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IN THIS ISSUE

About PJCD

The **Philippine Journal of Chest Diseases (PJCD)** [Print ISSN: 2094-1463**,** Electronic ISSN: 3028-1199] is an open-access, English language, online, medical science journal published by the **Philippine College of Chest Physicians (PCCP).**

Its editorial policies are based on the standards for scholarly publication set forth by the **International Committee of Medical Journal Editors (ICMJE) "Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly Work in Medical Journals,"** as well as best practices and guidelines of the **Committee on Publication Ethics (COPE).**

The **PJCD** seeks to be a high-quality, peer-reviewed publication oriented to the practice of pulmonary medicine. The journal publishes scientific papers in the form of original clinical and laboratory investigations, systematic reviews, case reports and series, grand rounds, guidelines and consensus statements, feature articles, opinion articles, editorials, and correspondences/letters to the editor considered to be of relevance to the art and science of pulmonary care.

The journal's target audience are local and international practitioners, clinicians, allied healthcare professionals, scientists and researchers working on pulmonary medicine. It shall accept manuscript submissions from consultants, fellows, residents, and other allied medical professions and specialties in the Philippines. Non-members of the PCCP may submit scientific manuscripts to the journal.

The **PJCD** is published by the PCCP two times a year (June and December).

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MESSAGE FROM THE PCCP PRESIDENT

Integrating the Publication Culture in a Medical Society

Research is difficult. It is a challenging task. Not everyone is comfortable in doing researches. It takes a special frame of mind and an extraordinary personality to view research as something that goes beyond a "requirement for promotion or graduation." However, the task is not just to undertake research. It is to disseminate these scholarly works. We want to ensure that the knowledge gained from these investigations gets to the appropriate end-user and gets translated into action… into something concrete and palpable. Aahhhh, but publication has its own unique set of challenges. Integrating this culture in a professional society is certainly daunting.

Every year, the PCCP Board of Trustees (BOT) grapples with our society's annual budget. We try to channel the needed funds into key activities to guarantee that these will go on unimpeded until they are accomplished. **Research and publication have always been priority areas of the current and past administrations.** This is evident with the steady increase in the percentage of our society's earnings being channeled into this area. We are also aware that funds for publication (that is, for efforts focused on matters related to the *Philippine Journal of Chest Diseases*), should also have its proportionate budget.

Publication will not only entail churning out the actual printed or electronic copies of our journal. A lot of significant efforts occur "away from the spotlight." These involve organizing the editorial team, training our "volunteers," enabling and strengthening our PJCD staff and core team, having peer reviewers who are invested in the whole process, and sustaining the interest of all stakeholders especially our members. This whole cycle is not easy... and needs to be repeated almost every year.

The BOT extends its congratulations and gratitude to the current PJCD team ably led by Dr. Miriam Lalas. We are aware of the time and dedication that each member has spent behind every issue. Unquestionably, the efforts that all of you have exerted are evident by the final product and these definitely are well-appreciated by the whole organization. I am aware of the milestones that you have laid out and the targets that you have set out for the subsequent years to ensure that PJCD evolves based on standards of a good medical journal and the needs of our members. You have the full trust and confidence of the BOT.

I would also like to take this opportunity to make some appeals to our PCCP members:

- Be involved in research that is worth publishing and attaching your name to.
- To the contributors, please respond to queries on time and be prompt with your replies. This will guarantee that turn-around times will be properly observed.
- We need more volunteers for PJCD. Be a peer reviewer. Be part of the editorial team. Be a research adviser. This will certainly contribute to more polished research publications. This will raise the quality of our journal.
- Consider PJCD as a viable publication for your original works

Publishing your investigative works should be part of your DNA. We owe it to the scientific community to share our findings. That is being a responsible researcher and PCCP member.

I fervently look forward to the days that PJCD will not trouble itself with only a few articles for publication in its next issue. I am confident that PCCP members will ultimately have the "publication DNA" embedded in our make-up. Until then, PJCD will continue to morph into a form that all of us can be proud of! We can count on that fact!

Jubert P. Benedicto, MD, FPCCP
President, Philippine College of Chest Physicians

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EDITORIAL PROCESS

Only submissions that are in scope and have passed preliminary screening for completeness and documentary requirements shall be considered by the Editor-in-Chief if these may proceed to review. The Editor-in-Chief shall assign an Associate Editor to oversee and facilitate the peer review process.

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Editorial decisions may be one of the following:
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Revisions required: The journal will publish the paper after minor revisions have been made to satisfactorily address the concerns raised.
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Original Article

Inhaler Technique Comparison Between Dry Powder Inhaler and Metered Dose Inhaler Among Adults with Obstructive Airway Disease in a Tertiary Government Hospital Outpatient Setting

Henry Y. Medina Jr., MD,[1] Ma. Cecilia C. Lozada, MD,[1] Cary Amiel G. Villanueva, MD,[1] Ma. Kriselda Karlene G. Tan, MD[1]

ABSTRACT

Background: In the management of obstructive airway diseases, inhaled medication remains a cornerstone of therapy. Aside from medication type, the manner of delivery through various devices is important. Evaluating current practice provides a measure of performance and allows identification of areas for improvement. The study evaluated inhaler techniques of patients on dry powder inhalers (DPI) versus metered dose inhalers (MDI) at the outpatient setting. The prevalence of specific inhaler technique errors was assessed along with associated factors.

Methodology: This study was conducted with a cross-sectional design, involving patients with use of DPI and/or MDI for the past six months. Inhaler technique was evaluated and a short instruction on proper technique was provided with repeat evaluation immediately after.

Results: A total of 124 participants were assessed, resulting in 76 DPI and 52 MDI technique observations. Overall, a higher prevalence of any error was observed for DPI at 88.2% versus MDI at 86.5%. Immediately post-instruction, repeat assessment showed significant improvement, with reduction of any error to 57.9% (DPI) and 50% (MDI) ($p < 0.001$ for both). The most common DPI errors were failure to perform full exhalation prior (77.6%) and lack of sufficient breath holding after (44.7%). The most common MDI errors were failure to perform full exhalation prior (71.2%) and improper inhalation (53.8%). For MDI users, only advanced age had an association with having any error (OR 1.10, CI 1.03 to 1.17).

Conclusions: Inhaler technique errors remain high in the outpatient setting regardless of device, with older participants at risk of having errors with MDI, but not with DPI. Although technique review and instruction show promise in reducing errors, the durability of these skills is known to decay. Appropriate patient and device selection, along with regular technique assessment and reinforcement by healthcare professionals, remains the recommended practice to maximize the benefit of inhalers.

Keywords: inhaler technique, obstructive airway disease, metered dose inhaler, dry powder inhaler

AFFILIATIONS
[1]Division of Pulmonary Medicine, Department of Medicine, Philippine General Hospital, University of the Philippines Manila

CORRESPONDING AUTHOR
Henry Y. Medina Jr., MD
Division of Pulmonary Medicine, Department of Medicine, Philippine General Hospital, University of the Philippines Manila; hymjr92@yahoo. com

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INTRODUCTION

Background and significance

Inhaled medication remains a cornerstone in the treatment of obstructive airway disease. The latest Global Initiative for Asthma (GINA) guidelines cite inhaler technique as one of the most important factors in improving asthma control in patients.[1,2] Medical progress has led to the advancement of medication delivery of key drugs—such as corticosteroids, beta agonists, and muscarinic receptor antagonists—whether as single agents or in combinations via a variety of devices.

Physicians continue to strive for the selection of the appropriate medication and dose for each patient to maximize symptom control, reduce exacerbations, as well as minimize unwanted side effects. A key part of this approach is the selection of the appropriate medication delivery device to meet the patient's needs and capabilities.

Significance and impact of the study

The study aims to identify the prevalence of incorrect steps of inhaler technique between dry powder inhaler (DPI) and metered dose inhaler (MDI) among patients with obstructive lung disease at the outpatient department. In doing so, the study aims to add to existing knowledge in the institution by identifying the specific inhaler technique errors with DPIs and MDIs and their possible associated patient- and management-related factors.

Once these errors are identified and their prevalence and impact determined, measures to improve healthcare delivery can be studied and implemented. Direct benefits to study participants include immediate correction of identified errors and reinforcement of proper technique. By improving adherence to proper inhaler technique, wastage of inhaler doses can be minimized, and improvement in disease control and exacerbation outcomes may be realized.

Objectives

The study aimed to answer the question of how adherent in terms of proper inhaler technique are patients on DPIs compared to those on MDIs. Specifically, the research aimed to identify the prevalence of errors for each step of proper inhaler technique among DPI and MDI users; identify factors possibly associated with inhaler technique error with DPI and MDI; and compare inhaler technique error before and after instruction, for both DPI and MDI.

METHODOLOGY

Study design and setting

The study had a primarily cross-sectional design. The study site involved the Philippine General Hospital Outpatient Department Clinics of the following services: Pulmonary

Medicine, General Medicine, and Family Medicine.

Inclusion and exclusion criteria

Study participants were adult patients diagnosed with an obstructive lung disease prescribed with an DPI and/or MDI for the past 6 months at the outpatient setting. Patients unable to use inhaler properly due to neurologic status or functional impairment including, but not limited to, use of tracheostomy, depressed sensorium, facial anatomic abnormalities precluding proper use of inhaler, and surgical resection of any lung segment, were excluded from the study.

Withdrawal criteria

Participants were allowed to withdraw from the study at any time and for any reason during their participation.

Data collection process

Participants enrolled in the study were assessed for their inhaler technique by investigators trained by a pulmonary medicine physician on the proper use of different inhaler devices. Participants' clinicodemographic data were recorded during the visit, including the date and time of the visit, diagnosis, smoking history, inhaler drug and device used, medical personnel who prescribed inhaler and evaluated technique, last recalled review of inhaler technique, compliance with inhaler prescription, need for assistance by family or caretakers during inhaler use, use of online or printed inhaler device instruction materials, recent exacerbations, and the latest forced expiratory volume in 1 second (FEV_1) value, if available.

Assessment of technique was performed by evaluating participants' actual inhaler use as last instructed by their respective healthcare provider. Assessment was done at the outpatient department examination areas where patients and their techniques are usually examined. Inhaler technique was evaluated onsite by the first trained investigator, while recording the interaction on video for further review and evaluation by a second trained investigator. Disagreements between the evaluation of the two investigators were mediated by a third trained investigator. Participants assisted by companions during regular use were allowed to be assisted and coached during the procedure. Participants who regularly used an MDI with a spacer were allowed to use their respective spacer during the evaluation.

A predetermined list of steps per inhaler device was used to evaluate inhaler technique pre-instruction. These steps were based on inserts as provided for by the manufacturers of the device and instructions by medical societies.[3,8-12] As done by a previous study by Tan et al,[13] each inhaler technique step was evaluated as "properly done" or "not properly done."

Once initial onsite assessment and recording had been done, participants received feedback from the investigator. A short verbal instruction followed where participants were guided through the proper steps of their respective device's inhaler technique. Repeat evaluation was done immediately after by the first trained investigator, with video recording which was further evaluated by the second trained investigator. Steps were marked as "properly done" or "not properly done" as before. This second set of inhaler technique data was recorded as post-correction/post-instruction.

The primary outcome was the prevalence of error at each step of inhaler use, as well as the overall prevalence of any error, both for DPI and MDI. Factors associated with inhaler technique error were analyzed per device type. Secondary outcomes were changes in the prevalence of any error in inhaler technique post-instruction.

STATISTICAL ANALYSIS

Based on the prevalence of critical error with inhaler use from a previous study[13] and a margin of error of 10%, the minimum sample size was estimated to be 77 and 50 technique observations for the DPI and MDI arms, respectively. Participant profiles and demographics were summarized using descriptive statistics. Counts and frequencies were used for categorical variables. Medians and interquartile ranges (IQR) were presented for non-normally distributed numeric variables. Normality was determined graphically using histograms and quantile-quantile plots.

One-way analysis of variance (ANOVA) and chi-square test were used to compare patient characteristics by inhaler device type. The McNemar test for paired data was used to compare the prevalence of inhaler technique errors before and after instruction due to small, expected values. Univariable logistic regression was used to determine factors associated with inhaler technique error. Two-tailed p-values <0.05 were considered statistically significant.

Data analysis was conducted using R version 4.2.2 with RStudio (Posit Team 2023).

Ethical considerations

The study protocol underwent review and approval by the University of the Philippines Manila Research Ethics Review Board (UPMREB code 2023-0855-01) and followed the principles of medical research set by the Declaration of Helsinki. Written informed consent was obtained from participants by members of the study team and trained research assistants before collecting information and recording video demonstrations of inhaler use.

RESULTS

A total of 124 unique participants were evaluated, with 128 inhaler technique observations recorded (72 patients on DPI, 48 patients on MDI, 4 patients on both) (Table 1). The median age of participants was 63 years for DPI users, 61 years for MDI users and, 50 years for those using both devices.

The majority of patients were prescribed inhalers for a diagnosis of bronchial asthma (76/124; 61.3%), followed by chronic obstructive pulmonary disease (46/124; 37.1%), and small airways disease (2/124; 1.6%). More than half of the participants were never smokers (76/124; 61.3%).

The most common inhaler drug used was an inhaled corticosteroid (ICS)/long-acting beta-agonist (LABA) combination, with budesonide/formoterol used by 45.2% (56/124) of participants. Most of these medications were first prescribed by and last checked by a Pulmonary Medicine Fellow (46.0% and 41.9%, respectively). Only 17 participants (13.7%) were initially prescribed an inhaler by a doctor not practicing Pulmonary Medicine or Primary Care (i.e., Internal Medicine or Family Medicine).

A majority of participants had undergone inhaler technique assessment during previous consultation (105/124; 84.7%). Among DPI users, 37.5% (27/72) were evaluated by a Pulmonary Medicine Fellow compared with 45.8% (22/48) for

Table 1. Clinico-demographic profile of participants

	Overall (n = 124)	DPI (n = 72)	MDI (n = 48)	Both (n = 4)	p-value
Age, years (median [IQR])	62.00 [50.75, 69.00]	63.00 [51.00, 71.00]	61.00 [51.00, 68.00]	50.50 [44.75, 55.50]	0.086
Sex, male (n, %)	48 (38.7)	33 (45.8)	15 (31.2)	0 (0.0)	0.075
Diagnosis (n, %)					
Bronchial asthma	76 (61.3)	34 (45.8)	40 (83.3)	3 (75.0)	0.001
Chronic obstructive pulmonary disease	46 (37.1)	38 (52.8)	7 (14.6)	1 (25.0)	
Small airways disease	2 (1.6)	1 (1.4)	1 (2.1)	0 (0.0)	
Educational attainment (n, %)					
College	40 (32.3)	21 (29.2)	18 (37.5)	1 (25.0)	0.906
Elementary	20 (16.1)	10 (13.9)	9 (18.8)	1 (25.0)	
High school	54 (43.5)	35 (48.6)	17 (35.4)	2 (50.0)	
Junior high	5 (4.0)	2 (2.8)	3 (6.2)	0 (0.0)	
None	1 (0.8)	1 (1.4)	0 (0.0)	0 (0.0)	
Postgraduate	4 (3.2)	3 (4.2)	1 (2.1)	0 (0.0)	
Smoking history (n, %)					
Current	4 (3.2)	3 (4.2)	1 (2.1)	0 (0.0)	0.054
Previous	44 (35.5)	33 (45.8)	10 (20.8)	1 (25.0)	
Never	76 (61.3)	36 (50.0)	37 (77.1)	3 (75.0)	
Pack-years, among smokers (median [IQR])	10.00 [5.00, 26.50]	10.00 [5.00,21.50]	10.00 [5.00, 43.50]	20.00 [20.00, 20.00]	0.781
Inhaler drug (n, %)					
Beclomethasone/formoterol	5 (4.0)	0 (0.0)	5 (10.4)	0 (0.0)	<0.001
Budesonide/formoterol	56 (45.2)	31 (43.1)	23 (47.9)	2 (50.0)	
Fluticasone furoate/umeclidinium/vilanterol	8 (6.5)	8 (11.1)	0 (0.0)	0 (0.0)	
Indacaterol/glycopyrronium	28 (22.6)	26 (36.1)	0 (0.0)	2 (50.0)	
Salmeterol/fluticasone	19 (15.3)	5 (6.9)	14 (29.2)	0 (0.0)	
Others	8 (6.5)	2 (2.8)	6 (12.5)	0 (0.0)	
Inhaler prescribed by (n, %)					
Fellow Pulmonologist	57 (46.0)	33 (45.8)	20 (41.7)	4 (100.0)	0.412
Resident Internal Medicine	27 (21.8)	19 (26.4)	8 (16.7)	0 (0.0)	
Resident Family Medicine	5 (4.0)	3 (4.2)	2 (4.2)	0 (0.0)	
Private pulmonologist	18 (14.5)	9 (12.5)	9 (18.8)	0 (0.0)	
Others	17 (13.7)	8 (11.1)	9 (18.8)	0 (0.0)	
Technique evaluated by (n, %)					
Fellow Pulmonologist	52 (41.9)	27 (37.5)	22 (45.8)	3 (75.0)	0.390
Resident Internal Medicine	19 (15.3)	11 (15.3)	7 (14.6)	1 (25.0)	
Resident Family Medicine	3 (2.4)	2 (2.8)	1 (2.1)	0 (0.0)	
Private Pulmonologist	10 (8.1)	4 (5.6)	6 (12.5)	0 (0.0)	
Nurse	6 (4.8)	6 (8.3)	0 (0.0)	0 (0.0)	
Pharmacist	3 (2.4)	3 (4.2)	0 (0.0)	0 (0.0)	
Others	12 (9.7)	5 (6.9)	7 (14.6)	0 (0.0)	
None	19 (15.3)	14 (19.4)	5 (10.4)	0 (0.0)	
Last checked, days (median [IQR])	90.00 [30.00, 230.00]	90.00 [32.25, 235.00]	120.00 [38.00,360.00]	55.00 [27.50, 82.50]	0.332
Compliance (n, %)					
As ordered	89 (71.8)	50 (69.4)	37 (77.1)	2 (50.0)	0.090
Missed most days	14 (11.3)	12 (16.7)	2 (4.2)	0 (0.0)	
Used most days	21 (16.9)	10 (13.9)	9 (18.8)	2 (50.0)	
Assistance, yes (n, %)	9 (7.3)	6 (8.3)	3 (6.2)	0 (0.0)	0.775
Used online or printed resources, yes (n, %)	21 (16.9)	15 (20.8)	5 (10.4)	1 (25.0)	0.299
Recent exacerbation (n, %)	47 (37.9)	34 (47.2)	13 (27.1)	0 (0.0)	0.024

MDI users and 75% (3/4) for two-device users. Only 19.4% (14/72) DPI users and 10.4% (5/48) MDI users never underwent inhaler technique assessment on their current device prior to study participation.

