28.04.2020. This is an open-access article distributed under the terms of the Creative Commons Attribution License (<https://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work, first published in the Interactive Journal of Medical Research, is properly cited. The complete bibliographic information, a link to the original publication on <http://www.i-jmr.org/>, as well as this copyright and license information must be included.

Original Paper

# Health-Related Effects of Home Nebulization With Glycopyrronium on Difficult-to-Treat Asthma: Post-Hoc Analyses of an Observational Study

Deepak Talwar<sup>1\*</sup>, MD, DM; Salil Bendre<sup>2\*</sup>, MD

<sup>1</sup>Department of Pulmonology and Sleep Medicine, Metro Centre for Respiratory Diseases, Noida, India

<sup>2</sup>Department of Chest Medicine, KLS Memorial Hospital, Mumbai, India

\* all authors contributed equally

**Corresponding Author:**

Deepak Talwar, MD, DM

Department of Pulmonology and Sleep Medicine

Metro Centre for Respiratory Diseases

94, Noida Road, D Block, Sector 11

Uttar Pradesh

Noida, 201301

India

Phone: 91 9899050000

Email: [hraastudy@gmail.com](mailto:hraastudy@gmail.com)

## Abstract

**Background:** Bronchial asthma remains a clinical enigma with poorly controlled symptoms or exacerbations despite regular use of inhaled corticosteroids. Home nebulization offers a simplified solution for the delivery of rescue and maintenance bronchodilators, which is especially true for patients with frequent exacerbations during management of uncontrolled or difficult-to-treat asthma.

**Objective:** We aimed to assess the clinical impact and outcomes associated with home nebulization—delivered long-acting bronchodilators for uncontrolled or difficult-to-treat asthma.

**Methods:** This observational, concurrent study was conducted with 60 patients at 2 centers during November 2018. Statistical analyses for prebronchodilator forced expiratory volume in one second (FEV<sub>1</sub>) and Global Initiative for Asthma (GINA) asthma control score in patients on long-acting bronchodilators and corticosteroids were conducted, with two-tailed *P* values <.05 considered statistically significant.

**Results:** Per protocol analyses (53/60) for consecutive cases receiving home nebulization with long-acting bronchodilators and corticosteroids were conducted. The baseline demographics included a male-to-female ratio of 30:23 and mean values of the following: age, 60.3 years (SD 11.8 years); weight, 64 kg (SD 16.8 kg); FEV<sub>1</sub>, 43% (SD 16%); GINA asthma control score, 3.0 points (SD 0.8 points); serum eosinophil level, 4% (SD 3%); fractional exhaled nitric oxide (FeNO), 12.1 ppb (SD 6 ppb). Of the patients, 100% (53/53) had uncontrolled symptoms, 69.8% (37/53) had prior exacerbations, 100% (53/53) used formoterol/budesonide, and 75.5% (40/53) used glycopyrronium. The per protocol group (n=53) had significantly improved mean prebronchodilator FEV<sub>1</sub> (23.7%, SD 29.8%; 0.46 L, SD 0.58 L; *P*<.001) and GINA asthma control score (2.1 points, SD 0.8 points, *P*<.001). At baseline, patients (n=40) receiving glycopyrronium/formoterol/budesonide (25/20/500 mcg) nebulization admixture had the following mean values: prebronchodilator FEV<sub>1</sub>, 38% (SD 15%); GINA asthma control score, 3.0 points (SD 0.8 points); reversibility, 12% (SD 6%); peripheral eosinophil level, 4% (SD 3%); FeNO, 12 ppb (SD 5.7 ppb). In the post hoc analyses, these patients had significantly improved mean prebronchodilator FEV<sub>1</sub> of 27.7% (SD 26.2%; 0.54 L, SD 0.51 L; *P*<.001) at 8 weeks compared with baseline. At baseline, patients (n=13) receiving formoterol/budesonide (20/500 mcg) nebulization had the following mean values: FEV<sub>1</sub>, 55% (SD 12%); GINA asthma control score, 3.0 points (SD 1.2 points); reversibility, 14% (SD 7%); serum eosinophil level, 4% (SD 3%); FeNO, 13.3 ppb (SD 6.8 ppb). In the post hoc analyses, these patients showed a significant improvement in prebronchodilator FEV<sub>1</sub> of 11.2% (SD 13.1%; 0.22 L, SD 0.25 L; *P*<.001) from baseline. Breathlessness of mild to moderate intensity was reported by 10 cases (10/53, 18.9%), with no other treatment-emergent adverse events or serious adverse events.

**Conclusions:** Home nebulization remains a viable option for symptomatic difficult-to-treat asthma cases with frequent use of rescue medications. Glycopyrronium as add-on therapy offers a synergistic response in patients on corticosteroids with difficult-to-treat asthma.

**Trial Registration:** Clinical Trial Registry of India CTRI/2018/11/016319; <https://tinyurl.com/y78cctm3>

(*Interact J Med Res* 2020;9(2):e17863) doi:[10.2196/17863](https://doi.org/10.2196/17863)

## KEYWORDS

difficult-to-treat asthma; exacerbation; glycopyrronium; home nebulization; uncontrolled asthma; vibrating mesh nebulizer

## Introduction

Bronchial asthma remains a clinical enigma with high rates of morbidity and mortality. The Global Burden of Disease Study [1] highlighted the increasing trends in bronchial asthma, with 37.9 million people currently affected and an increase in the prevalence rate from 3.3% to 4.2%. Notwithstanding the current advances in the understanding of the disease topography or landscape involving the clinical phenotypes and related endotypes of Th2 and non-Th2 inflammation, most patients in real-world settings continue to have uncontrolled or difficult-to-treat asthma. According to a Dutch survey [2] among patients with bronchial asthma, 17% of cases had difficult-to-treat asthma despite a background of Global Initiative for Asthma (GINA) Step 4 or Step 5 therapy involving medium to high doses of combination inhaled corticosteroid and long-acting beta agonist (ICS/LABA). Poor symptom control in such cases is often related to the modifiable risk factors of incorrect inhaler technique, poor adherence, smoking, incorrect diagnoses, small airway disease (SAD), or non-Th2 inflammation that may require a complementary approach with nebulization or therapies involving long-acting muscarinic antagonists (LAMAs) [3].

In patients with severe asthma experiencing more than 2 exacerbations per year or hospitalization, the complementary role of LAMAs has often been considered. Similarly, LAMAs have complemented medium to high doses of ICS/LABA resulting in improved asthma control scores, especially for patients with severe exacerbation [4,5].

However, for most severe cases with uncontrolled asthma, the need for a simplified device to deliver rescue and maintenance bronchodilators administered at home or in ambulatory settings to treat or prevent moderate or severe exacerbations that requires a minimal inspiratory flow rate remains unmet. GINA recommends review of inhaler techniques at every step of asthma control, with due patient recognition and choice of inhaler devices including nebulizers for delivery of acute or maintenance medications [6,7].

A post hoc analysis by Morjaria et al [8] highlights the use of ICS/LABA as single maintenance and reliever therapy compared with PRN salbutamol for a highly significant attenuation in the rate of severe exacerbations, especially in patients with moderate to severe asthma, which is similar to the findings with tiotropium as observed by Kerstjens et al [9]. The clinical dilemma on the choice of therapies involving ICS or LAMAs is further dissected by the representation of bronchial asthma as a heterogenous condition involving eosinophilic or noneosinophilic asthma

phenotypes. The noneosinophilic phenotype occurs in 50% of the severe asthma cases that are typified by biomarker assessments of peripheral eosinophil levels (300 eosinophils/ $\mu$ L) and fractional exhaled nitric oxide (FeNO; <30 ppb), wherein the role of LAMAs is usually suggested since these cases are nonresponsive to ICS, have a long standing history of uncontrolled or elderly asthma with airway remodeling, and likely have fixed airway obstruction changes suggestive of asthma-chronic obstructive pulmonary disease overlap or SAD. Usmani et al [10] observed an overall incidence of SAD of 50-60% among asthmatics, stating that its presence should not be overlooked or underestimated especially when managing severe asthma in real-world outpatient settings

Tiotropium has been clinically evaluated to offer ancillary control in noneosinophilic or paucigranulocytic asthma cases; this control may be correlated with its mechanistic action on the muscarinic receptors and related anti-inflammatory action. Glycopyrronium, an ultra-LAMA, offers quick, persistent, long-lasting bronchodilation and broad anti-inflammatory effects due to its stronger selectivity for M3 receptors as compared to other short-acting or long-acting LAMAs [11]. The anti-inflammatory action entails interleukin-1 $\beta$  and tumor necrosis factor-alpha cytokines for Th2-mediated and Th1-mediated inflammation control, as studied by Shen et al [12] and Kerwin et al [13], that may have relevance in the management of noneosinophilic or mixed granulocyte inflammatory phenotypes of severe asthma.

To further understand the clinical impact and role of home nebulization involving anticholinergics during the acute or maintenance phase of difficult-to-treat or uncontrolled asthma, we planned an observational, concurrent, multicentric study analyses.

## Methods

This observational, concurrent analysis (ie, the HRAA study) of home nebulization therapy was performed using 8 weeks of follow-up data from patients with uncontrolled asthma. The study was initiated following the review and approval of study documents by an independent institutional ethics committee at 2 centers across India. Consecutive cases of bronchial asthma receiving home nebulization in the last 3 weeks of November 2018 were enrolled using a 1:2 ratio of uncontrolled to difficult-to-treat cases, respectively, and followed for 8 weeks. For cases that had ongoing investigation, concurrent analyses were conducted for the missing details on the primary endpoint variables at 8 weeks. Patients receiving background therapy of inhaled ICS/LABA using a dry powder inhaler (DPI) or

pressurized meter dose inhaler (pMDI) were directly switched to nebulization therapy with new-generation devices during study enrollment. The study was conducted as per the principles of the International Conference of Harmonization for Good Clinical Practice and Declaration of Helsinki while ensuring confidentiality of patient identifiers and written informed consent for the patients receiving support for the nebulizer devices.

The inclusion criteria included adult patients undergoing home nebulization for moderate to severe bronchial asthma that was uncontrolled despite receiving low or medium dose ICS/LABA as maintenance therapy and requiring an emergency department visit or frequent use of rescue medications. The exclusion criteria included currently a smoker; exposure to nonsmoking risk factors including cigarette smoke and biomass or occupational hazards; and the need for long-term oral corticosteroids, leukotriene receptor antagonists, or antihistamine combinations. Cases of chronic obstructive pulmonary disease and asthma-chronic obstructive pulmonary disease overlap were excluded based on spirometry assessment for obstructive airway disease with demonstration of reversibility involving a change in forced expiratory volume in one second (FEV1) >12% and >200 mL following salbutamol inhalation

Per protocol analyses were conducted with patient records with  $\geq 1$  follow-up visit for primary endpoints involving improvements in post-bronchodilator FEV1 and GINA asthma control score at 4 and 8 weeks.

Primary analyses for clinical cases were performed to assess asthma control status with symptomatic assessment using the GINA symptom scale for daytime and nighttime symptoms and activity limitation. As per the GINA asthma control symptom assessment, asthma control was defined as well-controlled, partly controlled, or uncontrolled, with total scores of 0, 1-2, and 3-4, respectively, at baseline, 4 weeks, and 8 weeks (follow-up). Difficult-to-treat cases were defined as uncontrolled asthma for patients receiving GINA recommended Step 4 or Step 5 regimens involving inhaled ICS/LABA combination that

may have been optimized for treatment adherence or compliance and comorbidities as per the prescription records.

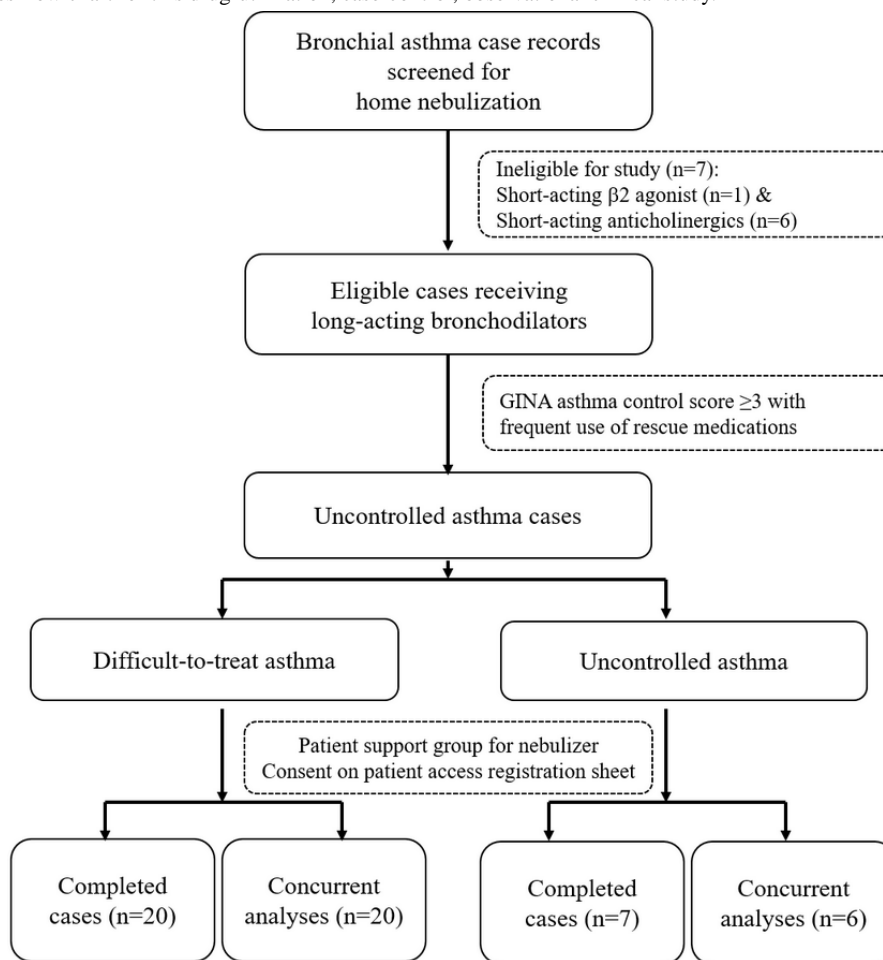
The primary study endpoints included the mean change at 8 weeks in prebronchodilator FEV1, as assessed using spirometry, and GINA asthma control score especially for daytime symptoms, nighttime symptoms, and activity limitations. A secondary endpoint was treatment-emergent adverse events at 8 weeks. The safety observations included treatment-emergent adverse events and were risk stratified as mild, moderate, or severe for any treatment modification, withdrawal, or referral for hospitalization. The National Coordination Centre, PvPI (India) was notified of all serious adverse events observed during the concurrent analyses.

This observational study was conducted to explore the current utilization and impact of home nebulization on the management of difficult-to-treat asthma; we determined an adequate sample size for the primary analyses involving Student's *t* tests for continuous and categorical variables. We planned and performed descriptive analyses for patient demographic variables and Student *t* tests to compare the primary efficacy variables including prebronchodilator FEV1 and GINA asthma control scores between home nebulization with ICS/LABA and home nebulization with ICS/LABA with anticholinergics. Primary and post hoc statistical analyses involving categorical and numerical data were carried out using Fisher exact tests and Student *t* tests in QuickCalcs GraphPad Prism (version 7.05; San Diego, CA). Two-tailed *P* values <.05 were considered statistically significant. Descriptive statistics were used to assess treatment-emergent adverse events at 8 weeks.

## Results

In this observational, concurrent study, 60 consecutive cases undergoing home nebulization with 8 weeks of follow-up records were analyzed. In the control arm, 7 patients were excluded from the per protocol analyses due to maintenance therapy involving inhaled corticosteroids with levosalbutamol (n=1) or combination salbutamol/ipratropium (n=6; [Figure 1](#)).

**Figure 1.** Patient analyses flow chart for this drug-utilization, case-control, observational clinical study.



Subsequent per protocol analyses were performed for 53 home nebulization prescriptions with long-acting bronchodilators including formoterol/budesonide with (n=40) or without (n=13) glycopyrronium. The choice of long-acting anticholinergic was assessed by the physician for the background use of short-acting anticholinergics in the acute phase and status as difficult-to-treat asthma after assessing compliance and adherence to ICS/LABA therapy. Baseline demographic characteristics included cases with severe uncontrolled asthma that were elderly with confirmed reversibility following observation of low FeNO levels following prior use of ICS/LABA with pMDI or DPI inhaler devices (Table 1).

All the patients with uncontrolled asthma were symptomatic (53/53, 100%) before referral to the emergency department or a hospital for persistent symptoms or exacerbation. Patients on a nebulized formoterol/budesonide (20/500 mcg) formulation administered twice daily were assessed as nonadherent to background therapy delivered by DPI or pMDI. On the other

hand, patients assessed as difficult-to-treat cases after evaluation for concomitant comorbidities and compliance were prescribed add-on therapy of nebulized glycopyrrolate (25 mcg), which was co-administered with ICS/LABA as a 4-mL formulation for inhalation.

The mean GINA asthma control scores were assessed from the records for daytime symptoms, nighttime symptoms, activity limitation, and rescue medication use at baseline and 8 weeks for all cases (Textbox 1). The responses for each component are scored as 1 (Yes) or 0 (No). Total scores of 3-4, 1-2, and 0 at each visit indicate uncontrolled, partly controlled, and well-controlled asthma, respectively. For the patients receiving long-acting anticholinergic add-on therapy, glycopyrrolate (25 mcg) was delivered with formoterol/budesonide (20/500 mcg) as a 4-mL admixture and administered twice a day with a vibrating mesh or compressor air nebulizer over a period of 10 minutes.