Self-reported compliance to prescribed frequency of use was 71.8% (89/124) overall. Between the two devices, MDI users had a higher self-reported compliance at 77.1% (37/48) compared to 69.4% (50/72) for DPI users.

The provision of routine assistance by a family member or caretaker during inhaler use was low (8.3% and 6.2% for DPI and MDI, respectively). The use of online or printed resources such as instructional videos was more common among DPI users (20.8%) versus MDI users (10.4%).

Only 6.1% of participants had recent spirometry done with available FEV_1 values; the rest did not have any spirometry in the last five years or were still pending formal evaluation by spirometry at the time of encounter. Assessment of the interquartile range revealed that the first quartiles of follow-up for DPI, MDI, and two-device users were similar at around 30 days, while the third quartile was different at 235 days for DPI users, 360 days for MDI users, and 82 days for two-device users.

Participants were last evaluated for their inhaler technique at a median interval of 90 days for DPI users, 120 days for MDI users, and 55 days for two-device users.

In the six months prior to study participation, 47.2% of DPI users reported at least 1 episode of exacerbation compared to 27.1% of MDI users (p = 0.024).

In the DPI group, a total of 76 observations were analyzed, with 72 from purely DPI users and 4 from both-device users. The prevalence of any error in inhaler technique was 88.2% (67/76), which significantly improved to 57.9% (44/76) immediately post-correction/post-instruction (p value <0.001) (Figure 1).

In the MDI group, a total of 52 observations were analyzed, with 48 from purely MDI users and 4 from both-device users. There was a similarly high prevalence of any error in inhaler technique at 86.5% (45/52), with significant improvement to 50.0% (26/52) immediately post-correction/post-instruction (p value <0.001) (Figure 1).

As noted in Table 2, majority of errors noted with DPI use pre-instruction occurred in step 4 (59 observations) or performing full exhalation prior to use. This was followed by step 7 (34 observations) or lack of sufficient breath holding, and step 6 (26 observations) or proper inhalation technique.

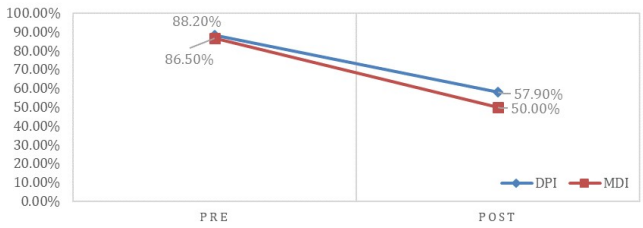

Figure 1. Prevalence of any inhaler technique error, pre- and post-instruction, by inhaler device (DPI/MDI). DPI, dry powder inhaler; MDI, metered dose inhaler participants

Table 2. Prevalence of error at each step of DPI use pre-instruction (n = 76)

Steps	Error, n (%)
Step 1 (Remove inhaler cover)	0 (0)
Step 2 (Priming next dose if applicable)	1 (1.3)
Step 3 (Proper positioning, no shaking)	4 (5.3)
Step 4 (Exhale fully prior to use)	59 (77.6)
Step 5 (Positioning between lips with good seal)	8 (10.5)
Step 6 (Deep and forceful inhalation)	26 (34.2)
Step 7 (Breath holding for 8-10 seconds)	34 (44.7)
Step 8 (Removal of mouthpiece)	5 (6.6)
Step 9 (Slow exhalation)	10 (13.2)

Table 3. Prevalence of error at each step of MDI use pre-instruction (n = 52)

Steps	Error, n (%)
Step 1 (Remove inhaler cover)	0 (0)
Step 2 (Shake container)	19 (36.5)
Step 3 (Exhale fully prior to use)	37 (71.2)
Step 4 (Proper inhaler positioning)	4 (7.7)
Step 5 (Simultaneous activation and inhalation)	5 (9.6)
Step 6 (Slow and deep inhalation)	28 (53.8)
Step 7 (Breath holding for 8-10 seconds)	18 (34.6)
Step 8 (Removal of mouthpiece with slow exhalation)	3 (5.8)

For MDI use (Table 3), most of the errors pre-instruction occurred in step 3 (37 observations) or, similar to DPI, performing full exhalation prior to use. There were 28 incorrect observations for step 6 or proper slow and deep inhalation of medication. More than a third (19 observations) failed to shake the container prior to use (step 2).

Among the patient- and management-related factors investigated (Table 4), only age had a statistically significant association with error in MDI technique. For every year older, the risk of having any error in MDI technique increased by 10% (OR 1.10, 95% CI 1.03 to 1.17).

DISCUSSION

The results of the study showed a high prevalence of inhaler technique error among both DPI and MDI users at the Philippine General Hospital Outpatient Department clinics of the following services: Pulmonary Medicine, General Medicine and Family Medicine. The prevalence rates noted in this study were higher compared to previous findings by Tan et al (72.4% and 84.6% for DPI and MDI, respectively).[13] Similar findings were found in multiple studies over the years, with prevalence of error ranging from 40% to 80% for both devices depending on observer findings and definition of technique acceptability[4-7,13,14,15] Although there was a significant reduction of inhaler technique errors immediately post-instruction for both groups, durability and retention of knowledge and skills must be properly assessed in longitudinal studies to significantly impact patient care.

Table 4. Association of patient- and management-related factors with any pre-instruction error in inhaler technique

Factor	DPI Unadjusted odds ratio (95% confidence interval)	MDI Unadjusted odds ratio (95% confidence interval)
Age in years	1.00 (0.95 to 1.05)	1.10 (1.03 to 1.17)
Age >60 years old	1.26 (0.31 to 5.13)	7.50 (0.83 to 67.49)
Male	7.31 (0.87 to 61.75)	0.48 (0.09 to 2.49)
Educational attainment		
Elementary	Ref	Ref
High school	2.40 (0.35 to 16.39)	1.58 (0.22 to 11.36)
College/postgraduate	1.05 (0.16 to 6.72)	2.25 (0.27 to 18.92)
Diagnosis		
COPD	0.82 (0.20 to 3.34)	…
Non-COPD	Ref	…
Asthma	…	…[2]
Smoking history		
Never smoker	Ref	Ref
Current smoker	0.44 (0.03 to 5.52)	(ever smoker)[1]
Previous smoker	7.22 (0.84 to 62.03)	0.71 (0.12 to 4.25)
Compliance		
As ordered	Ref	Ref
Used most days	1.17 (0.12 to 11.05)	(Not as ordered)[1]
Missed most days	0.32 (0.06 to 1.58)	2.18 (0.24 to 20.05)
Used online or printed resources	0.92 (0.17 to 4.95)	0.75 (0.07 to 7.57)

[1]Analysis for Smoking history and Compliance for MDI users adjusted due to small counts. "Current smoker" and "previous smokers" collapsed into "ever smoker" category and "used most days" and "missed most days" into "Not as ordered" category.
[2]Unreliable estimates for diagnosis of asthma as a factor due to too few non asthmatics in MDI user population, and all had at least 1 error during observation.
COPD, chronic obstructive pulmonary disease

Common errors in inhaler technique found for both DPI and MDI mirrored previous findings. In the study of Tan et al in the same institution years prior, the most common critical errors for MDI were poor coordination between actuation and inhalation and improper breathing technique—issues that persisted in our assessment seven years later. Similarly, DPI errors showed persistence of improper breathing technique. Errors common to both devices and that remained prevalent in this study were failure to exhale fully prior to inhaler use and lack of sufficient breath holding prior to exhalation of medication.[13]

Like previous findings by Lee et al, older age showed a significant association with error in inhaler technique with MDI but not with DPI. However, our study had a lower mean age of 61 years than the mean age of 76 years reported by Lee et al.[6] Possible reasons include deterioration of motor and cognitive skills leading to difficulty in synchronized inhalation and activation of inhaler device. Other factors investigated include education level and use of online or printed materials. However, we were unable to find an association with other factors possibly due to the distribution of our sampled population.

Regarding strategies to help reduce inhaler technique errors, only a small part of the study population reported utilization of instructional materials (i.e., videos or infographics) and assistance from caregiver. Improving access and utilization of these valuable resources can be of use in reducing inhaler technique errors and improving durability of skill and retention of knowledge.

Although not directly investigated as a possible associated factor, a notable finding is the wide interval between inhaler assessment for both devices, reaching up to 235 days for DPI and 360 days for MDI. Existing guidelines recommend reviewing patient inhaler technique at every visit as part of assessment of obstructive airway diseases.[1,2] Recommended intervals between follow-up for adjustment of inhaler medication range from 1 to 3 months. Median interval from last inhaler technique assessment was within recommendation for DPI and two-device users but longer for MDI users. Alarmingly, the third quartile of the population reached 235 days for DPI users and 360 days for MDI users since the last inhaler technique assessment. These patients may still have been seen by their respective physicians during this time, but no review of actual inhaler technique was conducted leading to large gaps in the follow-up period without periodic review and instruction.

Despite being seen in the clinics, 15.3% of the population reported no regular assessment or review of inhaler technique during their last outpatient clinic healthcare visit. A review of the practice in specialty as well as primary care clinics could help address these findings and aid in reinforcing proper inhaler technique and regular inhaler technique assessments. Looking into the knowledge, skills, and practice regarding inhaler technique assessment and providing instructions for healthcare professionals in these clinics ranging from trainees (residents/fellows), nursing staff, pharmacists, and even medical students can also be done.

Even a short period of providing verbal instructions and guiding patients through proper inhaler technique steps for both DPI and MDI showed a significant improvement in prevalence of errors from 88.2% to 57.9% and 86.5% to 50.0%, respectively. Despite the improvement, however, error rates remained high after step-by-step verbal guidance and instruction. Previous investigation on patients using MDIs by Jolly et al showed the need for repeated stepwise instruction and demonstration in a single sitting to achieve zero errors during return demonstration of proper inhaler technique.[14] In their study, only 24.1% of their 117 participants were able to achieve zero errors after a single intervention (written instruction or demonstration), implying that repeated reinforcement is necessary, particularly for certain steps requiring skill and coordination. For DPIs, a finding by Collier et al showed that different DPI device types may have different error rates due to intrinsic differences (such as Turbuhaler® which requires upright positioning during dose preparation, or HandiHaler® which requires the capsule to be punctured prior to inhalation).[15] Work done by Melani et al showed that instructing patients with faulty baseline techniques would require a longer time for MDIs (8.1 min) than DPIs (5.0 min for Diskus®, 5.3 min for HandiHaler®, and 6.0 min for Turbuhaler®), possibly due to the need for greater coordination for MDIs.[16]

Many other factors such as the provider's experience with instruction, mode of instruction, patient's age, previous inhaler device experience, and number of devices may also contribute.[15-17] A more in-depth study examining the effectiveness of available instruction strategies and related factors is needed to determine their efficacy in our setting.

Further, a single encounter providing proper instruction may be insufficient as inhaler technique is known to improve in the short term, but with a substantial decay noted in the next two to 12 months.[17]

Limitations

The study assessed the technique of ongoing inhaler use by participants as prescribed by their physician during a single time point. Assessment of compliance using means other than recall, as well as testing for optimal inspiratory flow rate for compatibility with the inhaler, was not conducted.

The study also reached only 76 DPI observations, compared to the minimum estimated requirement of 77, due to logistic issues, which may have led to an underpowered statistical analysis for the DPI group. Prevalence rates observed however, remain useful for evaluation and reassessment on ongoing inhaler instruction.

Recommendations

First, the study recommends further investigation into inhaler technique compliance and skill retention through a longitudinal assessment and review of related factors. The study also recommends a more in-depth analysis of barriers to effective inhaler technique for different device types through focus group discussions. Skills and knowledge assessment of healthcare providers can also be investigated. Lastly, the establishment of dedicated Asthma/COPD Clinics would help in record-keeping, enhancing service delivery, and providing an avenue for further research to ultimately improve patient care.

CONCLUSION

The prevalence of inhaler technique errors remains high in the outpatient setting regardless of device used, with older patients at risk of having errors with MDI, but not with DPI. Although inhaler technique review and instruction show promise in reducing the prevalence of errors, repeated instruction and demonstration are needed, along with interval assessment and reinforcement, as the durability of inhaler technique knowledge and skills is known to decay over time. Careful patient selection and matching with the appropriate inhaler device, along with proper and regular inhaler technique assessment and reinforcement, remains the recommended practice to maximize their utility. Routine visits to any healthcare worker trained in proper inhaler technique and instruction provide excellent opportunities to ensure optimal inhaler technique and adherence.

Local longitudinal studies that focus on inhaler technique assessment are recommended to better establish temporal trends and more clearly describe factors associated with the decay of technique over time, in order to identify points for intervention and healthcare improvement. Studies examining the effectiveness of different instructional strategies in the Philippine setting are also recommended to find accessible and effective solutions.

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Statement of Authorship

All authors certified fulfillment of ICMJE authorship criteria.

Authors' Disclosure

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References

1. Global Initiative for Asthma. Global strategy for asthma management and prevention. 2023. Accessed March 19, 2025. https://ginasthma.org/2023-gina-main-report/
2. Global Initiative for Chronic Obstructive Lung Disease. Global strategy for prevention, diagnosis and management of COPD: 2023 Report. 2023. Accessed March 19, 2025. https://goldcopd.org/2023-gold-report-2/
3. The National Asthma Council Australia. Accessed March 19, 2025. https://www.nationalasthma.org.au/living-with-asthma/resources/health-professionals/charts/inhaler-technique-checklists
4. Fink JB, Rubin BK. Problems with inhaler use: A call for improved clinician and patient education. *Respir Care*. 2005;50 (10):1360-1375. Accessed March 19, 2025. https://pubmed.ncbi.nlm.nih.gov/16185371/
5. Price D, David-Wang A, Cho SH, et al. Asthma in Asia: Physician perspectives on control, inhaler use and patient communications. *Journal of Asthma*. 2016;53(7):761-769. https://doi.org/10.3109/02770903.2016.1141951
6. Lee HY, Song JH, Won HK, et al. Comparing inhaler use technique based on inhaler type in elderly patients with respiratory disease. *Tuberculosis & Respiratory Diseases*. 2020;84(1):46-54. https://doi.org/10.4046/trd.2020.0021
7. Usmani OS, Lavorini F, Marshall J, et al. Critical inhaler errors in asthma and COPD: A systematic review of impact on health outcomes. *Respiratory Research*. 2018;19(1). https://doi.org/10.1186/s12931-017-0710-y
8. Consumer information: Symbicort Turbuhaler. Consumer information leaflet. AstraZeneca. Accessed March 26, 2025. https://www.astrazeneca.com/content/dam/az-ca/downloads/productinformation/symbicort-turbuhaler-consumer-information-leaflet-en.pdf
9. Quick guide to using your Symbicort inhaler. Consumer guide. AstraZeneca. Accessed March 26, 2025. https://www.symbicorttouchpoints.com/content/dam/physician-services/us/526-rwd-symbicort-hcp/pdf/03_using_the_symbicort_inhaler.pdf
10. Seretide Diskus. Product leaflet. GlaxoSmithKline. Accessed March 26, 2025. https://assets.gskstatic.com/pharma/PMPI_portal/Lebanon/seretide_discus_powder_for_inhalation_pil_lb.pdf
11. Handihaler. Instruction for use. Product leaflet. Boehringer Ingelheim. Accessed March 26, 2025. https://www.manualslib.com/manual/2150937/Boehringer-Ingelheim-Handihaler.html
12. Ultibro Breezhaler. Information for the user. Package leaflet. Novartis. Accessed March 26, 2025. https://www.medicines.org.uk/emc/files/pil.3496.pdf
13. Tan, MK, Manua, NP, Roa, CC, Jorge, MC. Assessment of inhalational technique among adult patients with obstructive airway disease at the outpatient department of a tertiary level hospital in the Philippines. Abstract. *Philippine Journal of Chest Diseases*. 2018;19(1). Accessed March 19, 2025. https://philchest.org.ph/journal/2018/PJCD%20vol%2019%20issue%201_final.pdf
14. Jolly GP, Mohan A, Guleria R, Poulose R, George J. Evaluation of metered dose inhaler use technique and

response to educational training. *Indian J Chest Dis Allied Sci.* 2015;57(1):17-20. Accessed March 19, 2025. https://pubmed.ncbi.nlm.nih.gov/26410977

15. Collier DJ, Wielders P, Van Der Palen J, et al. Critical error frequency and the impact of training with inhalers commonly used for maintenance treatment in chronic obstructive pulmonary disease. *International Journal of COPD*. 2020;(15):1301-1313. https://doi.org/10.2147/COPD.S224209
16. Melani AS, Bonavia M, Mastropasqua E, et al. Time required to rectify inhaler errors among experienced subjects with faulty technique. *Respiratory Care.* 2016;62(4):409-414. https://doi.org/10.4187/respcare.05117
17. Bosnic-Anticevich S, Bender BG, Shuler MT, Hess M, Kocks JWH. Recognizing and tackling inhaler technique decay in asthma and chronic obstructive pulmonary disease (COPD) clinical practice. *The Journal of Allergy and Clinical Immunology in Practice*. 2023;11(8):2355-2364.e5. https://doi.org/10.1016/j.jaip.2023.04.031

Original Article

Comparative Study of Bacterial Culture Isolates and Drug Resistance Patterns Among Elderly Patients with Bacterial Community-Acquired Pneumonia Before and During the COVID-19 Pandemic

Claire F. Forteza, MD, MPM-HSD,[1] Maryanne Dadulla-Daguinod, MD,[1] and Emmylou Adamos, MD[1]

ABSTRACT

Background: The COVID-19 pandemic has changed the microbiological distribution and drug-resistance patterns of pathogens in community-acquired pneumonia (CAP). This study aimed to evaluate these among elderly patients with CAP before and during COVID-19.

Methodology: Data was collected from patients aged 65 to 85 years with a diagnosis of bacterial pneumonia admitted to the Veterans Memorial Medical Center pre-COVID-19 and during COVID-19. The study compared bacterial pathogens, antimicrobial resistance patterns, length of hospital stay, and mortality between the two groups.