**Table 1.** Baseline demographics for the per protocol analysis group (n=53).

Parameters	Results, n (%)
<b>Gender</b>	
Male	30 (56.6)
Female	23 (43.4)
Age (years)	60.4 (11.8) <sup>a</sup>
Weight (kg)	64 (16.8) <sup>a</sup>
FEV1 <sup>b</sup> (%)	43 (16) <sup>a</sup>
FEV1 (L)	1.01 (0.42) <sup>a</sup>
Reversibility (%)	13 (6) <sup>a</sup>
History of a hospitalization or emergency department visit in the last year	37 (69.8)
FeNO <sup>c</sup> (ppb)	12.1 (6) <sup>a</sup>
Peripheral eosinophil (%)	4 (3) <sup>a</sup>
GINA <sup>d</sup> asthma control score	3.0 (0.8) <sup>a</sup>
Uncontrolled asthma with frequent rescue medication use	53 (100)
Prior pMDI <sup>e</sup> use	16 (30.2)
Prior DPI <sup>f</sup> use	37 (69.8)
Oral xanthine use	33 (62.3)
<b>Comorbidities</b>	
Hypertension	21 (39.6)
ASCVD <sup>g</sup>	3 (5.7)
Bronchiectasis	5 (9.4)
ARDS <sup>h</sup>	5 (9.4)
Atopy	5 (9.4)
<b>Treatment</b>	
Nebulized glycopyrronium/formoterol/budesonide (25/20/500 mcg)	40 (75.5)
Nebulized formoterol/budesonide (20/500 mcg)	13 (24.5)

<sup>a</sup>Mean (SD).

<sup>b</sup>FEV1: forced expiratory volume in one second.

<sup>c</sup>FeNO: fractional exhaled nitric oxide.

<sup>d</sup>GINA: Global Initiative for Asthma.

<sup>e</sup>pMDI: pressurized meter dose inhaler.

<sup>f</sup>DPI: dry powder inhaler.

<sup>g</sup>ASCVD: atherosclerotic cardiovascular disease.

<sup>h</sup>ARDS: acute respiratory distress syndrome.

**Textbox 1.** Global Initiative for Asthma (GINA) asthma symptom scale score was assessed at each visit to determine well-controlled, partly controlled, or uncontrolled asthma. The responses for each component are scored as 1 (Yes) or 0 (No).

- Daytime asthma symptoms >2 times/week
- Activity or exercise limited by asthma
- Waking during any night due to asthma
- Rescue medication (>2 times/week)

## Efficacy Variables

Per protocol analyses for the overall group (n=53) of prebronchodilator FEV1 and the total GINA asthma control scores for daytime and nighttime symptoms, activity limitation, and use of rescue medications at 8 weeks were significantly improved, by a mean 23.7% (SD 29.8%; 0.46 L, SD 0.58 L;  $P<.001$ ) and 2.1 points (SD 0.8 points,  $P<.001$ ), respectively.

The subgroup (n=40) receiving the glycopyrrolate/formoterol/budesonide (25/20/500 mcg) nebulizing solution admixture had a mean baseline FEV1 of 38% (SD 15%), mean reversibility of 12% (SD 6%), mean peripheral eosinophil level of 4% (SD 3%), and mean FeNO of 12 ppb (SD 5.7 ppb). In the post-hoc analyses, this subgroup had significant improvement in prebronchodilator FEV1 at 8 weeks, by a mean 27.7% (SD 26.2%; 0.54 L, SD 0.51 L;  $P<.001$ ).

The subgroup (n=13) receiving home nebulization with formoterol/budesonide (20/500 mcg) nebulizing solution had a mean baseline FEV1 of 55% (SD 12%), mean reversibility of 14% (SD 7%), mean peripheral eosinophil level of 4% (SD 3%), and a mean FeNO of 13.3 ppb (SD 6.8 ppb). Similarly, this subgroup showed significant improvement in FEV1 at 8 weeks, by a mean 11.2% (SD 13.1%; 0.22 L, SD 0.25 L;  $P<.001$ ).

At 8 weeks, the change in pre-bronchodilator FEV1 from baseline was significant in the group receiving nebulized formoterol/budesonide plus glycopyrronium add-on therapy ( $P<.001$ ), compared with baseline (Table 2). Both subgroups withstood the test of interaction while demonstrating statistically significant responses or improvement in FEV1 and GINA asthma control score at the end of the 8-week observation period ( $P<.001$ ), compared with baseline.

**Table 2.** Change in assessment values at 8 weeks, compared with baseline, for the overall group and by nebulized admixture.

Assessment	Nebulized ICS <sup>a</sup> + bronchodilators <sup>b</sup> (n=53)		Nebulized formoterol/budesonide + glycopyrronium (n=40)		Nebulized formoterol/budesonide (n=13)	
	Change	<i>P</i> value <sup>c</sup>	Change	<i>P</i> value <sup>c</sup>	Change	<i>P</i> value <sup>c</sup>
Pre-bronchodilator FEV1 <sup>d</sup> (L), mean (SD)	0.46 (0.58)	<.001	0.54 (0.51)	<.001	0.22 (0.25)	<.001
GINA <sup>e</sup> asthma control score (points), mean (SD)	-1.8 (0.8)	<.001	-1.8 (1.0)	<.001	-1.8 (1.0)	<.001

<sup>a</sup>ICS: inhaled corticosteroid.

<sup>b</sup>beta 2 agonists or anticholinergics.

<sup>c</sup>Compared with baseline.

<sup>d</sup>FEV1: forced expiratory volume in one second.

<sup>e</sup>GINA: Global Initiative for Asthma.

Patient compliance with the admixture procedure was assessed and confirmed (100%) at every visit by the investigator based on verbal affirmation from the patient before administration in the home setting.

## Safety Analyses

During the 8-week observation period, 10 cases had a single episode of breathlessness (10/53, 18.9%) that required rescue medication consisting of short-acting beta agonists (3/53, 5.7%) or short-acting muscarinic antagonists (7/53, 13.2%). These cases of breathlessness were noted in cases of uncontrolled asthma receiving home nebulization (3/20, 15%) and/or concomitant xanthines (7/20, 21%), with no significant difference in the consumption of rescue medication ( $P=.72$ ) between the groups.

No anticholinergic nor cardiovascular events or symptoms were noted with the use of long-acting bronchodilators during home nebulization during the observation period.

There were no other treatment-emergent adverse events or serious adverse events noted that required treatment modification or discontinuation of long-acting bronchodilator home nebulization therapy.

## Discussion

This real-world, observational study of home nebulization highlights the clinical impact and utilization of this strategy for cases of difficult-to-treat or uncontrolled asthma while delivering nebulized long-acting bronchodilators for symptomatic patients with severe airflow limitation.

Asthma is a heterogenous condition consisting of several phenotypes including eosinophilic and noneosinophilic or paucigranulocytic variants that usually respond to targeted therapy or symptomatic therapy with LAMAs. For patients with bronchial asthma and moderate to severe exacerbations, LAMAs offer complementary actions such as those highlighted by Kerstjens et al [9] for tiotropium and Virchow et al [14] for glycopyrronium. The current study conforms to the clinical approach described by those authors and describes the impact of LAMA add-on therapy for patients with bronchial asthma and moderate to severe exacerbations, with a clinically significant improvement in prebronchodilator FEV1 of 27.7% (SD 26.2%; 0.54 L, SD 0.51 L) at 8 weeks, when compared with baseline. However, these results assume significance since the all the cases were assessed for noneosinophilic or mixed granulocytic phenotype markers, including FeNO, before reversibility was confirmed.

Vibrating mesh nebulizers represent the new generation of inhaler devices that are compact, portable, noiseless, and convenient. They offer optimal lung deposition with tidal breathing while obviating the need for breath holding common with conventional devices with or without the use of spacers, thereby minimizing nonadherence and improving compliance in patients with physical or cognitive deficits. In this study, patient compliance and adherence were assessed as complete (100%), again highlighting the convenience of nebulization therapy in difficult-to-control cases where the adherence rates are usually inadequate, as reported by other epidemiological studies [3]. In this line, GINA further recommends customization or individualization of patient care at every step of asthma control, by taking into account self-assessed symptom control status, comorbidities, patient behavior or phenotypic characteristics, and preferences for a simplified unified inhalational device that can have an incremental impact on compliance and adherence to therapy, especially with the ultracompact mesh nebulizers [7].

These results are the first to highlight the likely clinical role of a home nebulization strategy to deliver long-acting maintenance bronchodilators including glycopyrronium for difficult-to-treat asthma or noneosinophilic asthma (NEA). It is estimated that around 50% of asthmatic patients are of the NEA phenotype, which can be neutrophilic or paucigranulocytic. Paucigranulocytic asthma cases usually have a lower incidence of atopy with airway hyperresponsiveness or reversibility as compared to eosinophilic asthma, again lending credibility to the clinical correlate with SAD with fixed airway obstruction due to remodeling effects [10,15-17]. In the post hoc analyses for the subgroup receiving the glycopyrronium nebulizing solution, none of the cases were atopic and had stable peripheral eosinophil levels (mean 4%, SD 3%) and FeNO (mean 12 ppb, SD 5.7 ppb), which indicated that they likely had the mixed granulocytic inflammatory or NEA phenotype that may not be responsive to anti-immunoglobulin E or other biologics that are

directed towards management of severe eosinophilic asthma, as suggested by Holguin et al [17].

### Limitations

The study results are limited by the retrospective nature with concurrent analyses of severe asthma cases receiving home nebulization with long-acting bronchodilators involving beta 2 agonists and/or long-acting anticholinergics. Post hoc analysis on the greater clinical improvement in lung function with LAMA or glycopyrronium add-on therapy was likely to be confounded by the underlying patient demographic variables for NEA or SAD. This requires further validation through active controlled trials.

However, this study highlights the clinical feasibility and impact of the early initiation of home nebulization for clinically symptomatic cases of uncontrolled asthma that have been optimized for treatment adherence and compliance to conventional inhaler therapies but requiring frequent use of rescue medications. The study also explores the clinical role of LAMA or glycopyrronium add-on therapy for difficult-to-treat asthma cases with little or no evidence of Th2 inflammation or history of atopy. These results require further validation through active controlled trials for assessment of glycopyrronium add-on therapy in difficult-to-treat NEA or mixed granulocytic inflammatory phenotypes that remain unexplored to this date despite the current availability of study publications on LAMAs [9,14].

### Conclusion

Home nebulization with new-generation vibrating mesh nebulizers remains a clinically feasible option for patients with severe asthma and uncontrolled symptoms. It simplifies treatment administration and strategies for adherence to prevent or maintain remission rates in these cases, as highlighted by GINA. A glycopyrronium add-on strategy offers bronchodilation that is clinically meaningful, especially for patients with difficult-to-treat asthma with moderate to severe exacerbations.

### Acknowledgments

The study authors acknowledge Krishnaprasad K, Glenmark Pharmaceuticals Ltd, for the statistical analyses provided in the development of the manuscript. The clinical study was supported by the Foundation for Pulmonary Allergy Critical Care and Sleep Medicine and Environmental Medical Association, India.

### Conflicts of Interest

None declared.

### References

1. Salvi S, Kumar G, Dhaliwal R, Paulson K, Agrawal A, Koul P, et al. The burden of chronic respiratory diseases and their heterogeneity across the states of India: the Global Burden of Disease Study 1990–2016. *The Lancet Global Health* 2018 Dec;6(12):e1363-e1374 [FREE Full text] [doi: [10.1016/S2214-109X\(18\)30409-1](https://doi.org/10.1016/S2214-109X(18)30409-1)] [Medline: [30219316](https://pubmed.ncbi.nlm.nih.gov/30219316/)]
2. Hekking PW, Wener RR, Amelink M, Zwinderman AH, Bouvy ML, Bel EH. The prevalence of severe refractory asthma. *J Allergy Clin Immunol* 2015 Apr;135(4):896-902. [doi: [10.1016/j.jaci.2014.08.042](https://doi.org/10.1016/j.jaci.2014.08.042)] [Medline: [25441637](https://pubmed.ncbi.nlm.nih.gov/25441637/)]
3. Majellano EC, Clark VL, Winter NA, Gibson PG, McDonald VM. Approaches to the assessment of severe asthma: barriers and strategies. *J Asthma Allergy* 2019;12:235-251 [FREE Full text] [doi: [10.2147/JAA.S178927](https://doi.org/10.2147/JAA.S178927)] [Medline: [31692528](https://pubmed.ncbi.nlm.nih.gov/31692528/)]



4. Wedzicha JA, Calverley PMA, Albert RK, Anzueto A, Criner GJ, Hurst JR, et al. Prevention of COPD exacerbations: a European Respiratory Society/American Thoracic Society guideline. *Eur Respir J* 2017 Sep;50(3) [[FREE Full text](#)] [doi: [10.1183/13993003.02265-2016](https://doi.org/10.1183/13993003.02265-2016)] [Medline: [28889106](#)]
5. Papisir S, Kotanidou A, Malagari K, Roussos C. Clinical review: severe asthma. *Crit Care* 2002 Feb;6(1):30-44 [[FREE Full text](#)] [doi: [10.1186/cc1451](https://doi.org/10.1186/cc1451)] [Medline: [11940264](#)]
6. Yáñez A, Soria M, De Barayazarra S, Recuero N, Rovira F, Jares E, et al. Clinical characteristics and comorbidities of elderly asthmatics who attend allergy clinics. *Asthma Res Pract* 2018;4:5 [[FREE Full text](#)] [doi: [10.1186/s40733-018-0041-x](https://doi.org/10.1186/s40733-018-0041-x)] [Medline: [29713490](#)]
7. Pocket Guide For Asthma Management Prevention (for Adults Children Older than 5 Years). A Pocket Guide for Health Professionals Updated. 2019. Global Initiative for Asthma URL: <https://ginasthma.org/wp-content/uploads/2019/04/GINA-2019-main-Pocket-Guide-wms.pdf> [accessed 2019-08-27]
8. Morjaria JB, Rigby AS, Morice AH. Symptoms and exacerbations in asthma: an apparent paradox? *Ther Adv Chronic Dis* 2019;10:2040622319884387 [[FREE Full text](#)] [doi: [10.1177/2040622319884387](https://doi.org/10.1177/2040622319884387)] [Medline: [31695864](#)]
9. Kerstjens HAM, Engel M, Dahl R, Paggiaro P, Beck E, Vandewalker M, et al. Tiotropium in asthma poorly controlled with standard combination therapy. *N Engl J Med* 2012 Sep 27;367(13):1198-1207. [doi: [10.1056/NEJMoa1208606](https://doi.org/10.1056/NEJMoa1208606)] [Medline: [22938706](#)]
10. Usmani OS, Singh D, Spinola M, Bizzi A, Barnes PJ. The prevalence of small airways disease in adult asthma: A systematic literature review. *Respir Med* 2016 Jul;116:19-27 [[FREE Full text](#)] [doi: [10.1016/j.rmed.2016.05.006](https://doi.org/10.1016/j.rmed.2016.05.006)] [Medline: [27296816](#)]
11. Tashkin DP, Gross NJ. Inhaled glycopyrrolate for the treatment of chronic obstructive pulmonary disease. *Int J Chron Obstruct Pulmon Dis* 2018;13:1873-1888 [[FREE Full text](#)] [doi: [10.2147/COPD.S162646](https://doi.org/10.2147/COPD.S162646)] [Medline: [29928118](#)]
12. Shen L, Liu Y, Shen H, Wen C, Jia Y, Dong X, et al. Inhalation of glycopyrronium inhibits cigarette smoke-induced acute lung inflammation in a murine model of COPD. *Int Immunopharmacol* 2014 Feb;18(2):358-364. [doi: [10.1016/j.intimp.2013.12.021](https://doi.org/10.1016/j.intimp.2013.12.021)] [Medline: [24389380](#)]
13. Kerwin E, Wachtel A, Sher L, Nyberg J, Darken P, Siddiqui S, et al. Efficacy, safety, and dose response of glycopyrronium administered by metered dose inhaler using co-suspension delivery technology in subjects with intermittent or mild-to-moderate persistent asthma: A randomized controlled trial. *Respir Med* 2018 Jun;139:39-47 [[FREE Full text](#)] [doi: [10.1016/j.rmed.2018.04.013](https://doi.org/10.1016/j.rmed.2018.04.013)] [Medline: [29858000](#)]
14. Virchow JC, Kuna P, Paggiaro P, Papi A, Singh D, Corre S, et al. Single inhaler extrafine triple therapy in uncontrolled asthma (TRIMARAN and TRIGGER): two double-blind, parallel-group, randomised, controlled phase 3 trials. *Lancet* 2019 Nov 09;394(10210):1737-1749. [doi: [10.1016/S0140-6736\(19\)32215-9](https://doi.org/10.1016/S0140-6736(19)32215-9)] [Medline: [31582314](#)]
15. McGrath KW, Icitovic N, Boushey HA, Lazarus SC, Sutherland ER, Chinchilli VM, Asthma Clinical Research Network of the National Heart, Lung, Blood Institute. A large subgroup of mild-to-moderate asthma is persistently noneosinophilic. *Am J Respir Crit Care Med* 2012 Mar 15;185(6):612-619 [[FREE Full text](#)] [doi: [10.1164/rccm.201109-1640OC](https://doi.org/10.1164/rccm.201109-1640OC)] [Medline: [22268133](#)]
16. Busse WW, Holgate ST, Wenzel SW, Klekotka P, Chon Y, Feng J, et al. Biomarker Profiles in Asthma With High vs Low Airway Reversibility and Poor Disease Control. *Chest* 2015 Dec;148(6):1489-1496 [[FREE Full text](#)] [doi: [10.1378/chest.14-2457](https://doi.org/10.1378/chest.14-2457)] [Medline: [26226215](#)]
17. Holguin F, Cardet JC, Chung KF, Diver S, Ferreira DS, Fitzpatrick A, et al. Management of severe asthma: a European Respiratory Society/American Thoracic Society guideline. *Eur Respir J* 2020 Jan;55(1). [doi: [10.1183/13993003.00588-2019](https://doi.org/10.1183/13993003.00588-2019)] [Medline: [31558662](#)]