Results: Data from 243 patients was analyzed. The COVID-19 group was younger and had more males compared to the pre-COVID-19 group (median age 70 [IQR 67–75] vs 74 [IQR 67–80] years; p = 0.015 and 74.50% vs 56.45%; p = 0.005, respectively). Hypertension was the most common comorbidity in the pre-COVID-19 group while diabetes was most common in the COVID-19 group. Similar proportions of almost all bacterial pathogens were observed. Among patients without COVID-19 co-infection, antimicrobial resistance was higher in the pre-COVID-19 group but was not significant (61.90% vs 55.56%; p = 0.316). Multidrug-resistant (MDR) pathogens were found to be higher in the COVID-19 group (21.37% vs 9.52%; p = 0.010). The majority of patients in both groups (~61%) had prolonged hospital stays. Overall mortality was lower in the COVID-19 group (41.88% vs. 56.35%; p = 0.024) while, for patients with MDR, mortality was higher in the COVID-19 group (24.49% vs 8.45%, p = 0.016).

Conclusions: The distribution of bacterial isolates did not differ significantly between pre-COVID-19 and COVID-19 periods. MDR was higher during the COVID-19 period. For MDR-infected patients, mortality was higher in the COVID-19 group. The findings of this study help inform the antimicrobial stewardship program of the institution. Vigilant surveillance and regular reporting of bacterial pathogens are needed to improve patient outcomes.

Keywords: bacterial pneumonia, COVID-19, antimicrobial resistance

AFFILIATIONS
[1]Department of Pulmonary Medicine, Veterans Memorial Medical Center, Quezon City

CORRESPONDING AUTHOR
Claire F. Forteza, MD, MPM-HSD
Department of Pulmonary Medicine, Veterans Memorial Medical Center, Quezon City; cfforteza@gmail.com

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INTRODUCTION

Pneumonia was the third leading cause of death in the Philippines as reported by the Philippine Statistics Authority in 2016, and it remains a major health problem associated with high morbidity and mortality across all age groups worldwide.[1] In the elderly population, pneumonia is the single most common cause of death from infectious diseases as this group is often characterized by impaired immunity caused by multiple factors such as immune senescence, malnutrition, comorbidities, and functional impairments.[2,3]

Pneumonia is categorized as community-, hospital-, and ventilator-associated pneumonia. The most common agents of community-acquired pneumonia (CAP) are *Streptococcus pneumoniae*, *Haemophilus influenzae, Mycoplasma pneumoniae, Staphylococcus aureus, Moraxella catarrhalis,* and *Legionella* species.[4-6]

Most of the pathogens mentioned above were based on studies done before the COVID-19 pandemic. But with the outbreak of SARS-CoV-2, the virus responsible for the pandemic, accompanied by the aging population, the microbiological distribution, epidemiology, antimicrobial consumption, and resistance were changed.[7] Tang et al conducted studies proving that the COVID-19 pandemic has changed the epidemiological distribution of respiratory pathogens. Non-pharmacological interventions such as social distancing, cancellation of social gatherings, travel restrictions, lockdowns, mask-wearing, and frequent hand hygiene significantly contributed to the changing epidemiology of respiratory infections.[7] Moreover, with the implementation of the above measures, hospitalization due to CAP was reduced. This may reflect the direct effect of non-pharmacological interventions as well as the implementation of virtual consultations and avoidance of exposure in the emergency department. In terms of virological and bacteriological epidemiology, there was a noted huge shift because SARS-CoV-2 became the most predominant virus causing upper respiratory tract infection and pneumonia, casting aside other viruses such as respiratory syncytial virus, parainfluenza, and adenovirus.[7] Various studies revealed similar results.[8-13] A study by Li et al documented a decline in the overall detection rate of common respiratory viruses from 26.9% in 2019 to 10.5% in 2020 in the pediatric population, with the same declining trend noted among adults and elderly population.[8,14,15] *S. pneumoniae,* which causes pneumococcal pneumonia and invasive pneumococcal disease, was significantly decreased during the pandemic.[7,15-19] *M. pneumoniae* was also found to decrease during the pandemic.[7,16,17]

After an extensive search, no local study on the epidemiology of bacterial respiratory pathogens in patients with respiratory

tract infection during COVID-19 was found, hence, this study was conducted. This study aimed to determine the microbiological distribution, antibiotic resistance, and clinical outcomes in cases of bacterial CAP before and during COVID-19. Specifically, it aimed to determine and compare the proportion of the different bacterial isolates among patients admitted for bacterial CAP before and during the COVID-19 pandemic; the proportion of drug-resistant pathogens; and lastly, the clinical outcomes in terms of length of hospital stay and mortality.

METHODOLOGY

Study design

The study used an observational analytical study design comparing the microbiological distribution, antibiotic resistance, and clinical outcomes among elderly patients with bacterial CAP before and during COVID-19. A records review was conducted.

Setting

The study was conducted at Veterans Memorial Medical Center for 12 months.

Study population

The study population consisted of elderly patients admitted for bacterial CAP. The first group was a historical cohort of elderly patients admitted from March 2017 to December 2019. The second group was a historical cohort of elderly patients admitted from March 2020 to December 2022.

Eligibility criteria

Inclusion criteria

1. Patients aged 65 to 85 years
2. Patients admitted to the general ward or intensive care unit
3. Diagnosed with CAP with bacterial isolates from a respiratory specimen
4. Bacterial isolates with specimen showing Gram stain satisfactory for interpretation (neutrophil count >25 per low power field and <10 epithelial cells)

Exclusion criteria

1. Patient records with incomplete data
2. Neutropenic patient
3. Patients transferred from other hospitals and being managed as a case of hospital acquired-pneumonia or ventilator-associated pneumonia

Sampling design

The principal investigator obtained a list of respiratory specimens submitted for culture studies from the Department of Pathology from January 2017 to December 2022. Patients with bacterial isolates from submitted specimens were listed and their records retrieved from the Medical Records Department for review. The medical records of each subject were screened by the principal investigator using the inclusion and exclusion criteria to ascertain if the subject was eligible for study.

Purposive sampling was employed using the list of patients obtained with a diagnosis of bacterial pneumonia as a sampling frame.

Sample size

At a 95% confidence level and 80% power of test, a minimum sample of 226 was required to detect at least 25% difference in clinical outcome. The calculation was based on the bacterial detection rate of 71% in the COVID cohort vs 62% in the pre-COVID cohort by Serigstad et al.[25]

Study procedure

For patients admitted from March 2017 to December 2019, the study collected data on: age, sex, admitting diagnosis, smoking history, comorbidities, bacteria isolated from culture studies, antibiotic sensitivity, antibiotic given during admission, number of days of hospital stay, and outcome (survive or mortality). For patients admitted from March 2020 to December 2022, the study collected data on the same, with the addition of co-infection with COVID-19 (yes or no).

Drug resistance was further classified as multidrug-resistant (MDR), extensively drug-resistant (XDR), and pan drug-resistant (PDR) based on the European Center for Disease Control and Center for Disease Control Atlanta definitions. Prolonged hospital stay was defined as hospitalization lasting 14 days or longer.

Statistical analysis

Shapiro-Wilk test was used to determine the normality of age distribution, which was the only continuous variable. Descriptive statistics were presented as frequencies and percentages for categorical variables, and median and interquartile range (IQR) for the non-normally distributed age variable. Wilcoxon rank-sum and chi-square test were used to compare medians and categorical variables, respectively. STATA 17.0BE was the statistical software used. P-values less than 0.05 were considered statistically significant.

Ethical consideration

The study was conducted in accordance with the Declaration of Helsinki. Ethical approval was granted by the Institutional Review Board of the institution (VMMC-IRB Control No. VMMC-2023-034). The primary researcher applied for a waiver of individual informed consent since the study only involved medical records review. Access to medical records was approved by the Department of Pathology and Medical Records Section. Measures to ensure confidentiality, data privacy, and anonymity were employed to reduce the potential risk of breach of confidentiality.

RESULTS

Clinical and demographic profile

A total of 243 patient records met the eligibility criteria and were included in the study (Table 1). The COVID-19 period patients were significantly younger than the pre-COVID-19 period patients (median age 70 [IQR 67–75] vs 74 [IQR 67–80] years; p = 0.015). Males predominated in both groups but significantly more males were in the COVID-19 than in the pre-COVID-19 group (74.50% vs 56.45%; p= 0.005). There was an almost equal distribution of moderate-risk (CAP MR) and high-risk pneumonia (CAP HR) patients in the COVID-19 group while the pre-COVID-19 group was predominated by high-risk pneumonia patients (56.35%). Both groups had a greater proportion of non-smokers. Hypertension was the most common comorbidity in the pre-COVID-19 group while diabetes was most common in the COVID-19 group. There were significantly fewer patients with heart failure in the COVID-19 group than in the pre-COVID-19 group (8.62% vs 17.46%; p= 0.043).

Tables 2 and 3 show the antibiotic/s used upon admission for CAP MR and CAP HR patients. Dual antibiotic therapy with

Table 1. Clinico-demographic profile of elderly patients admitted for bacterial CAP, before and during COVID-19

	Overall (n = 243)	Pre-COVID -19 (n = 126)	COVID-19 (n = 117)	p-value
Age, years (median [IQR])	72 (67–79)	74 (67–80)	70 (67–75)	0.015*
Sex, n (%)				
Male	157 (64.1)	71 (56.45)	86 (74.50)	0.005*
Female	86 (35.39)	55 (43.65)	31 (26.50)	
Diagnosis, n (%)				
CAP MR	114 (46.91)	55 (43.65)	59 (50.43)	0.290
CAP HR	129 (53.09)	71 (56.35)	58 (49.47)	
Smoking, n (%)				
Yes	110 (45.27)	55 (43.65)	55 (47.01)	0.599
No	133 (54.73)	71 (56.35)	62 (52.99)	
Comorbidity, n (%)				
Hypertension	94 (38.68)	48 (38.10)	46 (39.32)	0.845
Diabetes mellitus	87 (35.80)	40 (31.75)	47 (40.17)	0.171
Chronic obstructive pulmonary disease	64 (26.34)	30 (23.81)	34 (29.06)	0.353
Bronchial asthma	11 (4.53)	8 (6.35)	3 (2.56)	0.156
Heart failure	32 (13.22)	22 (17.46)	10 (8.62)	0.043*
Chronic kidney disease	35 (14.40)	15 (11.90)	20 (17.09)	0.250
Liver disease	1 (0.41)	0 (0.00)	1 (0.85)	0.298
Cerebrovascular disease	33 (13.58)	21 (16.67)	12 (10.26)	0.145
Cancer	23 (9.47)	13 (10.32)	10 (8.55)	0.638
No comorbidity	10 (4.13)	3 (2.38)	7 (6.03)	0.154
COVID-19 co-infection		…	46 (39.32)	

*p-values are significant (<0.05)
CAP: community-acquired pneumonia; CAP MR, CAP moderate risk; CAP HR, CAP high-risk

Table 2. Antibiotic/s used upon admission for CAP MR patients

n (%)	Overall (n = 114)	Pre-COVID-19 (n = 55)	COVID-19 (n = 59)
Ampicillin sulbactam	7 (6.14)	2 (3.64)	5 (8.47)
Cefepime	5 (4.39)	3 (5.45)	2 (3.39)
Cefoxitin	1 (0.88)	1 (1.82)	0 (0.00)
Ceftazidime	12 (10.53)	5 (9.09)	7 (11.86)
Ceftriaxone	65 (57.02)	31 (56.36)	34 (57.63)
Cefuroxime	9 (7.89)	6 (10.91)	3 (5.08)
Co-amoxiclav	1 (0.88)	1 (1.82)	0 (0.00)
Levofloxacin	1 (0.88)	1 (1.82)	0 (0.00)
Meropenem	0 (0.00)	0 (0.00)	0 (0.00)
Piperacillin tazobactam	13 (11.40)	5 (9.0)	8 (13.56)
Regimen			
Monotherapy	49 (42.98)	25 (45.45)	24 (40.68)
Dual therapy	65 (57.02)	30 (54.55)	35 (59.32)
Second drug			
Azithromycin	62/65 (95.38)	28/65 (43.08)	34/65 (52.31)
Clarithromycin	1/65 (1.54)	1/65 (1.54)	0/65 (0.00)
Levofloxacin	2/65 (3.08)	1/65 (1.54)	1/65 (1.64)

Table 3. Antibiotic/s used upon admission for CAP HR patients

n (%)	Overall (n = 129)	Pre-COVID-19 (n = 71)	COVID-19 (n = 58)
Ampicillin sulbactam	9 (6.98)	6 (8.45)	3 (5.17)
Cefepime	14 (10.85)	4 (5.63)	10 (17.24)
Cefoxitin	0 (0.00)	0 (0.00)	0 (0.00)
Ceftazidime	11 (8.53)	8 (11.27)	3 (5.17)
Ceftriaxone	29 (22.48)	12 (16.90)	17 (29.31)
Cefuroxime	5 (3.88)	3 (4.23)	2 (3.45)
Co-amoxiclav	0 (0.00)	0 (0.00)	0 (0.00)
Levofloxacin	0 (0.00)	0 (0.00)	0 (0.00)
Meropenem	4 (3.10)	2 (2.82)	2 (3.45)
Piperacillin tazobactam	57 (44.19)	36 (50.70)	21 (36.21)
Regimen			
Monotherapy	87 (67.44)	55 (77.46)	32 (55.17)
Dual therapy	42 (32.56)	16 (22.54)	26 (44.83)
Second drug			
Azithromycin	38/42 (90.48)	14/42 (33.33)	24/42 (57.14)
Clarithromycin	0/42 (0.00)	0/42 (0.00)	0/42 (0.00)
Levofloxacin	4/42 (9.52)	2/42 (4.76)	2/42 (4.76)

ceftriaxone and azithromycin was commonly given for CAP MR in both groups while monotherapy with piperacillin tazobactam was commonly administered for CAP HR in both groups. This study documented 39.32% confirmed COVID-19 co-infection cases during the COVID-19 period (Table 1).

Bacterial isolates

Overall, the top five most common bacterial isolates were *Klebsiella pneumoniae*, *Acinetobacter baumannii*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, and *Enterococcus faecalis* (Table 4). During the COVID-19 period, the most common isolated strains were *K. pneumoniae*, *S. aureus*, *A. baumannii*, *E. faecalis*, and *P. aeruginosa*. Meanwhile, among the pre-COVID-19 group, the most common strains were *A. baumannii*, *K. pneumoniae*, *Enterobacter aerogenes*, *P. aeruginosa*, and *S. aureus/E. faecalis*. The proportion of *A. baumannii* was significantly lower in the COVID-19 group than in the pre-COVID-19 group (10.3% vs 27.0%; p <0.001).

Bacterial sensitivity/resistance profile

As presented in Table 5, antimicrobial-resistant pathogens were lower in the COVID-19 group than in the pre-COVID-19 group but this was not statistically significant (55.56% vs 61.90%; p = 0.316). During COVID-19, 50% (23/46) of the bacterial isolates from COVID-19-confirmed patients were resistant. The proportion of MDR pathogens was significantly higher in the COVID-19 group compared to the pre-COVID-19 group (21.37% vs 9.52%; p = 0.010). Eight isolates (6.84%) were MDR with COVID-19 co-infection. The proportion of XDR pathogens was lower among the COVID-19 group than the pre-COVID-19 group (14.53% vs 21.43%). Nine isolates (7.69%) were XDR with COVID-19 infection. The proportion of PDR pathogens was significantly lower among the COVID-19 group compared to the pre-COVID-19 group (19.66% vs 30.95%; p = 0.044). Six isolates (5.13%) were PDR with COVID-19 co-infection.

The drug resistance patterns of all isolates before and during COVID-19 period are presented in Figures 1 and 2. As presented in Figure 1, pre-COVID-19, the top three MDR isolates (n = 12) were *K. pneumoniae* (n = 5), *A. baumannii* (n = 3), *and Enterococcus faecalis* (n = 2). The most common XDR (n

Table 4. Bacterial isolates from respiratory specimens of elderly patients admitted for bacterial CAP, before and during COVID-19

n (%)	Overall (n = 243)	Pre-COVID-19 (n = 126)	COVID-19 (n = 117)	p-value
Klebsiella pneumoniae	69 (28.4)	33 (26.2)	36 (30.8)	0.429
Acinetobacter baumannii	46 (18.9)	34 (27.0)	12 (10.3)	<0.001*
Pseudomonas aeruginosa	21 (8.6)	10 (7.9)	11 (9.4)	0.685
Staphylococcus aureus	19 (7.8)	6 (4.8)	13 (11.1)	0.065
Enterococcus faecalis	18 (7.4)	6 (4.8)	12 (10.3)	0.102
Enterobacter aerogenes	13 (5.3)	12 (9.5)	1 (0.9)	**
Escherichia coli	9 (3.7)	4 (3.2)	5 (4.3)	
Streptococcus viridans	9 (3.7)	3 (2.4)	6 (5.1)	
Enterobacter cloacae	6 (2.5)	2 (1.6)	4 (3.4)	
Burkholderia cepacia	4 (1.6)	2 (1.6)	2 (1.7)	
Coagulase-negative staphylococci (CONS)	4 (1.6)	3 (2.4)	1 (0.9)	
Klebsiella aerogenes	4 (1.6)	0 (0.0)	4 (3.4)	
Klebsiella oxytoca	4 (1.6)	3 (2.4)	1 (0.9)	
Stenotrophomonas	3 (1.2)	1 (0.8)	2 (1.7)	
Non-*enterococcus*	2 (0.8)	1 (0.8)	1 (0.9)	
Acinetobacter iwoffii	1 (0.4)	1 (0.8)	0 (0.0)	
Enterobacter gergoviae	1 (0.4)	0 (0.0)	1 (0.9)	
Hafnia alvei	1 (0.4)	1 (0.8)	0 (0.0)	
Citrobacter diversus	1 (0.4)	1 (0.8)	0 (0.0)	
Citrobacter	1 (0.4)	0 (0.0)	1 (0.9)	
Methicillin-resistant *Staphylococcus aureus* (MRSA)	1 (0.4)	1 (0.8)	0 (0.0)	
Providencia rettgeri	1 (0.4)	0 (0.0)	1 (0.9)	
Pseudomonas fluorescens	1 (0.4)	0 (0.0)	1 (0.9)	
Serratia rubidaea	1 (0.4)	1 (0.8)	0 (0.0)	
Enterobacter agglomerans	1 (0.4)	0 (0.0)	1 (0.4)	
Streptococcus species	1 (0.4)	1 (0.8)	0 (0.0)	
Streptococcus agalactiae	1 (0.4)	0 (0.0)	1 (0.9)	

*p-values are significant (<0.05)
**p-values cannot be generated due to the violation of the Chi-square test prerequisite: expected cell values of at least more than 5 in 80% of the cells

Table 5. Status of drug-resistance of bacterial isolates from elderly patients with bacterial CAP, before and during COVID-19

n (%)	Overall (n = 243)	Pre-COVID-19 (n = 126)	COVID-19 (n = 117)	p-value
Bacterial isolate				
Sensitive	100 (41.15)	48 (38.10)	52 (44.00)	0.316
With COVID-19 co-infection	23 (9.47)	…	23 (19.66)	
Resistant	142 (58.85)	78 (61.90)	65 (55.56)	0.316
With COVID-19 co-infection	23 (9.47)	…	23 (19.66)	
Subtype of drug resistance				
MDR	37 (15.23)	12 (9.52)	25 (21.37)	0.010*
With COVID-19 co-infection	8 (3.29)	…	8 (6.84)	
XDR	44 (18.11)	27 (21.43)	17 (14.53)	0.163
With COVID-19 co-infection	9 (3.70)	…	9 (7.69)	
PDR	62 (25.51)	39 (30.95)	23 (19.66)	0.044*
With COVID-19 co-infection	6 (2.47)	…	6 (5.13)	

*p-values are significant (<0.05)
MDR: multidrug-resistant; XDR: extremely drug-resistant; PDR: pan drug-resistant

= 27) and PDR (n = 39) isolates were *A. baumannii* (n = 7 and 17, respectively), *K. pneumoniae* (n = 5 and 10, respectively), *and E. aerogenes* (n = 4 and 5, respectively). In contrast, during the COVID-19 period (Figure 2), the top three MDR isolates (n = 25) were *K. pneumoniae* (n = 17), *Escherichia coli* (n = 3), *and E. faecalis* (n = 3). The most common XDR isolates (n = 17) were *K. pneumoniae* (n = 7) *and E. faecalis* (n = 3). For the PDR isolates (n = 23), the most common were *K. pneumoniae* (n = 5), *P. aeruginosa* (n = 4), and *A. baumannii* (n = 3).