## Abbreviations

- DPI:** dry powder inhaler
- FeNO:** fractional exhaled nitric oxide
- FEV1:** forced expiratory volume in one second
- GINA:** Global Initiative for Asthma
- ICS/LABA:** inhaled corticosteroid and long-acting beta agonist
- LAMA:** long-acting muscarinic antagonist
- NEA:** noneosinophilic asthma
- pMDI:** pressurized meter dose inhaler
- SAD:** small airway disease

*Edited by G Eysenbach; submitted 17.01.20; peer-reviewed by PS Shankar, K Krishnaprasad; comments to author 15.02.20; revised version received 18.02.20; accepted 29.02.20; published 29.04.20.*

*Please cite as:*

*Talwar D, Bendre S*

*Health-Related Effects of Home Nebulization With Glycopyrronium on Difficult-to-Treat Asthma: Post-Hoc Analyses of an Observational Study*

*Interact J Med Res 2020;9(2):e17863*

*URL: <http://www.i-jmr.org/2020/2/e17863/>*

*doi: [10.2196/17863](https://doi.org/10.2196/17863)*

*PMID: [32347812](https://pubmed.ncbi.nlm.nih.gov/32347812/)*

©Deepak Talwar, Salil Bendre. Originally published in the Interactive Journal of Medical Research (<http://www.i-jmr.org/>), 29.04.2020. This is an open-access article distributed under the terms of the Creative Commons Attribution License (<https://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work, first published in the Interactive Journal of Medical Research, is properly cited. The complete bibliographic information, a link to the original publication on <http://www.i-jmr.org/>, as well as this copyright and license information must be included.

Original Paper

# Public Awareness of Sepsis Compared to Acute Myocardial Infarction and Stroke in Jeddah, Saudi Arabia: Questionnaire Study

Nourah Al-Orainan<sup>1\*</sup>, MBBS; Adel Mohamed EL-Shabasy<sup>2\*</sup>, MSc, MBBS, PHD; Khawlah Alamin Al-Shanqiti<sup>1\*</sup>, MBBS; Rawan Awad Al-Harbi<sup>1\*</sup>, MBBS; Hadeel Rajeh Alnashri<sup>1\*</sup>, MBBS; Raghad Ahmed Rezaqallah<sup>1\*</sup>, MBBS; Alanoud Abdallah Mirghani<sup>1\*</sup>, MBBS

<sup>1</sup>Department of Medicine, King Abdulaziz University, Jeddah, Saudi Arabia

<sup>2</sup>Department of Anesthesiology and Critical Care, King Abdulaziz University, Jeddah, Saudi Arabia

\* all authors contributed equally

**Corresponding Author:**

Nourah Al-Orainan, MBBS

Department of Medicine

King Abdulaziz University

Main Bldg, 2nd Fl.

Jeddah, 21589

Saudi Arabia

Phone: 966 2 6401000 ext 18131

Email: [nalorainan@gmail.com](mailto:nalorainan@gmail.com)

## Abstract

**Background:** Sepsis is a state of organ dysfunction caused by an impaired host response to infection. It is one of the leading causes of death globally. Sepsis, acute myocardial infarction (AMI), and stroke share the primary management requirement of rapid intervention. This could be achieved through early presentation to the hospital, which demands previous knowledge of the disease to ensure better outcomes.

**Objective:** Our study aimed to assess the level of public awareness of sepsis compared with AMI and stroke.

**Methods:** This was a cross-sectional survey study performed in June and July 2018, with 1354 participants from Jeddah, Saudi Arabia, aged  $\geq 18$  years. Data entry was performed using Microsoft Excel and statistical analysis including chi-square tests and multilogistic regression was performed using SPSS software.

**Results:** A total of 1354 participants were included. Only 56.72% (768/1354) had heard of the term “sepsis” and 48.44% (372/768) of these participants were able to correctly identify it. In addition, 88.33% (1196/1354) had heard the term “myocardial infarction” and 64.63% (773/1196) knew the correct definition of that condition. Stroke was recognized by 81.46% (1103/1354) of participants and 59.20% (653/1103) of these participants correctly identified the condition. The difference between those who had heard of these diseases and those who knew the correct definition significantly differed from the values for awareness of sepsis and its definition.

**Conclusions:** We found that public awareness and knowledge of sepsis are poor amongst the population of Jeddah compared with the awareness and knowledge of AMI and stroke. This lack of knowledge may pose a serious obstruction to the prompt management needed to limit fatal outcomes.

(*Interact J Med Res* 2020;9(2):e16195) doi:[10.2196/16195](https://doi.org/10.2196/16195)

**KEYWORDS**

sepsis; public awareness; survey

## Introduction

Sepsis is defined as the state of organ dysfunction caused by an impaired host response to infection [1]. It affects up to 30

million people globally every year, potentially leading to 6 million deaths [2]. It is also one of the leading causes of death in critically ill patients, with a mortality rate of 30%-40% [3]. Although epidemiological studies on sepsis are limited in Saudi

Arabia, a study conducted in Buraidah Central Hospital, Qassim, revealed that 16% of all patients in intensive care had sepsis, and 40.3% of those cases were fatal [4].

In addition to the high mortality rate, survivors of an initial sepsis episode still face a significant risk of subsequent infections during the following year, posing a threat to their lives despite surviving an acute course [5]. They also experience a substantial reduction in long-term health-related quality of life [6].

The prime components of sepsis management are the rapid restoration of tissue perfusion with intravenous fluid and the suitable control of the infection source. This includes administration of proper antibiotics, drainage of infected fluids, and debridement of infected soft tissues [7].

Amongst the many steps required to manage sepsis, early administration of antibiotics has a significant impact on patient mortality. A retrospective study of 17,000 patients diagnosed with sepsis or septic shock found that a delay in the administration of antimicrobials beyond the first hour postdiagnosis drastically increased mortality [8]. A cohort study of 35,000 patients in the emergency department showed similar results [9]. The 2018 update from the Surviving Sepsis Campaign, which aims to reduce mortality through an evidence-based approach, recommends that management and resuscitation of sepsis cases must be started immediately as part of the 1-hour bundle [10].

In addition to sepsis, there are several other conditions that require rapid intervention, such as stroke and acute myocardial infarction (AMI).

The World Health Organization defines stroke as the rapid development of “clinical signs of focal disturbance of cerebral function, lasting more than 24 h or leading to death with no apparent cause other than that of vascular origin.” Recent epidemiological data show that 13.7 million incidences of stroke annually, 5.5 million of which are fatal [11]. In 2013, stroke was the second and third most common cause of death and disability, respectively, worldwide [12].

AMI is defined as the death of cardiac myocytes due to prolonged ischemia [13]. In 2005, coronary heart disease accounted for 7.6 million deaths, with AMI as one of the primary manifestations [12].

Although it remains one of the leading global causes of mortality [12], the treatment of AMI has undergone a dramatic change over the past decade, significantly reducing the mortality rate [14,15]. Similar changes in the treatment of sepsis have resulted in similar success in management; however, mortality rates have failed to decline as substantially as they have for AMI. This discrepancy in treatment outcomes suggests a need to assess other factors [16].

Since timely intervention is crucial for the management of these conditions, a delay in treatment could be one of the factors contributing to the mortality rate.

Many factors can prevent early treatment, some of which are institution-related, such as the availability of resources and doctors' level of training. Other factors are patient-related,

including late presentation to the hospital, which in turn may be attributed to a lack of awareness [17]. For this reason, several studies have been conducted to assess levels of public awareness.

One of the largest studies was “An international survey: Public awareness and perception of sepsis,” performed using structured telephone interviews of 6021 participants from Europe and America. Results indicated that public awareness of sepsis is low [18]. Similarly, a research study involving 1001 Swedish residents concluded that public knowledge of sepsis is low [19]. Other authors attempted to compare awareness of sepsis with that of other severe conditions, such as a Singapore study that compared knowledge of sepsis with knowledge of stroke and found that knowledge of both conditions was insufficient, but more evident with sepsis [20]. Awareness of sepsis and stroke was studied along with AMI awareness in Korea via web- and paper-based surveys of 1081 individuals. When the three conditions were compared, people were least informed about sepsis [21].

Although some studies have compared sepsis awareness with awareness of AMI and stroke, only a few studies investigated all three conditions in the same study, and no such study has been performed in Saudi Arabia.

Our research aimed to compare the level of public awareness of sepsis with that of AMI and stroke in order to plan proper interventions and improve outcomes.

## Methods

This study was approved by the Institutional Review Board of King Abdulaziz University Hospital (KAUH). This was a cross-sectional study conducted in KAUH, Saudi Arabia, Jeddah. A convenience sample of 1354 participants was calculated to represent the population of Jeddah, which is 3.4 million people, according to the national municipality, with a confidence interval of 99% and a margin of error of 3.5.