Clinical outcomes

Length of hospital stay

Overall, 150 (61.73%) elderly patients had prolonged hospital stay. A higher proportion of patients in the COVID-19 group had prolonged hospital stay compared to the pre-COVID-19 group but the difference was not statistically significant (73/117 [62.39%] vs 77/126 [61.11%]; p = 0.838). The top five common bacteria isolated in the pre-COVID-19 group were *A. baumannii, K. pneumoniae, P. aeruginosa, E. aerogenes, and S. aureus*. Meanwhile, in the COVID-19 group, *K. pneumoniae, A. baumannii, P. aeruginosa, E. faecalis, and S. aureus* were most common (Table 6). The proportion of *A. baumannii*-infected patients was significantly lower in the COVID-19 group than in the pre-COVID-19 group (13.70% vs 29.87%; p = 0.002). The proportion of patients infected by *K. pneumoniae, P. aeruginosa, and S. aureus* was higher among the COVID-19 group than the pre-COVID-19 group.

The proportion of MDR patients with prolonged hospital stay was higher among the COVID-19 group (15.07%) than in the pre-COVID-19 group (5.19%) while the proportion of XDR and PDR patients with prolonged hospital stay was higher among the pre-COVID-19 group than in the COVID-19 group (Table 7).

Mortality

Overall, 120 (49.38%) elderly patients died (Table 8). A significantly lower proportion of elderly patients died in the COVID-19 group compared to the pre-COVID-19 (49/117 [41.88%] vs 71/126 [56.35%]; p = 0.024). In the COVID-19 group, of the 46 COVID-19-confirmed patients, 19 (41.30%) died. Among the mortalities in the pre-COVID-19 group, the top five bacterial isolates were *A. baumannii, K. pneumoniae, E. aerogenes, P. aeruginosa, and E. faecalis* while, in the COVID-19 group, the top isolates were *K. pneumonia, A. baumannii, S. aureus, P. aeruginosa, and E. faecalis.* The proportion of *A. baumannii*-infected patients was significantly lower among the COVID-19 group than in the pre-COVID-19 group (14.29% vs 35.21%; p <0.001).

In terms of resistant strains, the proportion of MDR patients who died was significantly higher in the COVID-19 group compared to the pre-COVID group (24.49% vs 8.45%; p= 0.016). The proportion of XDR patients who died was higher in the pre-COVID-19 group compared to the COVID-19 group (26.76% vs 16.33%; p = 0.179). Lastly, the proportion of PDR patients who died was higher in the pre-COVID-19 group compared to the COVID-19 group (43.66% vs 30.61%; p =

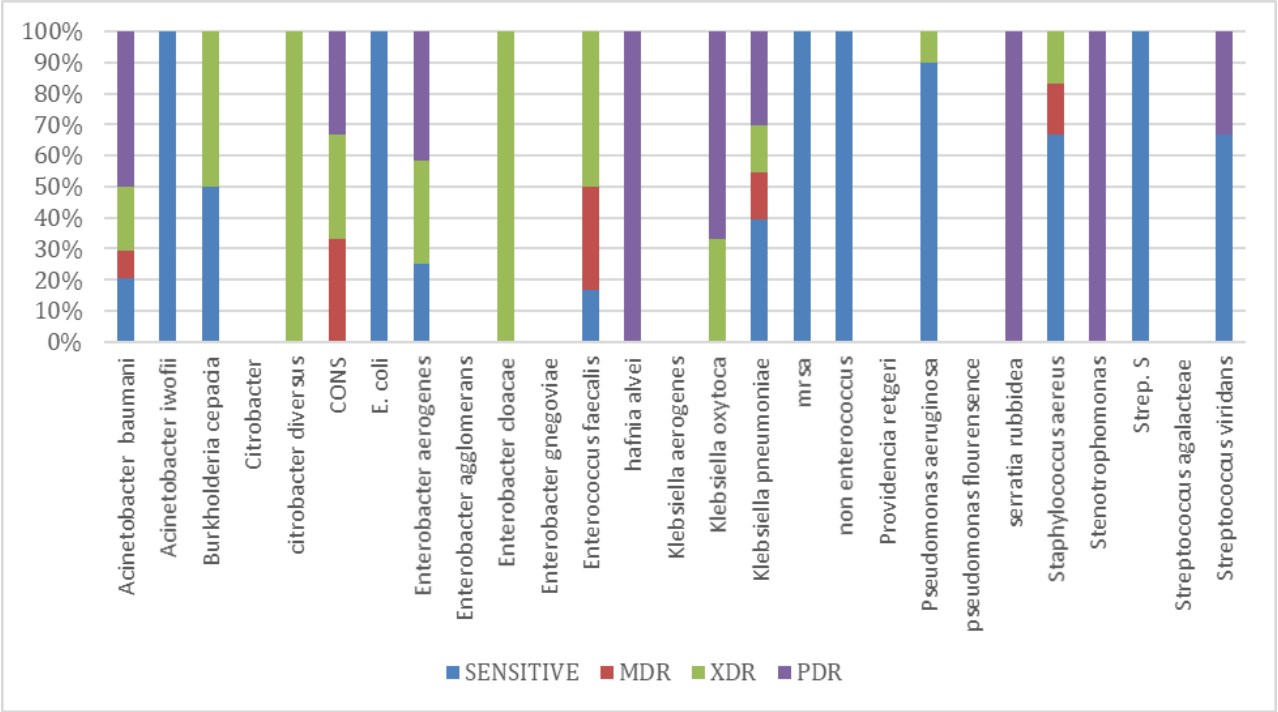

Figure 1. Classification of organisms according to European Center for Disease Control and Centre for Disease Control Atlanta as sensitive, multidrug-resistant (MDR), extensively drug-resistant (XDR), and pan drug-resistant (PDR) strains pre-COVID-19

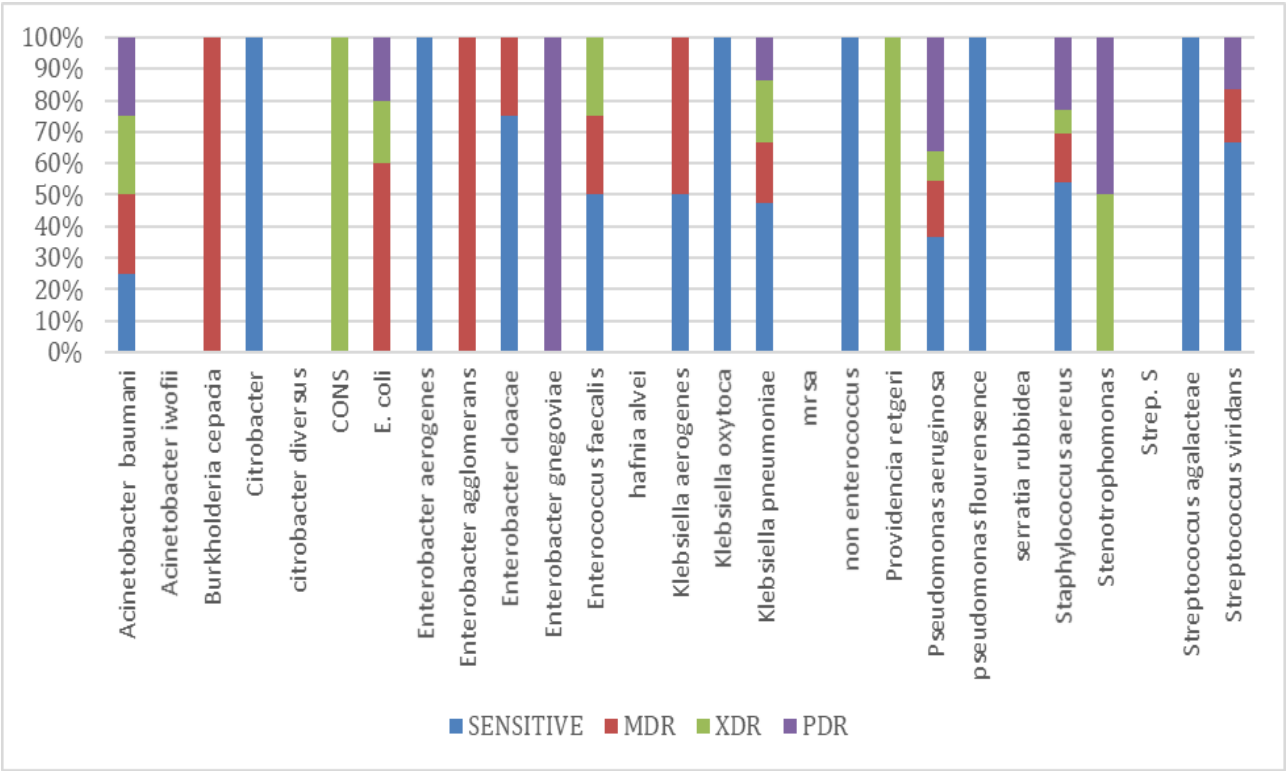

Figure 2. Classification of organisms according to European Center for Disease Control and Centre for Disease Control Atlanta as sensitive, multidrug-resistant (MDR), extensively drug-resistant (XDR), and pan drug-resistant (PDR) strains during COVID-19

Table 6. Bacterial isolates from elderly patients admitted for bacterial CAP with prolonged hospital stay, before and during COVID-19

n (%)	Overall (n = 150)	Pre-COVID-19 (n = 77)	COVID-19 (n = 73)	p-value
A. baumannii	33 (22)	23 (29.87)	10 (13.70)	0.002*
K. pneumoniae	37 (24.67)	17 (22.08)	20 (27.40)	0.450
P. aeruginosa	15 (10)	7 (9.09)	8 (10.96)	0.703
E. aerogenes	6 (4)	5 (6.49)	1 (1.37)	**
S. aureus	10 (6.67)	5 (6.49)	5 (6.85)	0.930
E. faecalis	10 (6.67)	3 (3.9)	7 (9.59)	**

*p-values are significant (<0.05)
**p values cannot be generated due to the violation of the Chi-square test prerequisite: expected cell values of at least more than 5 in 80% of the cells

Table 7. Drug-resistant strains isolated from elderly patients admitted for bacterial CAP with prolonged hospital stay, before and during COVID-19

n (%)	Overall (n = 150)	Pre-COVID-19 (n = 77)	COVID-19 (n = 73)	p-value
MDR	15 (10)	4 (5.19)	11 (15.07)	*
XDR	27 (18)	17 (22.08)	10 (13.70)	0.182
PDR	45 (30)	27 (35.06)	18 (24.66)	0.164

*p-values cannot be generated due to the violation of the Chi-square test prerequisite: expected cell values of at least more than 5 in 80% of the cells
MDR: multidrug-resistant; XDR: extremely drug-resistant; PDR: pan drug-resistant

Table 8. Bacterial isolates from elderly patients admitted for bacterial CAP who died, before and during COVID-19

n (%)	Overall (n = 120)	Pre-COVID-19 (n = 71)	COVID-19 (n = 49)	p-value
A. baumannii	32 (26.67)	25 (35.21)	7 (14.29)	<0.001*
K. pneumoniae	29 (24.17)	16 (22.54)	13 (26.53)	0.615
E. aerogenes	7 (5.83)	6 (8.45)	1 (2.04)	**
P. aeruginosa	9 (7.5)	5 (7.04)	4 (8.16)	**
E. faecalis	7 (5.83)	3 (4.23)	4 (8.16)	**
S. aureus	8 (6.67)	2 (2.82)	6 (12.24)	**

*p-values are significant (<0.05)
**p-values cannot be generated due to the violation of the Chi-square test prerequisite: expected cell values of at least more than 5 in 80% of the cells

0.148) (Table 9).

Table 9. Drug-resistant strains isolated from elderly patients admitted for bacterial CAP who died, before and during COVID-19

n (%)	Overall (n = 120)	Pre-COVID-19 (n = 71)	COVID-19 (n = 49)	p-value
MDR	18 (15.00)	6 (8.45)	12 (24.49)	0.016*
XDR	27 (22.50)	19 (26.76)	8 (16.33)	0.179
PDR	46 (38.33)	31 (43.66)	15 (30.61)	0.148

*p-values are significant (<0.05)
MDR: multidrug-resistant; XDR: extremely drug-resistant; PDR: pan drug-resistant

DISCUSSION

Our study revealed that the distribution of bacterial isolates did not differ between the periods studied. The most common bacterial pathogens documented in both the pre-COVID-19 and COVID-19 periods were *A. baumannii, K. pneumoniae, P. aeruginosa, E. aerogenes, E. faecalis, and S. aureus.* Comorbidities such as chronic obstructive pulmonary disease, renal disease, and diabetes mellitus put elderly patients at risk of community-acquired infection due to these bacteria.[3] *A. baumannii* was isolated less frequently during COVID-19 which contrasts with published literature.[20,21] The disparity may be attributed to differences in bacterial colonization across centers, clinical profiles of the patients, and sensitivity of available antibiotics. Our results support recent reports of increased prevalence of *K. pneumoniae* and *S. aureus* in COVID-19 cohorts.[7,22-24] In the study by Serigstad et al, *S. aureus* was the second most common bacterial pathogen detected during the pandemic at about 23% following *H. influenzae*.[25] *S. aureus* is a frequent colonizer of the upper respiratory tract, and nasal carriage is associated with infection and risk for bacteremia. It is also a common co-infecting pathogen in COVID-19 patients because of the molecular interaction between SARS-CoV-2 and *S. aureus*.[25] This might explain why *S. aureus* remained prevalent during the COVID-19 period.

Multidrug resistance was significantly higher during the COVID -19 period which may be due to multiple factors. First, was the reversal of already implemented preventive measures as institutions focused more on COVID-19, and personnel, resources, and attention were diverted from antimicrobial resistance surveillance and diagnosis. Secondly, studies claimed that, because of the pandemic, empiric utilization of antimicrobial agents increased.[7,17,26]

For both periods, the majority of patients had prolonged hospital stay. Prolonged hospital stay may not be solely associated with the causative agent's bacterial profile but also with disease severity, patient's comorbidities, and duration of antibiotic treatment.

The present study also documented significantly higher mortality among patients with bacterial CAP in the pre-COVID-19 period compared to the COVID-19 period. However, mortality in patients with MDR strains was significantly higher during the COVID-19 period. This finding is congruent with the analysis of other published literature.[27-31] Boral et al concluded that MDR *A. baumannii* infections occurred more frequently during COVID-19, and the case fatality rate was higher than pre -COVID-19 (83.3% vs 81.5%; p = 0.835).[20] The lack of effective antimicrobial treatments against resistant strains of *A. baumannii* may have contributed to the mortality rate. Meanwhile, disease severity was the underlying cause of mortality for those patients harboring resistant strains, based on Rao et al's study.[32]

This study had limitations being a single-center study where bacterial colonization may be different from other centers. The chart review nature of the study limited the investigator in the data that can be collected and validated. This study did not investigate other factors that might have an impact on resistance, for instance, the association between patient's comorbidities and resistant strains, as this was beyond the scope of the present study.

CONCLUSIONS

Our study concluded that the distribution of bacterial isolates did not differ significantly between the pre-COVID-19 and COVID-19 periods. The most common bacterial pathogens documented both in the pre-COVID-19 and COVID-19 periods were *A. baumannii, K. pneumoniae, P. aeruginosa, E. aerogenes, E. faecalis, and S. aureus.* Multidrug resistance was significantly higher during the COVID-19 period. The majority of patients had prolonged hospital stay for both periods. Mortality in

patients with MDR strains was significantly higher during the COVID-19 period.

These findings are essential in informing the antimicrobial stewardship program of the institution. Vigilant surveillance and regular reporting of bacterial pathogens, especially those with resistant strains, are needed to improve clinical outcomes. We recommend that similar studies be carried out for hospital-acquired pneumonia including ventilator-associated pneumonia.

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Dr. Chona A. De Vera: Conceptualization

Statement of Authorship
All authors certified fulfillment of ICMJE authorship criteria.