Inclusion criteria were resident of Jeddah and age  $\geq 18$  years. Data were collected through electronic self-administered questionnaires. In order to mitigate bias, participants were approached on different sites, including KAUH, shopping centers, and mosques in various regions of Jeddah. Data were also collected during different time periods (day and evening shifts) over the course of a month (June 24 to July 24, 2018).

The questionnaire used in this study was previously used in the “Awareness and knowledge of sepsis in the general Korean population” study [21], which measured knowledge of the 3 conditions and consisted of three sections. The first section included 4 questions regarding the awareness and knowledge of sepsis. The second included 2 questions about AMI, and the third asked 2 questions about stroke. The last question determines knowledge of disease impact by asking participants to compare the mortality of sepsis with AMI, stroke, and other presentations including, cardiac arrest, Trauma, Lung cancer, colorectal cancer, stomach cancer.

A section on the most important risk factors and symptoms of each disease in addition to an informed consent section was added.

The questionnaire was forward translated into Arabic and then backward translated into English by native speakers, and the two English copies were compared to ensure meaning compatibility. Once this was achieved, a pilot of 135 people answered the questionnaire to ensure no further adjustment was required, and the final version was distributed among the target sample.

Participants were asked to choose the correct risk factors and symptoms for each condition. With the exception of demographic data, all items called for multiple-choice responses.

Data were collected and entered in Microsoft Excel (Microsoft Corporation), followed by statistical analysis using Statistical

Package for the Social Sciences (SPSS; version 21; IBM Corporation) to perform chi-square tests and multiple logistic regression analysis;  $P < .05$  was considered significant.

## Results

Our research aimed to assess the level of public awareness of sepsis compared with AMI and stroke in order to plan proper interventions and improve outcomes.

### Demographics

A total of 1354 participants aged  $\geq 18$  years were included, with a mean age of 30.41 (SD 11.2) years. Of the total sample, 951/1354 (70.2%) were female and 403/1354 (29.8%) were male (Table 1).

**Table 1.** Participant demographics (N=1354).

Demographic	Value, n (%)
<b>Age (years)</b>	
≤19	14.99% (203/1354)
20-29	40.84% (553/1354)
30-39	23.48% (318/1354)
40-49	11.89% (16/1354)
50-59	6.64% (90/1354)
60-69	1.84% (25/1354)
70-90	0.29% (4/1354)
<b>Sex</b>	
Male	29.76% (403/1354)
Female	70.23% (951/1354)
<b>Education</b>	
Elementary or less	1.69% (231/354)
Middle school graduate	4.35% (59/1354)
High school graduate	28.50% (386/1354)
University or college students	59.89% (811/1354)
Postgraduate	5.53% (75/1354)

### Awareness of Sepsis Versus Acute Myocardial Infarction and Stroke

Of the 1354 participants, 56.72% (768/1354) had heard of the term “sepsis”; however, only 48.43% (372/768) of these knew the correct definition, comprising 27.47% (372/1354) of the overall study population. The term “myocardial infarction” was familiar to 88.33% (1196/1354) participants, and 64.63% (773/1196) of them knew the correct definition. The term stroke was known to 81.46% (1103/1354) participants, and 59.20% (653/1103) of them knew the correct definition (Table 2).

Chi-square test suggested a significant difference between the numbers of individuals who had heard of the term “sepsis” and those who had only heard of AMI and stroke ( $P < .001$  in both cases).

When asked about the correct definition of sepsis, 48.44% (372/768) chose “severe systemic inflammatory response to infection,” 24.61% (189/768) chose “I’m not sure,” 8.33% (64/768) chose “systemic poisoning as a result of ingestion of expired food,” 7.81% (60/768) chose “severe allergic reaction,” 2.47% (19/768) chose “systemic poisoning by raw fish or milk,” and 2.08% (16/768) chose “other.” Knowledge of the risk factors and symptoms of sepsis are listed in (Table 3).

When asked about AMI, 64.63% (773/1196) of respondents chose “death of heart cells or tissues due to occlusion of heart blood vessels,” 12.12% (145/1196) chose “irregular heartbeat,” 10.87% (130/1196) chose “not sure,” 5.51% (66/1196) chose “slow heart beats,” 2.09% (25/1196) chose “inflammation of heart muscle,” and 0.17% (2/1196) chose “other.” Knowledge

of the risk factors and symptoms of AMI is described in [Table 3](#).

When asked how to define stroke, 59.20% (653/1103) of participants answered “brain dysfunction due to occlusion or rupture of blood vessel,” 22.57% (249/1103) chose “traumatic injury to brain,” 11.70% (129/1103) chose “not sure,” 3.17% (35/1103) chose “inflammation to brain tissue,” 3.26% (36/1103) chose “type of brain tumour,” and 0.09 % (1/1103) chose “other.” Survey results regarding the risk factors and symptoms of stroke are described in [Table 3](#).

A significant difference was found in the likelihood of respondents selecting the correct definition of sepsis versus that of AMI and sepsis ( $P < .001$ ).

### Mortality of Sepsis

Participants’ assessment of sepsis mortality was underestimated compared with other diseases. When asked to compare sepsis mortality rates with those of other disease, three conditions were thought to produce higher mortality rates than sepsis. cardiac arrest was thought to cause more deaths by 87.89% (1190/1354)

of respondents. AMI came second 72.82 % (986/1354), followed by stroke 71.20% (964/1354), and lung cancer 57.68 % (781/1354) . Sepsis was thought to be more fatal than several other illnesses including trauma 66.99% (907/1354), stomach cancer 55.76% (755/1354), and colorectal cancer 54.87% (743/1354).

### Source of Information

Participants’ sources of information varied, yet media/internet was the most common source at 38% (514/1354) followed by friends/family at 20.8% (295/1354), school at 16% (217/1354), hospital or medical personnel at 8.1% (110/1354), self or relatives at 7.6% (103/1354), and other at 0.9% (122/1354); 4.8% (650/1354) were not sure.

### Factors Affecting Awareness

A multiple logistic regression analysis was conducted to study factors affecting awareness, and the results revealed that education (college or above) was a predictor of term knowledge (odds ratio 2.787, 95% CI 1.25-6.201,  $P = .012$ ), yet gender and age were not significant.

**Table 2.** Participant knowledge of the terms sepsis, myocardial infarction, and stroke (N=1354).

Number of participants who have heard of the term	Yes, n (%)	No, n (%)	Not sure, n (%)
Those who have heard of the term sepsis	768 (56.72)	500 (36.90)	86 (6.40)
Those who have heard of the term acute myocardial infarction	1196 (88.33)	116 (8.57)	42 (3.10)
Those who have heard of the term stroke	1103 (81.46)	174 (12.85)	77 (5.69)

**Table 3.** Participant knowledge of sepsis, myocardial infarction, and stroke risk factors and symptoms.

Symptoms and risk factors	Correctly answered questions, n (%)	Correctly identified all, n (%)
<b>Sepsis, n=768</b>		
<b>Risk factors</b>		12.65
Low immunity	637 (82.94)	
Burns/injuries	3637 (47.26)	
Diabetes	287 (37.36)	
Tubes/catheters	482 (62.76)	
<b>Symptoms</b>		14.1
Rapid heartbeat	276 (35.93)	
Fever	373 (48.57)	
Difficulty breathing	519 (67.57)	
Altered mentation	338 (44.0)	
<b>Myocardial infarction, n=1196</b>		
<b>Risk factors</b>		47.74
High cholesterol	968 (80.94)	
High blood pressure	1037 (86.71)	
Smoking	1080 (90.30)	
Obesity	1030 (86.12)	
Diabetes	716 (59.87)	
<b>Symptoms</b>		33.96
Difficulty breathing	1021 (85.37)	
Chest pain	1042 (87.12)	
Rapid heartbeat	903 (75.50)	
Arm/Jaw/Back pain	722 (60.37)	
Sweating	789 (66.07)	
<b>Stroke, n=1103</b>		
<b>Risk factors</b>		27.28
Diabetes	590 (53.49)	
Obesity	534 (48.41)	
Smoking	714 (64.73)	
Hypertension	959 (86.94)	
High cholesterol	748 (67.82)	
<b>Symptoms</b>		42.24
Difficulty speaking	908 (82.32)	
Facial drooping	789 (71.53)	
Altered mental status	892 (80.87)	
Weak arm or leg	615 (55.85)	

## Discussion

### Awareness of Sepsis in Jeddah Compared to the World

Our study aimed to assess the level of public awareness of sepsis compared with AMI and stroke.

Sepsis is a serious health concern; if not managed promptly, it could lead to death. Delay in sepsis management could be attributed to a lack of awareness as suggested by research studies such as the Rubulotta international survey [18]. Only a limited number of studies have compared sepsis knowledge with knowledge of other conditions for which treatment time is critical, and none were completed in Saudi Arabia. We

distributed a self-filled modified sepsis-awareness questionnaire [21] among 1354 residents of Jeddah and found a significant difference in the level of sepsis knowledge compared to knowledge of stroke and AMI.