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References

1. Bersales, LG. Deaths in the Philippines, 2016. Philippine Statistics Authority. Released February 12, 2018. Accessed May 2023. https://psa.gov.ph/content/deaths-philippines-2016
2. Stupka JE, Mortensen EM, Anzueto A, Restrepo MI. Community-acquired pneumonia in elderly patients. *Aging Health*. 2009;5 (6):763-774. https://doi.org/10.2217/ahe.09.74
3. Bernal, SB, Santiaguel J, Lim-Teodoro A. Prevalence, demographic, clinical characteristics and outcomes of elderly patients with community acquired pneumonia admitted in a tertiary Medical Center: A Retrospective Cohort Study. *J Geriatr Med Gerontol.* 2021;7:117. https://doi.org/10.23937/2469-5858/1510117
4. Metlay J, Waterer G, Long Ann et al. Diagnosis and treatment of adults with community-acquired pneumonia. *Am J Respir Crit Care Med.* 2019 Oct;200(7):e45-e67. https://doi.org/10.1164/rccm.201908-1581
5. Philippine Society for Microbiology and Infectious Diseases. Clinical practice guidelines management and prevention of adult community-acquired pneumonia. Accessed May 2023. https://www.psmid.org/wp-content/uploads/2021/12/2020-Community-Acquired-Pneumonia-Clinical-Practice-Guidelines.pdf
6. Asokan G, Ramadhan T, Ahmed E, Sanad H. WHO Global priority pathogens list: A bibliometric analysis of Medline-PubMed for knowledge mobilization to infection prevention and control practices in Bahrain. *Oman Med J*. 2019;34:184-193. https://doi.org/10.5001/omj.2019.37
7. Tang HJ, Lai CC, Chao CM. Changing epidemiology of respiratory tract infection during COVID-19 pandemic. *Antibiotics (Basel)*. 2022 Feb 25;11(3):315. https://doi.org/10.3390/antibiotics11030315
8. Mutnal MB, Arroliga AC, Walker K, Mohammad A, et al. Early trends for SARS-CoV-2 infection in central and north Texas and impact on other circulating respiratory viruses. *J Med Virol*. 2020;92:2130–2138. https://doi.org/10.1002/jmv.26010
9. Olsen, SJ, Azziz-Baumgartner E, Budd, AP, et al. Decreased influenza activity during the COVID-19 pandemic—United States, Australia, Chile, and South Africa, 2020. *Am J Transplant*. 2020 Dec;20(12):3681-3685. https://doi.org/10.1111/ajt.16381
10. Lee L, Butt K, Buckrell S, et al. National influenza mid-season report, 2020–2021. *Can Commun Dis Rep*. 2021;47:1–4. https://doi.org/10.14745/ccdr.v47i01a01
11. Soo RJJ, Chiew CJ, Ma S, Pung R, Lee V. Decreased influenza incidence under COVID-19 control measures, Singapore. *Emerg Infect Dis*. 2020;26:1933–1935. https://doi.org/ https://doi.org/10.3201/eid2608.201229
12. Kuo SC, Shih SM, Chien LH, Hsiung CA. Collateral benefit of COVID-19 control measures on influenza activity, Taiwan. *Emerg Infect Dis*. 2020;26:1928–1930. https://doi.org/10.3201/eid2608.201229
13. Lee H, Lee H, Song KH, Kim ES, et al. Impact of public health interventions on seasonal influenza activity during the COVID-19 outbreak in Korea. *Clin Infect Dis*. 2021 Jul 1;73(1):e132-e140. https://doi.org/10.1093/cid/ciaa672
14. Li F, Zhang Y, Shi P, Cao L, et al. Epidemiology of viruses causing pediatric community-acquired pneumonia in Shanghai during 2010-2020: What happened before and after the COVID-19 outbreak? *Infect Dis Ther*. 2022 Feb;11(1):165-174. https://doi.org/10.1007/s40121-021-00548-x
15. Chan K-PF, Ma T-F, Ip MS-M, et al. Invasive pneumococcal disease, pneumococcal pneumonia and all-cause pneumonia in Hong Kong during the COVID-19 pandemic compared with the preceding 5 years: A retrospective observational study. *BMJ Open. BMJ Open*. 2021;11:e055575. https://doi.org/10.1136/bmjopen-2021-055575
16. Fujita, J. Mycoplasma pneumoniae pneumonia and respiratory syncytial virus infection in Japan during the severe acute respiratory syndrome coronavirus 2 pandemic. *Respir. Investig*. 2021 Jan;59(1):5-7. https://doi.org/10.1016/j.resinv.2020.11.002
17. Brueggemann A, Van Rensburg MJ, Shaw D, et al. Changes in the incidence of invasive disease due to Streptococcus pneumoniae, Haemophilus influenzae, and Neisseria meningitidis during the COVID-19 pandemic in 26 countries and territories in the Invasive Respiratory Infection Surveillance Initiative: A prospective analysis of surveillance data. *Lancet Digit Health.* 2021;3:e360–e370. https://doi.org/10.1016/S2589-7500(21)00077-7
18. Chao CM, Lai CC. Increasing Legionella in Taiwan during COVID-19 pandemic. *Am J Infect Control*. 2022 Jan 28;50(2):237–238. https://doi.org/10.1016/j.ajic.2021.10.024
19. Clemente I, Santini SJ, Vittorini P, et al. Fall of viral and bacterial pneumonia hospitalizations following COVID-19 pandemic mitigation strategies: A Central Italian Region retrospective study. *Intern Emerg Med*. 2023;18(4):1181-1189. https://doi.org/10.1007/s11739-023-03213-y.
20. Boral J, Genç Z, Pınarlık F, et al. The association between Acinetobacter baumannii infections and the COVID-19 pandemic in an intensive care unit. *Sci Rep*. 2022;12(1):20808. https://doi.org/10.1038/s41598-022-25493-8
21. Rangel K, Chagas TPG, De-Simone SG. *Acinetobacter baumannii* Infections in Times of COVID-19 Pandemic. *Pathogens*. 2021 Aug 10;10(8):1006. https://doi.org/ 10.3390/pathogens10081006.
22. Chemisova O, Noskov A, Pavlovich N et al. Etiology of Community-Acquired and Hospital-Acquired Pneumonia Associated with COVID-19. *Int J Infect Dis*. 2022 Feb 28;116:S39. https://doi.org/10.1016/j.ijid.2021.12.093
23. Musuuza JS, Watson L, Parmasad V, Putman-Buehler N et al. Prevalence and outcomes of co-infection and superinfection with SARS-CoV-2 and other pathogens: A systematic review and meta-analysis. *PLoS One*. 2021;16(5):e0251170. https://doi.org/10.1371/journal.pone.0251170
24. Bassetti M, Magnasco L, Vena A et al. Methicillin-resistant Staphylococcus aureus lung infection in coronavirus disease 2019: How common?. *Curr Opin Infect Dis*. 2022;35(2):149-162. https://doi.org/10.1097/QCO.0000000000000813.
25. Serigstad S, Markussen DL, Ritz C, et al. The changing spectrum of microbial aetiology of respiratory tract infections in hospitalized patients before and during the COVID-19 pandemic. *BMC Infect Dis*. 2022;22(1):763. https://doi.org/10.1186/s12879-022-07732-5

26. Erdem I, Ardic E, Turker E, et al. Comparison of antibiotic use in the COVID-19 pandemic with the pre-pandemic period in a university hospital. *Arch Med Sci*. 2022 Aug 30;18(5):1392-1394. https://doi.org/10.5114/aoms/152752.
27. Hurtado IC, Valencia S, Pinzon EM et al. Antibiotic resistance and consumption before and during the COVID-19 pandemic in Valle del Cauca, Colombia. *Rev Panam Salud Publica*. 2023 Apr 19;47:e10. https://doi.org/10.26633/RPSP.2023.10.
28. Khaznadar O, Khaznadar F, Petrovic A et al. Antimicrobial Resistance and Antimicrobial Stewardship: Before, during and after the COVID-19 Pandemic. *Microbiol Res*. 2023 *14*(2), 727-740. https://doi.org/10.3390/microbiolres14020052
29. Khoshbakht R, Kabiri M, Neshani A, et al. Assessment of antibiotic resistance changes during the Covid-19 pandemic in northeast of Iran during 2020-2022: an epidemiological study. *Antimicrob Resist Infect Control*. 2022;11(1):121. https://doi.org/10.1186/s13756-022-01159-y
30. Lakbar I, Medam S, Ronflé R et al. Association between mortality and highly antimicrobial-resistant bacteria in intensive care unit-acquired pneumonia. *Scientific Reports*. 2021 Aug 13;11 (1):16497. https://doi.org/10.1038/s41598-021-95852-4
31. Polly M, de Almeida BL, Lennon RP et al. Impact of the COVID-19 pandemic on the incidence of multidrug-resistant bacterial infections in an acute care hospital in Brazil. *Am J Infect Control*. 2022;50(1):32-38. https://doi.org/10.1016/j.ajic.2021.09.018
32. Rao CM, Rout P, Pattnaik AP et al. The Microbial Profile and Resistance Pattern of Pathogens Isolated From Long COVID Pneumonia Patients and Their Correlation to Clinical Outcome: Our Experience From a Tertiary Care Hospital. *Cureus*. 2022;14 (3):e23644. https://doi.org/10.7759/cureus.23644

Original Article

Pilot Study on the Comparison of Seven Commonly Used Over-the-Counter Pulse Oximeter Finger Devices

Sara Kristel P. Sungahid, MD[1] and Albert L. Rafanan, MD[1]

ABSTRACT

Background: Over-the-counter pulse oximeters are commonly used in patient care but have yet to be evaluated for their accuracy and precision. The objective of the study was to compare the accuracy of seven over-the-counter pulse oximeter finger devices in measuring oxygen saturation (SpO_2), with arterial blood gas oxygen saturation (SaO_2) as the reference value.

Methodology: This was a cross-sectional study from June to November 2023. Pulse oximeter readings of participants aged 18 and above were compared with their SaO_2. Precision was calculated using mean bias and standard deviation while accuracy was assessed through average root mean square error (ARMS). Subgroup analysis of patients with hypoxemia (SaO_2 <95%) was done.

Results: The study included 107 participants. Among the devices, ChoiceMMed MD300C29 had the lowest standard deviation (±1.84) and Yongrow showed the lowest mean bias (0.21), indicating higher precision among the devices studied. ChoiceMMed MD300C29 was the most accurate based on the ARMS score (1.89%). In contrast, IMDK had the highest mean bias (-0.90) and the largest standard deviation (±2.47), indicating lower precision. Hypoxemic subgroup analysis revealed significant biases, lower precision, and lower accuracy for all devices.

Conclusion: ChoiceMMed MD300C29 and Yongrow demonstrate superior precision, with the former emerging as the most accurate. IMDK lags with the lowest precision and accuracy. Subgroup analysis shows less precision and accuracy of readings for hypoxemic patients, cautioning against the reliance on over-the-counter pulse oximeters for accurate SpO_2 measurements. For enhanced accuracy, the study recommends the use of devices with lower mean bias, standard deviation, and ARMS values.

Keywords: pulse oximeter, precision, accuracy

AFFILIATIONS
[1]Section of Pulmonary and Critical Care Medicine, Department of Internal Medicine, Chong Hua Hospital, Cebu City

CORRESPONDING AUTHOR
Sara Kristel P. Sungahid, MD
Section of Pulmonary and Critical Care Medicine, Department of Internal Medicine, Chong Hua Hospital, Cebu City; sarasungahid44@gmail.com

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INTRODUCTION

A pulse oximeter is a device that uses light beams to estimate the oxygen saturation of the blood and the pulse rate. It is usually placed on the finger. Oxygen saturation gives information about the amount of oxygen carried in the blood, without the need to draw a blood sample.[1] The device provides approximate values for these in vivo parameters and is utilized in many areas of medicine.[2] In clinical practice, monitoring of SpO_2 values (i.e., oxygen saturations measured by pulse oximeter) is required to titrate oxygen therapy to avoid the risks of hypoxemia and hyperoxemia.[3]

Using pulse oximeters is a common practice in hospitals to measure oxygen saturation and pulse rate. With the recent pandemic, its use was not only limited to the hospital but also in individual homes.[1,5] Pulse oximetry has become an indispensable, low-cost, and non-invasive diagnostic tool to assess a patient's oxygen saturation.[4]

Pulse oximetry is utilized from first-patient contact, monitoring, outpatient care and, most importantly, in critical care units. In our hospital, nurses and doctors use their own, personally purchased pulse oximeters to aid in the assessment and monitoring of their patients. These pulse oximeters are widely available and sold in many channels (e.g., drugstores, online sellers) but have yet to be evaluated for their accuracy and validity.

The United States Food and Drug Administration (FDA) distinguishes between prescription use and over-the-counter (OTC) categories of pulse oximeters, with the former undergoing FDA review and clinical testing for accuracy. On the other hand, OTC oximeters, often marketed and used for general wellness or sporting/aviation purposes, may lack FDA clearance for medical use.[1]

In evaluating pulse oximeter accuracy, we must consider factors that may affect measurements such as skin pigmentation, dyshemoglobinemias, severe anemia, low perfusion, and nail polish.[6] A study found that oxygen saturation is often overestimated in individuals with darker skin pigmentation or those identified as Black/African American. Hence, a lower SpO_2 target could lead to occult hypoxemia and worse outcomes for patients with darker skin tones.[7,8]

This validation study compares oxygen saturation measurements from various over-the-counter pulse oximeters (SpO_2), with arterial blood gas oxygen saturation (SaO_2) as reference. The study will use FDA-required performance metrics, including average root mean square error (ARMS; sometimes referred to as accuracy root mean square error) and bias, to evaluate pulse oximeter accuracy.

Objectives

General objective

To compare the accuracy and precision of seven OTC pulse oximeter devices in measuring peripheral oxygen saturation, with arterial oxygen saturation measurement as the standard value.

Specific objectives

1. To determine the mean difference between SpO_2 taken by OTC pulse oximeter finger devices and standardized

SaO_2 measured via arterial blood gas (ABG) analysis
2. To determine the accuracy of OTC pulse oximeter finger devices compared to SaO_2, reported as the average root mean square error (ARMS)
3. To determine the agreement between SpO_2 and standardized SaO_2
4. To evaluate and compare the precision and accuracy of OTC pulse oximeter finger devices in patients with hypoxemia (SaO_2 <95%).

METHODOLOGY

Study design

This was a single-center, cross-sectional study.

Study procedure

Study participants were patients scheduled for ABG testing at Chong Hua Hospital Cebu, Philippines from June 2023 to November 2023.

The inclusion criteria for the study encompassed individuals aged 18 and above, ordered for ABG testing, and possessing an axillary temperature above 35°C, a hemoglobin level greater than 9 g/dL, and a mean arterial pressure exceeding 60 mmHg.

The exclusion criteria included individuals with dyshemoglobinemia, patients with nail polish and/or artificial fingernails, those exhibiting finger clubbing or have peripheral vascular disease, and patients who had received intravenous dyes in the past 7 days.

The sample size was set at 200 data points, in line with the FDA guidelines for accuracy testing.[1] Of the 200 patients scheduled for ABG testing, only 107 met the criteria.

During arterial blood extraction for ABG, the investigators measured the SpO_2 on the patient's finger. An arterial blood volume of 2 cm^3 was obtained from the radial or brachial artery, sent to the laboratory at room temperature, and analyzed within 30 minutes following World Health Organization guidelines. The axillary temperature of the patient was also obtained. During blood extraction, patients were placed in the supine position with the head of the bed elevated to 30 degrees. Other procedures (e.g., suctioning, position change, medication administration) were avoided during this short period.

A single index finger was used to measure SpO_2 values for seven pre-selected pulse oximeters. Each pulse oximeter was placed on the finger for at least 10 seconds until a stable reading was established. All seven readings were taken within 3 minutes from the ABG extraction. A plastic cover was placed on each SpO_2 measurement location to prevent environmental light interference. Measured SpO_2 were recorded in the data sheet. Battery levels of all pulse oximeters were constantly checked; batteries were changed immediately if the indicator showed non-full charge to ensure optimal device performance.

A survey was conducted among hospital staff to identify the top seven pulse oximeter models they frequently use, which were then selected for this study. The pulse oximeters evaluated were: (1) ChoiceMMed MD300C13; (2) ChoiceMMed MD300C29; (3) ChoiceMMed MD300C5; (4) INDOPLAS; (5) Contec CMS50ED; (6) Yongrow YK-83LED; and (7) IMDK C101A3 (Supplementary Material 1). All are readily available for purchase online. Among them, only ChoiceMMed MD300C13 and ChoiceMMed MD300C29 models are FDA-approved. All ChoiceMMed pulse oximeters included in the study also hold ISO (International Organization for Standardization) certifications while the others do not.

Statistical analysis

Comparisons of pulse oximeter readings (SpO_2) with arterial SaO_2 were used to calculate bias, precision (standard deviation [SD] of the bias), mean absolute error, and root mean square error (ARMS). Bias was calculated as the difference between SpO_2 and SaO_2 readings for all patients using each brand of pulse oximeter. The mean bias was determined by averaging these differences across each pulse oximeter brand, with the sign (positive or negative) determining the direction of bias; absolute values were used to determine the magnitude of bias. For each brand, the precision (in %) was computed as the standard deviation of the difference between SpO_2 and SaO_2. The mean absolute error (in %) was calculated as the average absolute difference between SpO_2 and SaO_2. The ARMS (in %) was computed as the square root of the average squared difference between SpO_2 and SaO_2.

Linear regression plots were used to visualize the relationship between SaO_2 and the bias (SpO_2 – SaO_2) of each brand. Bland-Altman plots showed the mean bias and limits of agreement (95% confidence interval). Variability in bias was classified according to Cohen's effect size criteria as low (under 20%), fair (20% to 40%), moderate (40% to 60%), high (60% to 80%), and very high (80% to 100%). To determine the correlation between SaO_2 and bias, multiple R and R-squared tests were used. A multiple R value of less than 0.3, 0.3 to 0.5, and 0.5 to 1 was interpreted as weak, moderate, and strong correlation, respectively.

Hypoxemia was defined as having an SaO_2 of less than 95%. Independent samples t-test was used to compare the bias between patients with and without hypoxemia (<95% vs ≥95%). Levene's test was used to compare the precision between the subgroups. A p-value less than 0.05 was considered significant. Data processing and analysis were done using Microsoft Excel.

Ethical considerations

The study was conducted in adherence to the Declaration of Helsinki and approved by the Institutional Review Board (IRB)/Ethics Committee of Chong Hua Hospital (IRB reference code 3123-04). Verbal consent was obtained prior to the procedure, as pulse oximeter monitoring is recognized as an acceptable standard of care.

RESULTS

Table 1 shows the demographic and clinical characteristics of the study participants (n = 107). The mean age was 63 years, ranging from 32 to 92 years. The majority of participants were male (78%) and most identified as Asian (95%). The mean hemoglobin level was 11.41 g/dL, with values ranging from 9.1 to 14.9 g/dL.

Table 2 shows the accuracy of OTC pulse oximeter finger devices compared to SaO_2, reported as the mean bias (SD) and ARMS.

Among the seven brands, Yongrow had the lowest mean bias (0.21) and ChoiceMMed MD300C29 had the lowest standard deviation (±1.84). The latter also had the lowest ARMS score (1.89%). In contrast, IMDK, INDOPLAS, and Yongrow had the highest ARMS values.