Our results also showed that only 56.72% of respondents had heard of sepsis, which was less than the level of awareness found in the Korean population (76.9%) [21] but higher than that in other countries included in the international survey, such as the United Kingdom (14%), Spain (13%), France (4%), Italy (8%), the United States (19%), Germany (52%), and Singapore (0.5%) [18-20]. The differences between our study and previous ones may be attributable to the fact that the Arabic translation of the word “sepsis” is self-explanatory to some extent.

The percentage of people who can identify the correct definition of sepsis is 48.43%, which is slightly higher than the majority of the countries in previous studies, ranging from 4.2% to 47% [18,20,21]. Although our study found higher numbers than previous studies, the overall percentage of those who know the correct definition among the entire population is 27.47%, which is consistent with 27.3% in the Korean community. This reflects how poor sepsis awareness is within our society.

Several factors may influence the level of knowledge in the polled community. For example, most of the participants (65.42%) are well educated (college and above), and those with a college education and above tend to be more knowledgeable ( $P=.012$ ). This is similar to the findings in Singapore, although females in that study were significantly more likely to know the term than they were in this study.

The second part of the questionnaire tested knowledge of AMI. We found that 88.3% of participants had heard of the term, and 64.63% of them knew the correct definition. Much like the Korean population, the difference between knowledge of sepsis and AMI is strongly significant ( $P<.001$ ), although the overall knowledge of AMI in this study was slightly lower than that in the Korean population in which 94.3% have heard of the term and 80.0% identified the correct definition [21].

Similarly, when asked about stroke, 81.46% had heard of the term, and 59.20% of them knew the correct definition. This is again lower than the numbers in Korea (96.9% and 93.1%, respectively) [21]; however, this result is similar to the findings of a study completed in Riyadh, Saudi Arabia, where 87.7% of the population had heard of the term [22]. Despite this difference, knowledge of stroke and its correct definition is still significantly higher than that of sepsis ( $P<.001$ ).

To further evaluate the level of knowledge and identify which aspects of the disease were familiar to the public, we asked participants who had heard of the term “sepsis” to choose the correct risk factors and symptoms of the disease; only 12.65% were able to select all the correct risk factors. The most chosen risk factor was low immunity (82.94%). When asked about symptoms, 14.19% knew all symptoms provided in the questionnaire, and the most frequently chosen symptom was difficulty breathing (67.57%). When asked to choose risk factors for AMI, 47.74% correctly identified all that applied. Of those who had heard of the term, 90.30% chose smoking as a risk factor. When asked about the symptoms of AMI, 33.96%

correctly identified all symptoms that applied, and the most frequently chosen symptom was chest pain (87.12%).

When asked about stroke, 27.28% of participants who had heard of the term could correctly identify all risk factors, with the most common 86.94% being hypertension. When asked to identify the symptoms of stroke, 42.24% correctly identified all relevant symptoms, with the most common 82.32% being difficulty speaking.

To the best of our knowledge, no research has been conducted to characterize public knowledge of risk factors and symptoms of sepsis. In our study, knowledge of risk factors and symptoms varied, yet sepsis knowledge was the lowest of the three conditions.

In addition to the poor awareness of sepsis, its mortality is underestimated; people of Jeddah placed it after cardiac arrest, AMI, stroke, and lung cancer. This may correlate with the fact that sepsis symptoms are vague and unspecific, often intersecting with the features of other diseases, so deaths may be misattributed to illnesses other than sepsis [23], particularly if knowledge of these symptoms is lacking. This leads to an underestimation of its seriousness and a misrepresentation of the actual mortality rate.

Findings suggest knowledge of stroke and AMI is significantly higher than knowledge of sepsis. One possible reason is that both have characterized signs and symptoms that are familiar to the public and have been promoted through various campaigns. For example, The Saudi Stroke Association, which was established in 2006, has been raising public awareness as part of its goal to reduce poor outcomes [24].

Similar efforts have been made to enhance knowledge of cardiovascular diseases [25,26]. Only a few such attempts have been made to increase awareness of sepsis. The National Sepsis Reduction Campaign launched in Riyadh in April 2018 is one such example.

Previous studies showed that this high awareness of AMI and stroke led to reductions in late presentation to the hospital [27,28]. Sepsis needs rapid management as well; therefore, more public education for sepsis is necessary to improve recognition of the seriousness of the disease and reduce delays in presentation to the hospital.

In our study, internet/media was cited as the predominant source of information (38%), suggesting that upcoming awareness campaigns should use this format to improve reach and efficacy.

Our study has several limitations. Our questionnaire was multiple choice, which could yield higher estimates of correct answers due to chance or random selection. Most of the sample group was also well educated. Although this reflects the overall educational status of Jeddah’s population, this does not necessarily represent the entire country’s population. These two points could have positively biased the results and limited their generalizability.

## Conclusion

Our study aimed to assess the level of public awareness of sepsis and compared it with that of AMI and stroke. We found that



public awareness and knowledge about sepsis is inadequate within the population of Jeddah compared with that of AMI and stroke. This may obstruct the prompt management needed to limit the mortality of sepsis.

More attempts to raise awareness are crucial. Coordinated efforts should be made to place well defined, applicable, and time-framed strategies to reach this goal. International Sepsis Day constitutes a valuable opportunity to improve the reach of societal awareness campaigns. We suggest using media and the internet as a platform to involve the public and deliver important information.

In order to reach older members of the community and those who have no access to the internet, we recommend targeting

visitors of primary health care centers, chronic disease clinics, and hospitals, each of which particularly serves the population most at risk. Education could be distributed through posters, banners, and verbal counseling by physicians and regulated efforts must be implemented to train health care providers on appropriate methods of patient education.

### Future Studies

Future studies should use a validated questionnaire to assess participants' awareness of sepsis, stroke, and AMI more in depth and question their knowledge of not only the terms and common symptoms but also the proper response when symptoms present and are recognized. We recommend the use of interventional studies to assess the impact of efforts made to improve public awareness of sepsis.

### Conflicts of Interest

None declared.

### References

1. Singer M, Deutschman CS, Seymour CW, Shankar-Hari M, Annane D, Bauer M, et al. The Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3). *JAMA* 2016 Feb 23;315(8):801-810 [FREE Full text] [doi: [10.1001/jama.2016.0287](https://doi.org/10.1001/jama.2016.0287)] [Medline: [26903338](https://pubmed.ncbi.nlm.nih.gov/26903338/)]
2. Fleischmann C, Scherag A, Adhikari NKJ, Hartog CS, Tsaganos T, Schlattmann P, et al. Assessment of Global Incidence and Mortality of Hospital-treated Sepsis. Current Estimates and Limitations. *Am J Respir Crit Care Med* 2016 Feb;193(3):259-272. [doi: [10.1164/rccm.201504-0781oc](https://doi.org/10.1164/rccm.201504-0781oc)]
3. Sepsis Internet. 2018. World Health Organization URL: <http://www.who.int/sepsis/en/> [accessed 2018-06-24]
4. Gasim GI, Musa IR, Yassin T. Sepsis in Buraidah Central Hospital, Qassim, Kingdom of Saudi Arabia. *IJHS* 2016 Jun;10(2):167-172. [doi: [10.12816/0048809](https://doi.org/10.12816/0048809)]
5. Wang T, Derhovanessian A, De Cruz S, Belperio JA, Deng JC, Hoo GS. Subsequent infections in survivors of sepsis: epidemiology and outcomes. *J Intensive Care Med* 2014 Dec 26;29(2):87-95 [FREE Full text] [doi: [10.1177/0885066612467162](https://doi.org/10.1177/0885066612467162)] [Medline: [23753224](https://pubmed.ncbi.nlm.nih.gov/23753224/)]
6. Heyland DK, Hopman W, Coe H, Tranmer J, McColl MA. Long-term health-related quality of life in survivors of sepsis. Short Form 36: a valid and reliable measure of health-related quality of life. *Crit Care Med* 2000 Nov;28(11):3599-3605. [doi: [10.1097/00003246-200011000-00006](https://doi.org/10.1097/00003246-200011000-00006)] [Medline: [11098960](https://pubmed.ncbi.nlm.nih.gov/11098960/)]
7. Marshall JC, Maier RV, Jimenez M, Dellinger EP. Source control in the management of severe sepsis and septic shock: an evidence-based review. *Crit Care Med* 2004 Nov;32(11 Suppl):S513-S526. [doi: [10.1097/01.ccm.0000143119.41916.5d](https://doi.org/10.1097/01.ccm.0000143119.41916.5d)] [Medline: [15542959](https://pubmed.ncbi.nlm.nih.gov/15542959/)]
8. Ferrer R, Martin-Loeches I, Phillips G, Osborn TM, Townsend S, Dellinger RP, et al. Empiric Antibiotic Treatment Reduces Mortality in Severe Sepsis and Septic Shock From the First Hour. *Critical Care Medicine* 2014;42(8):1749-1755. [doi: [10.1097/ccm.0000000000000330](https://doi.org/10.1097/ccm.0000000000000330)]
9. Liu VX, Fielding-Singh V, Greene JD, Baker JM, Iwashyna TJ, Bhattacharya J, et al. The Timing of Early Antibiotics and Hospital Mortality in Sepsis. *Am J Respir Crit Care Med* 2017 Oct;196(7):856-863. [doi: [10.1164/rccm.201609-1848oc](https://doi.org/10.1164/rccm.201609-1848oc)]
10. Levy MM, Evans LE, Rhodes A. The Surviving Sepsis Campaign Bundle: 2018 update. *Intensive Care Med* 2018 Jun 19;44(6):925-928. [doi: [10.1007/s00134-018-5085-0](https://doi.org/10.1007/s00134-018-5085-0)] [Medline: [29675566](https://pubmed.ncbi.nlm.nih.gov/29675566/)]
11. Anthony Rodgers, Patrick Vaughan. The world health report 2002 - Reducing Risks, Promoting Healthy Life. The World health organization 2002 [FREE Full text]
12. Feigin VL, Norrving B, Mensah GA. Global Burden of Stroke. *Circ Res* 2017 Feb 03;120(3):439-448. [doi: [10.1161/circresaha.116.308413](https://doi.org/10.1161/circresaha.116.308413)]
13. Kristian Thygesen, Joseph S. Alpert. Myocardial infarction redefined—A consensus document of The Joint European Society of Cardiology/American College of Cardiology Committee for the Redefinition of Myocardial Infarction. *European Heart Journal* 2000 Sep 15;21(18):1502-1513. [doi: [10.1053/euhj.2000.2305](https://doi.org/10.1053/euhj.2000.2305)] [Medline: [10973764](https://pubmed.ncbi.nlm.nih.gov/10973764/)]
14. Ellis SG, da Silva ER, Heyndrickx G, Talley JD, Cernigliaro C, Steg G, et al. Randomized comparison of rescue angioplasty with conservative management of patients with early failure of thrombolysis for acute anterior myocardial infarction. *Circulation* 1994 Nov;90(5):2280-2284. [doi: [10.1161/01.cir.90.5.2280](https://doi.org/10.1161/01.cir.90.5.2280)] [Medline: [7955184](https://pubmed.ncbi.nlm.nih.gov/7955184/)]
15. Ribichini F, Wijns W. Acute myocardial infarction: reperfusion treatment. *Heart* 2002 Sep;88(3):298-305 [FREE Full text] [doi: [10.1136/heart.88.3.298](https://doi.org/10.1136/heart.88.3.298)] [Medline: [12181231](https://pubmed.ncbi.nlm.nih.gov/12181231/)]