Table 1. Participant characteristics (n = 107)

Characteristics	
Age, years	
Mean (Min to Max)	63 (32 to 92)
Sex, n (%)	
Male	83 (78)
Female	24 (22)
Race, n (%)	
Asian	102 (95)
White	5 (5)
Hemoglobin, g/dL Mean (Min to Max)	11.41 (9.1 to 14.9)

Table 2. Performance of pulse oximeters compared to arterial blood gas

Pulse oximeter	Mean bias (SD)	ARMS, %
ChoiceMMed MD300C13 (Beijing, China)	0.53 (1.91)	1.98
ChoiceMMed MD300C29 (Beijing, China)	0.49 (1.84)	1.89
ChoiceMMed MD300C5 (Beijing, China)	0.60 (1.95)	2.03
INDOPLAS (Quezon, Philippines)	-0.70 (2.17)	2.27
Contec (Hebei, China)	-0.33 (2.12)	2.14
Yongrow (Xuzhou, China)	0.21 (2.18)	2.18
IMDK (Guangdong, China)	-0.90 (2.47)	2.61

SD, standard deviation; ARMS, average root mean square error

Figures 1.1 to 1.7 present the relationship between SaO_2 levels and bias (SpO_2 – SaO_2, in %) for the different pulse oximeter devices. Each figure includes a linear regression plot illustrating how bias changes with varying SaO_2 levels, alongside Bland-Altman plots displaying mean bias and its limits of agreement. All devices showed a statistically significant relationship between SaO_2 and bias ($p < 0.05$; values not shown), with bias generally decreasing as SaO_2 increased, as indicated by the downward slopes and negative regression coefficients.

ChoiceMMed MD300C13 and ChoiceMMed MD300C29 exhibited fair variability in bias (25.2% and 28.3%, respectively) with strong correlations (multiple R = 0.506 and 0.532, respectively). ChoiceMMed MD300C5 demonstrated moderate variability (37.7%) with strong correlations (multiple R = 0.614). INDOPLAS displayed low variability (17.9%) with moderate correlation (multiple R = 0.423), while CONTEC showed fair variability (21.7%) with moderate correlation (multiple R = 0.466). Yongrow exhibited fair variability (22%) and moderate correlation (multiple R = 0.469). IMDK had poor variability (7.5%) and weak correlation (multiple R = 0.274).

The strength of the correlation varied across devices, with ChoiceMMed MD300C5 showing the strongest correlation (R = 0.614) followed by ChoiceMMed MD300C29 (R = 0.532) and ChoiceMMed MD300C13 (R = 0.506), while IMDK showed the weakest correlation (R = 0.274). The percentage of variability in bias also differed, indicating differences in the consistency of bias across different devices.

Table 3 provides a detailed breakdown of mean bias, precision, and ARMS values across the different devices, for hypoxemic and non-hypoxemic patients.

The majority of patients (81%) had SaO_2 of 95% or greater. Mean bias was significantly greater among patients with hypoxemia compared to patients without hypoxemia. This was noted across all pulse oximeters except IMDK. Precision values were also significantly higher among patients with hypoxemia for all devices, with precision values close to zero being more precise. As to the ARMS of hypoxemic patients, their scores were noted to be higher.

DISCUSSION

In evaluating the performance of each pulse oximeter device, the mean bias was used to represent the average difference between the measured SpO_2 values and the standardized SaO_2. Notably, Yongrow demonstrated the lowest mean bias, suggesting better precision. However, it had a wide standard deviation compared to other devices. Conversely, ChoiceMMed MD300C29 exhibited the lowest standard deviation, reinforcing its precision. Standard deviation provides a measure of the variability or spread of the bias scores, with lower SD indicating less variability and higher SD suggesting greater variability in bias. Both the mean bias and standard deviation should be considered in assessing precision.

Conversely, IMDK exhibited the highest mean bias and a larger standard deviation, indicating lower precision among the evaluated devices. Positive mean biases were observed with the three ChoiceMMed devices and Yongrow, implying a tendency to slightly overestimate SaO_2. In contrast, INDOPLAS, Contec, and IMDK exhibited negative mean biases, suggesting a tendency to slightly underestimate SaO_2.

To assess the overall accuracy of the pulse oximeter devices, ARMS values were computed, with lower values signifying better accuracy. All ChoiceMMed devices demonstrated relatively lower ARMS values, indicating better overall accuracy compared to other devices. Conversely, IMDK recorded the highest ARMS value, indicating a higher level of error in SaO_2 estimation. Nevertheless, ARMS values for all devices were less than 3%, or the acceptable performance range set by the FDA.

The correlation between SpO_2 values from OTC pulse oximeters and standardized SaO_2 displayed variability among different devices. The ChoiceMMed devices exhibited strong correlations while Indoplas, Contec, and Yongrow demonstrated moderate correlations, and IMD showed weak correlation.

Based on the linear regression, ChoiceMMed MD300C5 showed a stronger correlation between SaO_2 and bias, and a more

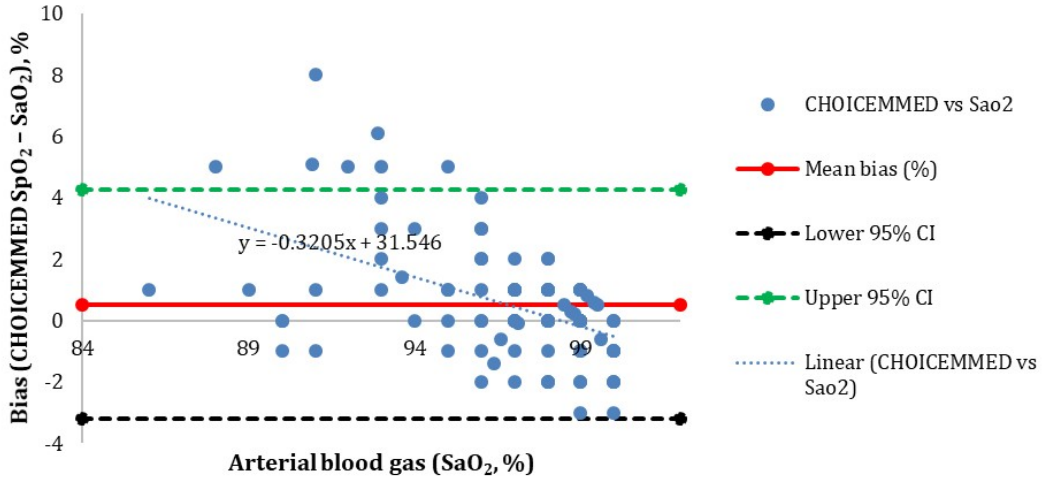

Figure 1.1. Linear regression and Bland-Altman plot of SaO2 vs bias for ChoiceMMed MD300C13

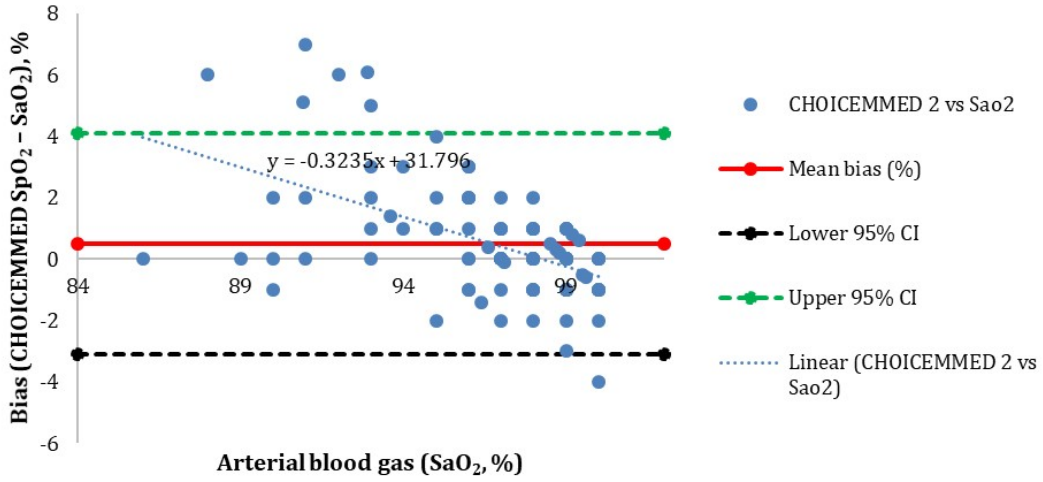

Figure 1.2. Linear regression and Bland-Altman plot of SaO2 vs bias for ChoiceMMed MD300C29

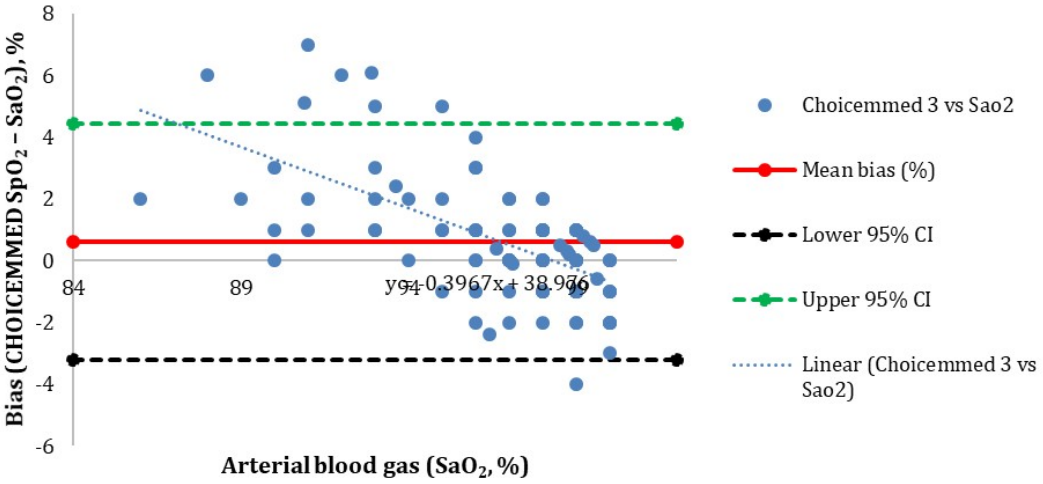

Figure 1.3. Linear regression and Bland-Altman plot of SaO2 vs bias for ChoiceMMed MD300C5

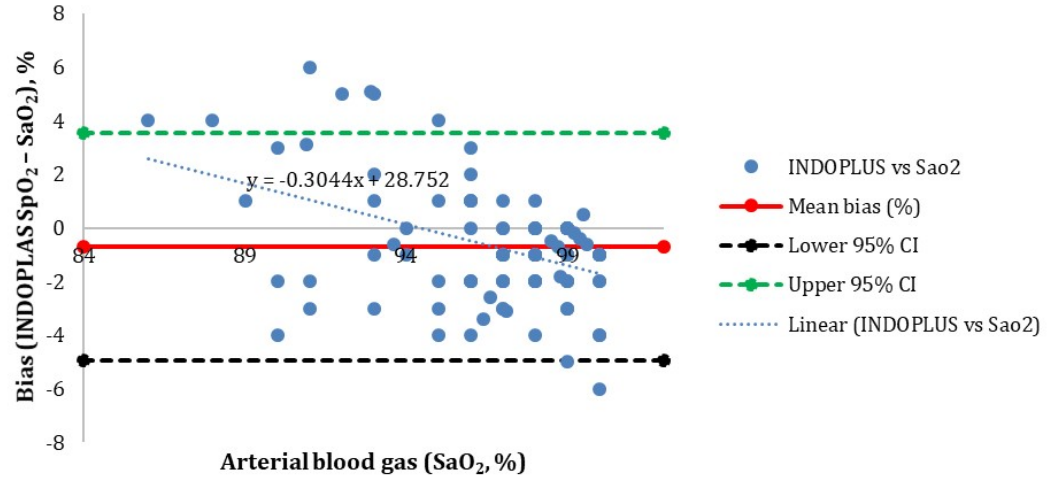

Figure 1.4. Linear regression and Bland-Altman plot of SaO2 vs bias for INDOPLAS

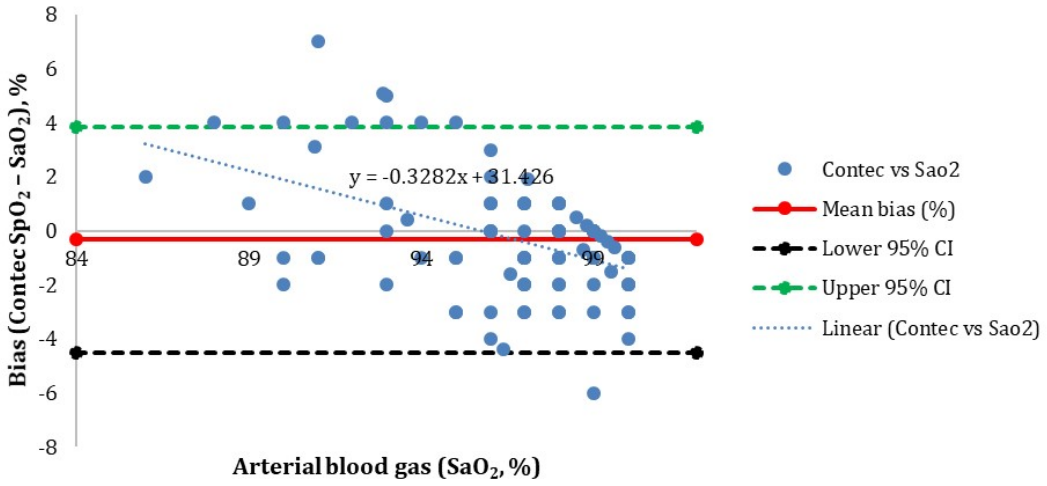

Figure 1.5. Linear regression and Bland-Altman plot of SaO2 vs bias for Contec

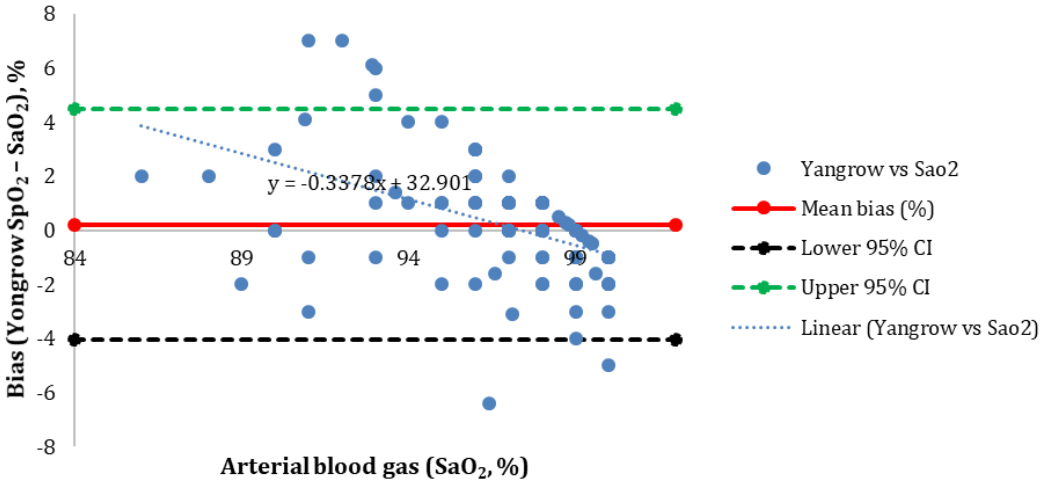

Figure 1.6. Linear regression and Bland-Altman plot of SaO2 vs bias for Yongrow

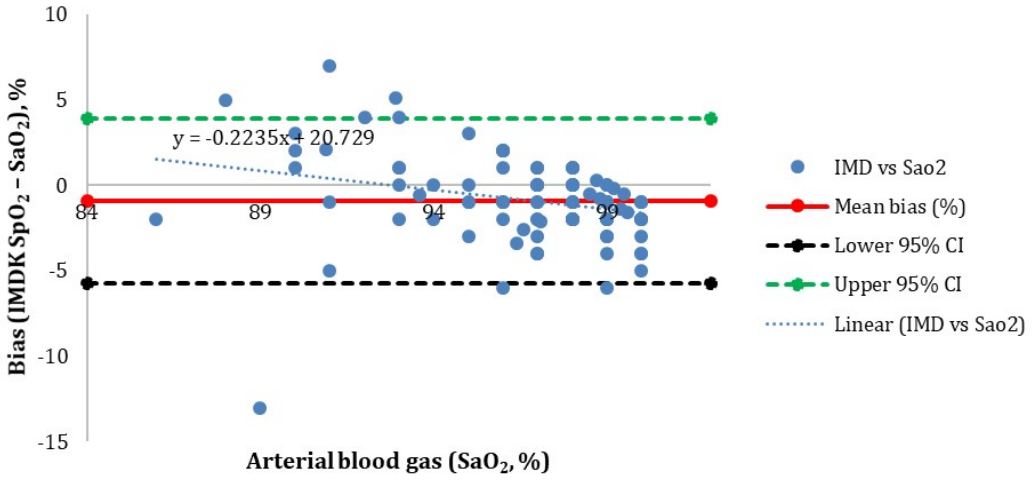

Figure 1.7. Linear regression and Bland-Altman plot of SaO2 vs bias for IMDK

Table 3. Comparison of mean bias, precision, and ARMS in patients with hypoxemia (SaO_2 <95%) and without hypoxemia (SaO_2 ≥95%)

		With hypoxemia (n = 20)	Without hypoxemia (n = 87)	Overall	p-value
ChoiceMMed MD300C13	Mean bias	2.48	0.08	0.53	0.001
	Precision	2.57	1.40	1.91	<0.001
	ARMS (%)	3.52	1.40	1.98	…
ChoiceMMed MD300C29	Mean bias	2.48	0.04	0.49	<0.001
	Precision	2.53	1.27	1.84	<0.001
	ARMS (%)	3.49	1.26	1.89	…
ChoiceMMed MD300C5	Mean bias	2.88	0.07	0.60	<0.001
	Precision	2.19	1.46	1.95	0.004
	ARMS (%)	3.58	1.45	2.03	…
INDOPLAS	Mean bias	1.13	-1.12	-0.70	0.005
	Precision	3.14	1.63	2.17	<0.001
	ARMS (%)	3.26	1.98	2.27	…
Contec	Mean bias	1.83	-0.83	-0.33	<0.001
	Precision	2.72	1.61	2.12	<0.001
	ARMS (%)	3.22	1.80	2.14	…
Yongrow	Mean bias	2.23	-0.25	0.21	0.002
	Precision	2.99	1.64	2.18	<0.001
	ARMS (%)	3.67	1.65	2.18	…
IMDK	Mean bias	0.48	-1.22	-0.90	0.100
	Precision	4.32	1.68	2.47	<0.001
	ARMS (%)	4.24	2.07	2.61	…

significant decrease in bias with increasing SaO_2, suggesting that it may perform best only when the SaO2 is sufficiently high.