16. Rhee C, Dantes R, Epstein L, Murphy DJ, Seymour CW, Iwashyna TJ, CDC Prevention Epicenter Program. Incidence and Trends of Sepsis in US Hospitals Using Clinical vs Claims Data, 2009-2014. *JAMA* 2017 Oct 03;318(13):1241-1249 [FREE Full text] [doi: [10.1001/jama.2017.13836](https://doi.org/10.1001/jama.2017.13836)] [Medline: [28903154](https://pubmed.ncbi.nlm.nih.gov/28903154/)]
17. Lumb PD. Sepsis: will awareness improve outcome? *J Crit Care* 2012 Aug;27(4):327-328. [doi: [10.1016/j.jcrc.2012.06.014](https://doi.org/10.1016/j.jcrc.2012.06.014)] [Medline: [22824082](https://pubmed.ncbi.nlm.nih.gov/22824082/)]
18. Rubulotta FM, Ramsay G, Parker MM, Dellinger RP, Levy MM, Poeze M, Surviving Sepsis Campaign Steering Committee, European Society of Intensive Care Medicine, Society of Critical Care Medicine. An international survey: Public awareness and perception of sepsis. *Crit Care Med* 2009 Jan;37(1):167-170. [doi: [10.1097/ccm.0b013e3181926883](https://doi.org/10.1097/ccm.0b013e3181926883)] [Medline: [19123265](https://pubmed.ncbi.nlm.nih.gov/19123265/)]
19. Mellhammar L, Christensson B, Linder A. Public Awareness of Sepsis Is Low in Sweden. *Open Forum Infect Dis* 2015 Dec 26;2(4):ofv161 [FREE Full text] [doi: [10.1093/ofid/ofv161](https://doi.org/10.1093/ofid/ofv161)] [Medline: [26634220](https://pubmed.ncbi.nlm.nih.gov/26634220/)]
20. Phua J, Lim H, Tay C, Aung N. Public awareness of sepsis and stroke in Singapore: a population-based survey. *Ann Acad Med Singapore* 2013 Jun;42(6):269-277 [FREE Full text] [Medline: [23842767](https://pubmed.ncbi.nlm.nih.gov/23842767/)]
21. Park M, Kim K, Lee JH, Kang C, Jo YH, Kim DH, et al. Awareness and knowledge of sepsis in the general Korean population: comparison with the awareness and knowledge of acute myocardial infarction and stroke. *Clin Exp Emerg Med* 2014 Sep 30;1(1):41-48 [FREE Full text] [doi: [10.15441/ceem.14.014](https://doi.org/10.15441/ceem.14.014)] [Medline: [27752551](https://pubmed.ncbi.nlm.nih.gov/27752551/)]
22. Alotaibi M, Alotaibi F, AlKhodair Y, Falatah E, AlMutairi H. Knowledge and Attitude of Stroke Among Saudi Population in Riyadh, Kingdom of Saudi Arabia. *International Journal of Academic Scientific Research* 2017;5(1):149-157.
23. Poeze M, Ramsay G, Gerlach H, Rubulotta F, Levy M. An international sepsis survey: a study of doctors' knowledge and perception about sepsis. *Crit Care* 2004 Dec;8(6):R409-R413 [FREE Full text] [doi: [10.1186/cc2959](https://doi.org/10.1186/cc2959)] [Medline: [15566585](https://pubmed.ncbi.nlm.nih.gov/15566585/)]
24. Saudi SAI. org. Ssa URL: <http://www.ssa.org.sa/> [accessed 2019-09-10]
25. Saudi HA|OWI. com. Saudi-heart URL: <https://saudi-heart.com/> [accessed 2019-09-10]
26. King FCCLTACOWHDI. med. Ngha URL: <https://ngha.med.sa/English/MediaCenter/News/Pages/XVIIIOctVI.aspx> [accessed 2019-09-10]
27. Naegeli B, Radovanovic D, Rickli H, Erne P, Seifert B, Duvoisin N, et al. Impact of a nationwide public campaign on delays and outcome in Swiss patients with acute coronary syndrome. *Eur J Cardiovasc Prev Rehabil* 2011 Apr 11;18(2):297-304. [doi: [10.1177/1741826710389386](https://doi.org/10.1177/1741826710389386)] [Medline: [21450676](https://pubmed.ncbi.nlm.nih.gov/21450676/)]
28. Papapanagiotou P, Iacovidou N, Spengos K, Xanthos T, Zaganas I, Aggelina A, et al. Temporal trends and associated factors for pre-hospital and in-hospital delays of stroke patients over a 16-year period: the Athens study. *Cerebrovasc Dis* 2011;31(2):199-206. [doi: [10.1159/000321737](https://doi.org/10.1159/000321737)] [Medline: [21178341](https://pubmed.ncbi.nlm.nih.gov/21178341/)]

## Abbreviations

**AMI:** acute myocardial infarction

**KAUH:** King Abdulaziz University Hospital

*Edited by G Eysenbach; submitted 10.09.19; peer-reviewed by S Stefanov, A Davoudi, S Manaktala, T Clavier, H Alshamiri, I Mircheva; comments to author 09.10.19; revised version received 11.12.19; accepted 24.01.20; published 15.06.20.*

*Please cite as:*

*Al-Orainan N, EL-Shabasy AM, Al-Shanqiti KA, Al-Harbi RA, Alnashri HR, Rezaqallah RA, Mirghani AA*

*Public Awareness of Sepsis Compared to Acute Myocardial Infarction and Stroke in Jeddah, Saudi Arabia: Questionnaire Study*

*Interact J Med Res* 2020;9(2):e16195

URL: <http://www.i-jmr.org/2020/2/e16195/>

doi: [10.2196/16195](https://doi.org/10.2196/16195)

PMID: [32538794](https://pubmed.ncbi.nlm.nih.gov/32538794/)

©Nourah Al-Orainan, Adel Mohamed EL-Shabasy, Khawlah Alamin Al-Shanqiti, Rawan Awad Al-Harbi, Hadeel Rajeh Alnashri, Raghad Ahmed Rezaqallah, Alanoud Abdallah Mirghani. Originally published in the Interactive Journal of Medical Research (<http://www.i-jmr.org/>), 15.06.2020. This is an open-access article distributed under the terms of the Creative Commons Attribution License (<https://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work, first published in the Interactive Journal of Medical Research, is properly cited. The complete bibliographic information, a link to the original publication on <http://www.i-jmr.org/>, as well as this copyright and license information must be included.

---

Publisher:  
JMIR Publications  
130 Queens Quay East.  
Toronto, ON, M5A 3Y5  
Phone: (+1) 416-583-2040  
Email: [support@jmir.org](mailto:support@jmir.org)

---

<https://www.jmirpublications.com/>