Absolute accuracy measures (mean bias and ARMS) provide a more comprehensive overview of the device's performance across all conditions. These metrics are more relevant for determining the overall accuracy of the device's readings. Thus, while ChoiceMMed MD300C5 showed a better linear relationship between SaO_2 and bias, ChoiceMMed MD300C29 demonstrated superior overall accuracy and consistency when considering absolute measures of performance. This explains why ChoiceMMed MD300C29 might be considered better in terms of mean bias and ARMS, even if ChoiceMMed MD300C5 appeared more sensitive to SaO_2 variations. However, it should be noted that the difference between the two might not be significant, which is a limitation in this paper since pairwise comparison of the bias for each pulse oximeter was not done.

The subgroup analysis for hypoxemic and non-hypoxemic patients revealed several important findings. Firstly, the majority of patients had SaO_2 levels of 95% or greater. Secondly, there was a significant increase in bias among patients with SaO_2 less than 95% across all pulse oximeters except IMDK. Thirdly, precision was notably large, which indicates less precision in patients with SaO_2 less than 95% for all pulse oximeters. ARMS values in the hypoxemic subgroup also exceeded the 3% threshold. This indicates that the pulse oximeters, while meeting general accuracy standards, may show decreased precision and accuracy in the context of hypoxemia.

Limitations

The study was a single-center pilot study that used convenience sampling and involved a sole data collector. This may have resulted in a single-observer bias and an increased risk of human error in data collection. Additionally, the restricted variability in SaO_2, with the study population mostly having SaO_2 exceeding 95%, hindered further analysis of patients with lower SaO_2. Potential moment-to-moment differences in pulse oximeter readings during sequential device placement were acknowledged, prompting the randomization of device measurement sequences to minimize this effect. The population size was not able to meet the desired data points set by FDA, which may have resulted in an underpowered analysis. Lastly, the study lacked blinding, as an investigator applied the devices to the patient's finger, while serving as the sole data collector.

Recommendations

It is strongly recommended that future investigations be conducted through a larger, multi-center study to enhance the generalizability and robustness of the results. The inclusion of an FDA-approved medical-grade pulse oximeter as a comparator is advised to establish a more comprehensive benchmark for performance evaluation.

To refine accuracy assessments, it is suggested that SaO_2 be subcategorized into specific ranges (less than 70%, 70% to 80%, 80% to 90%, and 90% to 100%) with equal populations. This subcategorization could offer a nuanced understanding of each device's accuracy across different SaO_2 ranges. However, if not conducted in a controlled experimental environment, a larger population size may be necessary to ensure statistical validity.

To streamline the study and minimize potential confounding factors, it is advised to limit the number of oximeters to less than five. This limitation aims to reduce the time differences in measurements for each device, thereby enhancing reliability of the comparative analyses.

CONCLUSION

This study provides a comprehensive evaluation of OTC pulse oximeter devices by comparing their performance—through mean bias, precision, and accuracy—to standardized SaO_2 measurements. Devices with lower mean bias and smaller standard deviations are more precise, and lower ARMS values are more accurate. ChoiceMMed MD300C29 and Yongrow demonstrate superior precision, with the former emerging as the most accurate. IMDK lags with the lowest precision and accuracy.

The correlation between SpO_2 values from OTC pulse oximeters and standardized SaO_2 displayed variability among different models which underscore the diverse performance characteristics and associations among the evaluated pulse oximeter models.

In states of hypoxemia, precision and accuracy of devices were lower. These findings underscore the importance of considering oxygen saturation levels when assessing the performance of pulse oximeter.

Clinicians and users should consider device-specific characteristics and limitations when interpreting SpO_2 values. Further research is warranted to validate these findings in a larger population group, with variable SaO_2 measurements, and in specific clinical conditions.

Statement of Authorship

All authors certified fulfillment of ICMJE authorship criteria.

Authors' Disclosure

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References

1. U.S. Food and Drug Administration. Performance evaluation of pulse oximeters taking into consideration skin pigmentation, race and ethnicity. Prepared for the February 2, 2024, meeting of the Anesthesiology and Respiratory Therapy Devices Panel of the Medical Devices Advisory Committee. Center for Devices and Radiological Health (CDRH), U.S. Food and Drug Administration; 2024:1,3,30. Accessed April 28, 2025. https://www.fda.gov/news-events/press-announcements/fda-proposes-updated-recommendations-help-improve-performance-pulse-oximeters-across-skin-tones
2. International Organization for Standardization. ISO 9919:2005(E) Medical electrical equipment—Particular requirements for the basic safety and essential performance of pulse oximeter equipment for medical use. Geneva: ISO; 2005: viii.
3. Pilcher J, Ploen L, McKinstry S, Bardsley G, Chien J, Howard L, et al. A multicentre prospective observational study comparing arterial blood gas values to those obtained by pulse oximeters used in adult patients attending Australian and New Zealand hospitals. *BMC Pulm Med*. 2020;20(1):2. https://doi.org/10.1186/s12890-019-1007-3
4. Harskamp RE, van der Laan AM, van Goor H, et al. Performance of popular pulse oximeters compared with simultaneous arterial oxygen saturation or clinical-grade pulse oximetry: A cross-sectional validation study in intensive care patients. *BMJ Open Respir Res*. 2021;8(1):e000939. https://doi.org/10.1136/bmjresp-2021-000939
5. Schrading WA, McCafferty B, Grove J, Page DB. Portable, consumer-grade pulse oximeters are accurate for home and medical use: implications for use in the COVID-19 pandemic and other resource-limited environments. *JACEP Open*. 2020;1(6):1450-1458. https://doi.org/10.1002/emp2.12292
6. U.S. Food and Drug Administration. Pulse oximeter accuracy and limitations: FDA safety communication. 2022. Accessed April 28, 2025. https://www.fda.gov/media/162709/download
7. Shi C, Goodall M, Dumville J, Hill J, Norman G, Hamer O, et al. The accuracy of pulse oximetry in measuring oxygen saturation by levels of skin pigmentation: a systematic review and meta-analysis. *BMC Med*. 2022;20(1):267. https://doi.org/10.1186/s12916-022-02452-8
8. Herbst A, Goel S, Beane A, Brotherton BJ, Dula D, Ely EW, et al. Oxygen saturation targets for adults with acute hypoxemia in low and lower-middle income countries: a scoping review with analysis of

Original Article

The Use of Central Venous Catheters in the Management of Pleural Effusion in a Tertiary Hospital in Cebu City

Raymond Philip D. Huang, MD[1] and Roger Y. Sy, MD[1]

ABSTRACT

Background: There is limited data on the use of central venous catheters (CVCs) in the drainage of pleural effusions. The study aimed to describe the use of CVCs for this purpose.

Methodology: This was a cross-sectional descriptive study done in a tertiary hospital in Cebu City. All patients aged ≥18 years old with pleural effusion who underwent CVC, pigtail catheter, or chest tube thoracostomy (CTT) insertion for pleural fluid drainage were included. Data collected included total drainage of pleural fluid, average daily pleural fluid drainage, duration of catheter use, complications, number of patients sent home with catheters, and number of pleurodesis performed.

Results: A total of 229 patients were included in the study (CVC: 114, pigtail: 22, CTT: 93). Transudative pleural effusion was more frequently encountered in the CVC group (18.78%). Malignancy (28.95%), congestive heart failure (22.81%), tuberculosis (15.79%), pneumonia (15.79%), and chronic kidney disease (14.91%) were the more common causes of pleural effusion in the CVC group. The average daily pleural fluid output and total pleural fluid drainage were highest in the CVC group (527.5 ± 284.9 mL and 5020.47 ± 5691.29 mL, respectively). The duration of catheter use was similar in the three groups. The number of patients sent home with catheters and the number of pleurodesis performed were observed to be highest in the CVC group (48.12% and 61.11%, respectively). Accidental removal was most frequently observed in the CVC group (8/12) although the overall incidence was low at 5.24%. Pneumothorax occurred most frequently in the CTT group (53/64).

Conclusions: The study demonstrates the use of CVCs as an alternative drainage procedure for pleural effusions of various causes. CVCs can also provide an access to perform pleurodesis. A low incidence of complications was observed. Further studies are needed to establish the efficacy and safety of CVCs.

Keywords: central venous catheter, pigtail catheter, chest tube thoracostomy, indwelling pleural catheter

AFFILIATIONS
[1]Section of Pulmonary Medicine, Chong Hua Hospital, Cebu City

CORRESPONDING AUTHOR
Raymond Philip D. Huang, MD
Section of Adult Pulmonary Medicine, Chong Hua Hospital, Cebu City; rayphilhuang5@gmail.com

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INTRODUCTION

Background of the study

Large pleural effusions can cause atelectasis of the involved lung, causing significant symptoms such as cough and dyspnea.[1] Therefore, interventions to remove the pleural fluid and expand the affected lung should be undertaken. Traditionally, recurrent pleural effusions were managed with repeated thoracenteses.[2] However, the repeated punctures may cause patient discomfort and are associated with complications such as pneumothorax and bleeding. At present, common practices to drain pleural effusion include thoracentesis under ultrasound guidance, insertion of a pigtail catheter, and placement of a large-bore closed tube thoracostomy (CTT). However, placement of large-bore chest tubes (French 24-32) is inconvenient as the procedure needs to be done in the operating room, results in more pain and discomfort for the patient, and is associated with higher cost. Pigtail catheter (French 10) is another option for pleural fluid drainage but it may not be available in some settings and may require referral to a surgeon or interventional radiologist. Despite the limitations, the introduction of indwelling pleural catheters, an example of which is the pigtail catheter, has changed the landscape of the management of recurrent pleural effusion, particularly malignant pleural effusion.[2] They were approved by the FDA in 1997 and are now considered the treatment of choice in malignant pleural effusion with evidence to support their use in other causes of recurrent pleural effusion as well.[2]

A central venous catheter (CVC) is an indwelling catheter that is inserted into a large central vein, most commonly the internal jugular, subclavian, or femoral vein.[3] This catheter is commonly used as access for medication, dialysis, total parenteral nutrition, hemodynamic monitoring, and interventions such as transvenous pacemaker placement.[3] However, CVCs (French 7) have been used off-label to drain large effusions or recurrent effusions. The advantages include avoidance of repeated thoracenteses, therefore, reducing the complications of frequent puncture and causing less patient discomfort as compared to large-bore CTT. In addition, CVCs can be inserted at bedside under ultrasound guidance, making it convenient and less costly.[1]

There is limited literature on the use of CVCs in the drainage of pleural effusions. Singh et al prospectively studied 10 patients and found that CVCs effectively drained large pleural effusions with no major complications.[1] Yazdanbod et al retrospectively studied 84 patients with malignant effusions who underwent triple-lumen CVC insertion, reporting a median catheter duration of 38 days, with no post-procedure complications, and significant improvement in quality of life at 30 and 60 days.[4] Song et al retrospectively studied 104 patients with tuberculous pleurisy and compared CVC drainage to standard pleural puncture.[5] The CVC group had a faster resolution of effusion, shorter hospital stay, and fewer complications (1.9% vs 15.4%; $p < 0.05$) despite draining a lower total fluid volume.[5] Similarly, Wu et al conducted a prospective study of 104 patients with pneumoconiosis-related pleural effusions, finding that CVC drainage led to higher fluid output, faster effusion resolution, and a significantly higher cure rate (83.33% vs 46.43%; $p < 0.01$) compared to repeated thoracenteses.[6] These

studies suggest that CVCs may be a safe and effective alternative for pleural effusion drainage, particularly in cases requiring repeated interventions.

In our institution, CVC insertion under ultrasound guidance is the common method of drainage for non-loculated or recurrent pleural effusion to facilitate weaning in patients who require oxygen support and to provide symptomatic relief of dyspnea. Chest tube thoracostomy, on the other hand, is usually reserved for complicated or loculated pleural effusion.

Research question
What are the demographic and clinical characteristics of patients managed for pleural effusion, the pleural fluid properties, drainage outcomes, and complication rates across three different types of pleural fluid drainage procedures (CVC, pigtail catheter, CTT)?

Objectives
General objective
To describe the use of CVCs in the drainage of pleural effusions and compare with other drainage procedures (pigtail catheter and CTT).

Specific objectives
1. To describe the baseline demographic and clinical characteristics of patients with pleural effusion in whom central venous catheters (CVCs) were inserted in Chong Hua Hospital and compare with those who underwent other drainage procedures:
    A. Age
    B. Gender
    C. Comorbidities
        - Heart failure
        - Malignancy
        - Renal disease
        - Liver disease
        - Pneumonia
        - Pulmonary tuberculosis
    D. Pleural fluid characteristics
        - Color and turbidity
        - Differential count (red blood cell, white blood cell, polymorphonuclear neutrophils, lymphocytes)
        - Total protein
        - Lactate dehydrogenase
        - Culture
        - Exudative
        - Transudative
2. To identify common causes of pleural effusion in patients who received CVC drainage and compare with those who underwent other drainage procedures
3. To determine the total pleural fluid drained and average pleural fluid output per day using CVCs and compare with other drainage procedures
4. To determine the average duration of use of CVCs for pleural fluid drainage and compare with other drainage procedures
5. To identify complications with the use of CVCs for pleural fluid drainage and compare with other drainage procedures

METHODOLOGY
Study design
This was a a cross-sectional descriptive study.

Study setting
The study was conducted in Chong Hua Hospital, a 660-bed capacity private tertiary hospital in Cebu City.

Study population
The study included patients admitted at Chong Hua Hospital who were 18 years old and above with radiographic or sonographic evidence of pleural effusion who underwent insertion of CVC, pigtail catheter, or large-bore chest tube from January 2018 to July 2023.

Data collection
Data on patients admitted at Chong Hua Hospital with a discharge diagnosis of pleural effusion who underwent CVC, pigtail catheter, or chest tube insertion were obtained through a computerized registry. Patients' baseline characteristics as well as the total amount of pleural fluid drained, average amount of pleural fluid drained per day, duration of catheter use, associated complications, number of patients sent home with catheters, and number of pleurodesis performed were collected from a retrospective chart review.

Data analysis
Frequencies and percentages were determined for the baseline characteristics of the study population. The mean and standard deviation were determined for the total pleural fluid output, daily pleural fluid output, and duration of catheter use.

Ethical considerations
Review and approval of the research protocol by the Institutional Review Board of Chong Hua Hospital was done prior to commencement of the study (IRB reference code 1123-02). Informed consent was waived as the study involved a retrospective chart review. Personal data of all patients included in the study remained confidential. This study adhered to the principles outlined in the Declaration of Helsinki.

RESULTS
A total of 229 patients were included in the study, with 114 patients in the CVC group, 22 patients in the pigtail group, and 93 patients in the CTT group. Table 1 shows the baseline demographics of patients included in this study. The overall mean age was 61.06 ± 18.49 years with a younger patient population (53.26 ± 19.6 years) in the CTT group. Among the CVC group, chronic kidney disease (38.6%) and heart failure (30.70%) were the most prevalent comorbidities. Yellowish pleural fluid was most frequently observed in the CVC group (73/122; 59.84%) while reddish pleural fluid was most frequently encountered in the CTT group (47/83; 56.63%). The pleural fluid neutrophil count was highest in the CTT group (27.25 ± 30.19%). On the other hand, the pleural fluid lymphocyte count was highest in the CVC group (74.85 ± 28.68%). The pleural fluid total protein was highest in the pigtail catheter group (7.3 ± 21.02 g/dL) while pleural fluid LDH was highest in the CTT group (851.69 ± 2462 U/L). Bacterial growth on pleural fluid culture was most frequently observed in the CTT group (17/21; 80.95%). Transudative pleural effusion was most frequently encountered in the CVC group (43/54; 79.63%). There was a total of 9 cases of bilateral catheter insertion for bilateral pleural effusion which was most frequently observed in the CVC group (5/9; 55.56%).

Table 2 shows the primary causes of pleural effusion in patients who underwent CVC, pigtail catheter, and CTT insertion. Malignancy (35.48%), pulmonary tuberculosis

Table 1. Baseline characteristics of patients with pleural effusion

	Overall (n = 229)	Central venous catheter (n = 114)	Pigtail catheter (n = 22)	Chest tube thoracostomy (n = 93)
Age, mean ± SD	61.06 ± 18.49	66.14 ± 15.47	67.68 ± 16.81	53.26 ± 19.6
Gender, n (%)				
Female	102 (44.54)	49 (42.98)	13 (59.09)	40 (43.01)
Male	127 (55.46)	65 (57.02)	9 (40.91)	53 (56.99)
Comorbidities, n (%)				
Heart Failure	49 (21.40)	35 (30.70)	6 (27.27)	8 (8.60)
Malignancy	77 (33.62)	33 (28.95)	10 (45.45)	34 (36.56)
Liver disease	27 (11.79)	11 (9.65)	3 (13.64)	13 (13.98)
Chronic kidney disease	49 (21.40)	44 (38.60)	1 (4.55)	4 (4.30)
Pneumonia	83 (36.24)	41 (35.96)	8 (36.36)	34 (36.56)
Pulmonary tuberculosis	49 (21.40)	20 (17.54)	3 (13.64)	26 (27.96)
Color, n (%)				
Yellow	122 (53.28)	73 (64.04)	14 (63.64)	35 (37.63)
Red	83 (36.24)	29 (25.44)	7 (31.82)	47 (50.54)
Turbidity, n (%)				
Clear	2 (0.87)	1 (0.88)	1 (4.55)	0 (0)
Turbid	204 (89.08)	104 (91.23)	20 (90.91)	80 (86.02)
Differential count, mean ± SD				
RBC (mm^3)	25252.6 ± 72023.27	19024.6 ± 75362.84	18636.36 ± 35644.31	34452.06 ± 73793.9
WBC (mm^3)	3133.61 ± 28945.86	1064.03 ± 1757.17	1089.59 ± 1199.96	6154.05 ± 45351.87
PMN (%)	21.73 ± 24.59	17.25 ± 19.06	21.68 ± 19.28	27.25 ± 30.19
Lymphocyte (%)	67.34 ± 33.23	74.85 ± 28.68	69.23 ± 28.72	57.69 ± 37.06
Total protein (g/dL), mean ± SD	3.77 ± 6.77	3.4 ± 1.85	7.3 ± 21.02	3.39 ± 2.27
LDH (U/L), mean ± SD	488.66 ± 1656.29	187.32 ± 241.49	515.55 ± 1355.84	851.69 ± 2462
Culture, n (%)				
With growth	21 (9.17)	1 (0.88)	3 (13.64)	17 (18.28)
No growth	183 (79.91)	104 (91.23)	13 (59.09)	66 (70.97)
Exudative, n (%)	125 (54.59)	58 (50.88)	13 (59.09)	54 (58.06)
Transudative, n (%)	54 (23.58)	43 (37.72)	5 (22.73)	6 (6.45)
Unilateral insertion, n (%)	220 (96.07)	109 (95.61)	21 (95.45)	90 (96.77)
Bilateral insertion, n (%)	9 (3.93)	5 (4.39)	1 (4.55)	3 (3.23)

RBC, red blood cell; WBC, white blood cell; PMN, polymorphonuclear neutrophils; LDH, lactate dehydrogenase

Table 2. Primary causes of pleural effusion in patients who underwent CVC, pigtail catheter, and CTT insertion

n (%)	Overall (n = 229)	Central venous catheter (n = 114)	Pigtail catheter (n = 22)	Chest tube thoracostomy (n = 93)
Malignancy	75 (32.75)	33 (28.95)	9 (40.91)	33 (35.48)
Tuberculosis	52 (22.71)	18 (15.79)	4 (18.18)	30 (32.26)
Pneumonia	32 (13.97)	18 (15.79)	1 (4.55)	13 (13.98)
Heart failure	36 (15.72)	26 (22.81)	5 (22.73)	5 (5.38)
Chronic kidney disease	20 (8.73)	17 (14.91)	1 (4.55)	2 (2.15)
Liver disease	12 (5.24)	10 (8.77)	1 (4.55)	1 (1.08)
Empyema	7 (3.06)	0 (0)	0 (0)	7 (7.53)

(32.26%), and pneumonia (13.98%) were the more common etiologies of pleural effusion in the CTT group. Moreover, empyema thoracis was the primary indication for drainage with CTT in all empyema cases (n = 7). On the other hand, malignancy (28.95%), congestive heart failure (22.81%), tuberculosis (15.79%), pneumonia (15.79%), and chronic kidney disease (14.91%) were the more common causes of pleural effusion in the CVC group. Liver disease was the primary indication for pleural fluid drainage in 8.77% of cases in the CVC group.

Table 3 shows the average pleural fluid output per day, total pleural fluid drainage, duration of catheter use, number of patients sent home with catheter, and number of pleurodesis performed in patients who underwent CVC, pigtail catheter, and CTT insertion. The average pleural fluid output per day and total pleural fluid drainage were observed to be highest in the CVC group (527.5 ± 284.9 mL and 5020.47 ± 5691.29 mL, respectively). The duration of catheter use (in hospital days) was similar in the three groups. The number of patients sent home with catheters and the number of pleurodesis performed were observed to be highest in the CVC group (64/133; 48.12% and 33/54; 61.11%, respectively).

Table 4 presents the complications encountered in patients who underwent CVC, pigtail catheter, and CTT insertion. A low incidence of bleeding, infection, and obstruction was observed across all catheter types. Accidental removal was most frequently observed in the CVC group (8/12; 66.67%) although the overall incidence was low at 5.24%. Pneumothorax occurred most frequently in the CTT group (53/64; 82.81%). Six patients in the CVC group (6/114; 5.26%) subsequently underwent CTT insertion due to complicated pleural effusion.

Table 5 shows the cost of the use of CVC, pigtail catheter, and CTT in our institution excluding professional fees. CVC

Table 3. Average pleural fluid output per day, total pleural fluid drainage, duration of catheter use, number of patients sent home with catheter, and number of pleurodesis performed in patients who underwent CVC, pigtail catheter, and CTT insertion

	Overall (n = 229)	Central venous catheter (n = 114)	Pigtail catheter (n = 22)	Chest tube thoracostomy (n = 93)
Average pleural fluid output per day, mL (mean ± SD)	443.75 ± 291.4	527.5 ± 284.9	378.68 ± 197.79	356.48 ± 290.54
Total pleural fluid drainage, mL (mean ± SD)	4070.44 ± 4699.39	5020.47 ± 5691.29	3132.55 ± 4079.21	3127.74 ± 2986.79
Duration of catheter use, hospital days (mean ± SD)	11.79 ± 14.38	12.54 ± 16.88	10.32 ± 10.46	11.22 ± 11.66
Patients sent home with catheter, n (%)	133 (58.08)	64 (56.14)	13 (59.09)	56 (60.22)
Pleurodesis performed, n (%)	54 (23.58)	33 (28.95)	3 (13.64)	18 (19.35)

Table 4. Complications encountered in patients who underwent CVC, pigtail catheter, and CTT insertion

n (%)	Overall (n = 229)	Central venous catheter (n = 114)	Pigtail catheter (n = 22)	Chest tube thoracostomy (n = 93)
Bleeding	3 (1.31)	1 (0.88)	2 (9.09)	0 (0)
Pneumothorax	64 (27.95)	11 (9.65)	0 (0)	53 (56.99)
Infection	8 (3.49)	4 (3.51)	0 (0)	4 (4.30)
Accidental removal	12 (5.24)	8 (7.02)	1 (4.55)	3 (3.23)
Obstruction	4 (1.75)	3 (2.63)	0 (0)	1 (1.08)

Table 5. Comparison of the costs for CVC, pigtail catheter, and CTT insertion

	Central venous catheter	Pigtail catheter	Chest tube thoracostomy
Cost of catheter	Php 5,000	Php 8,000	Php 1,000
Cost of procedure	Php 22,000	Php 30,000	Php 30,000
Total cost	Php 27,000	Php 38,000	Php 31,000

insertion has the lowest cost among the three types of catheters.

DISCUSSION

This study has provided an overview of the use of CVCs as indwelling pleural catheters for the drainage of pleural effusions of various etiologies in our institution. CVCs were used in patients with transudative pleural effusions due to congestive heart failure and chronic kidney disease as well as in those with exudative effusions caused by malignancy, tuberculosis, and pneumonia. In contrast, higher pleural fluid LDH and positive cultures were more frequently encountered in the CTT group as CTT is the most common drainage procedure for complicated, loculated, and infected pleural effusion in our institution. The higher pleural fluid output in the CVC group may be due to conditions causing recurrent pleural effusion (e.g., malignancy, congestive heart failure, chronic kidney disease). Singh et al reported the use of CVCs for the drainage of pleural effusion of various causes such as liver disease, cardiac disease, pneumonia, and pancreatitis.[1] Yazdanbod et al similarly described the use of CVC for the drainage of malignant pleural effusion, with significant improvement in the quality of life.[4] Song et al reported the use of CVC for the drainage of tuberculous pleural effusion, with significant early improvement in the pleural effusion, chest pain, and fever.[5]

A noteworthy finding was the lower incidence of complications encountered in the CVC group. Pneumothorax was observed to be more frequent in patients who underwent CTT insertion which might be due to the more traumatic nature of inserting a large-bore tube. A reddish pleural fluid was likewise more frequently seen in the CTT group due to the larger wound incision required. Accidental removal was more frequently observed in the CVC group although the incidence was low. In our institution, CVC is inserted as an indwelling pleural catheter under ultrasound guidance. In some instances, CVCs are not secured with sutures to facilitate easier removal which might explain the higher rates of accidental removal in this study. The conversion rate to closed tube thoracostomy in patients with CVC was observed to be low in this study which shows that CVCs may provide adequate drainage without the need for escalation to a more invasive procedure. Song et al reported significantly lower complications with the use of CVCs compared to conventional pleural puncture and drainage for the management of tuberculous pleural effusion.[5] Moreover, the authors highlighted several advantages of CVCs for pleural fluid drainage including reduced need for repeated thoracentesis, fewer procedural complications, and greater patient comfort compared to large-bore chest tubes.[1] Pleurodesis, which is an important aspect of pleural effusion management, can also be performed using CVCs, as demonstrated in the study. Successful pleurodesis through CVC was described by Ghoneim et al in hepatic hydrothorax.[9]

Further, this study highlights the low cost associated with CVC insertion in the long-term management of pleural effusion. Among the three drainage methods, CVCs had the lowest total cost. The ability to insert CVCs at the bedside under ultrasound guidance, without the need for an operating room, likely contributes to its lower procedural costs.[1] CVC insertion also allows patients to be sent home for continued drainage which may further reduce hospitalization costs, particularly in those with malignant or recurrent effusions. CVCs for pleural fluid drainage can be particularly advantageous in resource-limited settings where access to operating rooms and specialized procedures is restricted. The minimally-invasive nature, ease of placement, and associated patient comfort make them a practical alternative when dedicated pleural drainage devices are unavailable.

The off-label use of CVCs for pleural fluid drainage may raise important ethical considerations particularly regarding patient safety, informed consent, and adherence to best clinical

practices. While CVCs are not specifically designed for this purpose, the authors believe that their use may be justified in scenarios where alternative drainage devices are unavailable especially in resource-limited settings. Informed consent was obtained prior to CVC insertion in patients included in this study as routine for these procedures. The risks and benefits were also explained to patients. While off-label use of medical devices is not inherently unethical, the acceptability of using CVCs for pleural drainage hinges on the principle of beneficence—maximizing patient benefit while minimizing harm. Given the low complication rates, low cost and broad availability, CVCs may provide a practical alternative for pleural fluid drainage in specific clinical scenarios.

Limitations

This study was done as a six-year retrospective chart review. The study was conducted in a single institution which may limit generalizability of the findings to other healthcare settings. The retrospective nature of data collection also introduced the potential for documentation bias. The total duration of pleural catheter use included in-patient days of catheter use only, with some patients being sent home with catheters. The initial volume of pleural effusion on ultrasound prior to catheter insertion was not included in the study. Re-expansion pulmonary edema, as a rare complication of pleural fluid drainage, was not documented in some of the cases, hence, was not included in this study.

Recommendations

A prospective study on the use of CVCs for the drainage of pleural effusions is recommended to establish its efficacy and safety in comparison to other types of indwelling catheters. Moreover, a subgroup analysis focusing on recurrent pleural effusions—such as those caused by malignancy, congestive heart failure, chronic kidney disease, and liver disease, where CVCs were more commonly used—is recommended. A cost-effectiveness analysis may also be performed in future prospective studies.

CONCLUSION

This study provides an overview of the use of CVCs as an alternative drainage procedure for non-complicated pleural effusion. CVC has been used in pleural effusions of various causes and has a low incidence of complications. Moreover, it provides an access through which pleurodesis can be performed.

Statement of Authorship

All authors certified fulfillment of ICMJE authorship criteria.

Authors' Disclosure

The authors declared no conflict of interest.

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References

1. Singh, K, Loo, S, Bellomo, R. (2003). Pleural drainage using central venous catheters. *Critical Care*. 2003;7(6):R191-194. https://doi.org/10.1186/cc2393
2. Siddiqui, F, Ihle, RE, Siddiqui AH. Intrapleural catheter. In StatPearls. StatPearls Publishing. Accessed May 11, 2025. http://www.ncbi.nlm.nih.gov/books/NBK493229/
3. Kolikof, J, Peterson, K, Baker, AM. Central venous catheter insertion. In StatPearls. StatPearls Publishing. Accessed May 11, 2025. http://www.ncbi.nlm.nih.gov/books/NBK557798/
4. Yazdanbod, A, Salehifar A, Maleki, N, Habibzadeh, S, Tavosi, Z. Successful use of central venous catheters in the management of recurrent malignant pleural effusions: One new option. *Supportive Care in Cancer.* 2015;23(8):2267–2271. https://doi.org/10.1007/s00520-014-2595-3
5. Song, L, Zhang, Y, Jia, Q. Central venous catheter based closed thoracic drainage in the treatment of tuberculous pleuritis. *Pakistan Journal of Medical Sciences.* 2019;35(4):1024–1029. https://doi.org/10.12669/pjms.35.4.63
6. Wu, S., Zhang, M. Central venous catheter for coal workers pneumoconiosis complicated with pleural effusion and pneumothorax efficacy analysis. *Chinese Journal of Industrial Hygiene and Occupational Diseases.* 2015; 33(1): 51-53. https://pubmed.ncbi.nlm.nih.gov/25876977/.
7. Chest tube insertion (Small bore catheter—CVC) evaluation form. Section of Pulmonary Medicine. Chong Hua Hospital
8. Cooke, DT and David, EA. Large-bore and small-bore chest tubes: Types, function, and placement. *Thoracic Surgery Clinics.* 2013;23(1):17–24. https://doi.org/10.1016/j.thorsurg.2012.10.006
9. Ghoneim, AHA, El Gammal, MS, AboZaid, MMN, El Rahman, AA. Efficacy of central venous catheter in pleurodesis in refractory hepatic hydrothorax. *The Egyptian Journal of Chest Diseases and Tuberculosis.* 2019;68(2):236. https://doi.org/10.4103/ejcdt.ejcdt_82_18

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- Intervention, to include main and secondary outcome measure(s);
- Data and statistical analyses, to include what specific software was used for the computations.
- For Original Articles, statements regarding adherence to the Declaration of Helsinki, approval by the Institutional Review Board (IRB)/Ethics Committee, and description of the informed consent process shall be included.

Results: Results must be concise. This may include demographic data of the study population, outcomes, and measurements. Data shall be accompanied by confidence intervals (usually at the 95% interval) and exact *p-values* or other indicators of statistical significance. Negative results should also be reported.
Discussion: The discussion shall be restricted to the significant findings presented. Results should not be repeated in this section. Limitations should be stated, to include whether additional studies are required, and the implications of the results.
Conclusion/s: The conclusion(s) shall be directly supported by the results and shall state how the study addresses the objectives. Overgeneralization and speculation are discouraged.

For **Case Reports/Series and Grand Rounds**, the manuscript should contain the following general sections: Introduction, Case Presentation, Discussion, and Conclusion.

Introduction: The Introduction shall provide a brief summary of what is unique about the case and what it adds to the scientific literature.
Case Presentation: The Case Presentation shall include the patient history, physical examination, test results, differential diagnoses, diagnosis, treatment, and, when available, the course on follow-up and outcomes.
Discussion: This section should contain the discussion of the diagnosed condition, including the treatment options and managements, as in other clinical manuscripts. The strengths and limitations of the case should be stated.
Conclusion: The conclusion shall provide readers with the learning points gathered from the case report/series or grand rounds.

For **Grand Rounds**, the body of the text, including commentaries by specialty experts (discussants) should be edited from the presentation for clarity and conformity with the length guidelines described above. The names of the discussants should be reflected in the commentary, along with relevant identifiers (e.g., ***Dr. Juan Dela Cruz, Pulmonologist:*** <commentary>).

When not pertinent to the case, manuscripts should refrain from giving away patient details not relevant to the case that, collectively, risk identifying the patient to the public.

Abbreviations
All abbreviations shall be spelled out once (i.e., the first time they are mentioned in the text), followed by the abbreviation enclosed in parentheses.

Abbreviations shall be restricted to those that are widely used, accepted, and understood.

Measurements
All measurements and weights shall be expressed in SI units.

Mention of Drugs and Medications

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Use generic names only in the text body. State the trade name of a particular drug cited in parentheses including the manufacturer's name, city, state and/or country when first mentioned in the text.

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With regard to instruments or equipment utilized in the study, enclose in parentheses the specific model, manufacturer's name, city, state and/or country.

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Potential conflicts of interest where existing, shall be disclosed. This includes but is not limited to: ownership, employment, research support (including provision of equipment or materials), involvement as speaker, consultant, or any other financial relationship or arrangement with manufacturers, companies or suppliers. Such disclosure will indicate whether the person and/or his/her immediate family has any financial relationship with pharmaceutical companies, medical equipment manufacturers, biomedical device manufacturers, or any companies with significant involvement in the field of health care.

Acknowledgments
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Tables
All tables shall be embedded within the body of the text at the appropriate points.

Only tables cited in the text should be included. All tables should be called out in the text and shall be numbered in ascending order depending on the sequence they were referred to in the text. A different order for tables and figures is to be used. Symbols are * † ‡ § ¶.

Table titles must be placed on top of the table.

Headings within the table must be bold-faced. Columns should be clearly labeled, including units of measure.

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Footnotes may be placed at the bottom of the table if there is a need to make the table understandable that will not easily fit into the table title or data cells.

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Each figure must be numbered consecutively in Arabic numerals by order of citation in the text. Each shall have a brief explanatory legend as necessary. Legends must identify all symbols or letters that appear on the prints. Any figure that has been published elsewhere or adapted shall have an acknowledgement to the original source. A copy of the release to publish the figure signed by the copyright holder must also be submitted.

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Modifications, such as cropping, changes in color, orientation, or placement of arrows or shapes, should be disclosed.

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Graphs may be submitted in "PowerPoint" or "Excel" format. Raw data may be requested by the Editorial Board for verification of computations.

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Illustrations must be professionally rendered with appropriate labels.

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Photographs (clinical photographs, fluorescein angiograms, computed tomography [CT] scans, magnetic resonance imaging [MRI], X-ray, photomicrographs, transmission/scanning electron micrographs [TEM/SEM], graphs, etc.) shall have a resolution of at least 600 dpi. Photographs may be in black and white, or submitted in full color.

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Supporting material that cannot be included in the publication of the manuscript for reasons of space but is complementary and directly relevant to the manuscript content, can be made available online as supplementary material. These may include additional figures or tables, data sets, or detailed methods.

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Philippine Journal of CHEST DISEASES

The official publication of the Philippine College of Chest Physicians

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In consideration of our submission to the **Philippine Journal of Chest Diseases**, all of the undersigned author(s) hereby certify, that we have fulfilled the ICMJE Authorship criteria: (1) active and sufficient participation in the conception or design of the work, the acquisition, analysis and interpretation of data for the work; AND (2) drafting the work, revising it critically for important intellectual content; AND (3) responsibility for the final approval of the version to be published; AND (4) accountability for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Philippine Journal of CHEST DISEASES
The official publication of the Philippine College of Chest Physicians

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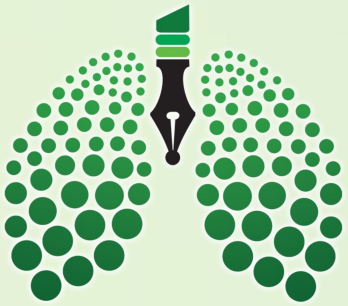

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MAILING ADDRESS: 84-A Malakas Street, Pinyahan, Quezon City, Philippines 1100

LANDLINE NUMBER: +632 8924 9204