

PEAK FLOW METER ASSESSMENT, LENGTH OF STAY, AND INPATIENT COSTS IN COPD: A NARRATIVE REVIEW

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Abstract

This study investigates the relationship between Peak Flow Meter (PFM) assessment, length of stay (LOS), and inpatient costs in patients with chronic obstructive pulmonary disease (COPD). The study addresses a managerial and clinical gap in Indonesia's INA-CBGs reimbursement context, where objective respiratory assessment tools remain underutilized despite their potential to support value based care. A narrative review was conducted using the SANRA criteria to synthesize clinical, operational, and policy-level evidence. Literature was systematically screened to evaluate the role of PFM in early clinical assessment, its influence on decision making accuracy, its indirect impact on LOS reduction, and the financial implications within hospital payment structures. Key findings were interpreted to develop a conceptual framework aligning PFM integration with Indonesia's healthcare financing system. The evidence consistently demonstrates that PFM enables rapid and objective evaluation of airway obstruction, reduces diagnostic uncertainty, and minimizes delays in treatment initiation. These improvements contribute to shorter LOS and greater efficiency. Reduced LOS is further associated with lower inpatient costs under INA-CBGs, highlighting the operational significance of standardized PFM use. This study provides a conceptual foundation for integrating PFM into hospital admission protocols as a low-cost and scalable innovation for COPD management.

Keywords: Flow Meter Assessment, Inpatient Costs in Copd, Length of Stay

Introduction

Chronic obstructive pulmonary disease (COPD) ranks among the leading causes of morbidity and mortality worldwide, imposing an expanding clinical and economic burden on health systems. The World Health Organization reports COPD as the third leading cause of death, while recent projections indicate a continued rise in prevalence due to aging populations, persistent tobacco exposure, and air pollution (Boers et al., 2023; World Health Organization, 2024). Beyond its clinical burden, COPD imposes substantial economic costs on health systems through recurrent hospitalizations and long treatment episodes. In Indonesia, the prevalence of COPD among adults has reached 3.7% (Kementerian Kesehatan RI, 2019), accompanied by increasing hospital admissions and complications that intensify system-wide pressures. The Indonesian Case-Based Groups (INA-CBGs) reimbursement scheme was designed to promote efficiency, yet studies consistently reveal gaps between INA-CBGs tariffs and actual hospital expenditures, leading to persistent financial deficits for providers (Satibi et al., 2019; Utami & Fanny, 2021). This reflects what McKinsey & Company has described as “the big squeeze,” where healthcare demand continues to grow while operational margins shrink (Singhal & Repasky, 2020).

Length of stay (LOS) serves as both a key efficiency indicator and a dominant determinant of inpatient costs. Each additional day of hospitalization adds to cumulative expenditures and clinical risks. International evidence demonstrates that COPD clinical pathways significantly reduce LOS while

maintaining or improving patient outcomes (Evison et al., 2023; Miravittles et al., 2023). Local facility data reinforce this challenge. At RSU Hidayah Boyolali, a type D private hospital in Central Java, COPD inpatients recorded an average LOS of 6.29 days and an average real hospital cost of IDR 6.76 million. More than 95% of cases resulted in claim deficits during August 2024 to July 2025 (internal hospital data). Although drawn from a single institution, these findings mirror systemic inefficiencies observed across Indonesian hospitals, underscoring the urgency of addressing LOS as a managerial priority. Optimizing LOS requires strengthening the accuracy of early clinical assessment. The Peak Flow Meter (PFM), which measures peak expiratory flow (PEF), offers a simple, inexpensive, and rapid tool to evaluate airway obstruction. Prospective studies show that lower PEF values at admission predict hospitalization needs and correlate with longer LOS in COPD exacerbations (Cen et al., 2019; Cen & Weng, 2022; Pothirat et al., 2015). Moreover, clinical audits confirm that standardized objective assessment reduces decision-making delays and practice variability, contributing to shorter hospital stays (Ruparel et al., 2016). Despite this potential, PFM has not been systematically integrated into Indonesian hospital protocols. This review was developed using the SANRA framework to ensure clarity, transparency, and critical engagement with relevant literature.

Against this background, this article presents a narrative synthesis of current evidence linking PFM, LOS, and inpatient costs in COPD. It proposes a conceptual framework where PFM indirectly reduces costs through the mediating role of LOS, emphasizing both its clinical utility and financial relevance within Indonesia's INA-CBGs prospective payment system.

Method

This article was developed in accordance with the Scale for the Assessment of Narrative Review Articles (SANRA) to ensure methodological transparency, interpretive rigor, and critical synthesis. The SANRA framework was chosen because it accommodates the integration of clinical, managerial, and policy perspectives relevant to COPD. Unlike meta-analytic methods, this narrative review emphasizes conceptual integration, logical coherence, and evaluative interpretation rather than quantitative aggregation.

Data Sources

Literature searches were conducted through international databases such as PubMed, Scopus, Google Scholar, and ScienceDirect, using the keywords “COPD”, “exacerbation”, “peak flow meter”, “length of stay”, and “inpatient cost”, were applied individually and in combination to ensure comprehensive coverage of relevant evidence. In addition, relevant national policy documents were also reviewed, including the National Clinical Practice Guidelines (PNPK) for COPD 2019 (Perhimpunan Dokter Paru Indonesia, 2019) and regulations related to the INA-CBGs prospective reimbursement system in Indonesia (Kementerian Kesehatan RI, 2022).

Inclusion and Exclusion Criteria

Articles were included if published between 2018 and 2025, focused on patients with acute exacerbation of COPD (AECOPD), and addressed variables related to PFM/PEF, length of stay (LOS), or inpatient costs. Eligible publications were available in full text, in either English or Indonesian. Reviews and meta-analyses that contributed theoretical or contextual insights were also included. Non-COPD studies, single case reports, and abstracts without full text were excluded. The inclusion process emphasized methodological rigor and conceptual relevance to ensure that selected studies substantively contributed to the proposed framework linking PFM, LOS, and inpatient costs.

Literature Selection Process

The literature selection followed a structured process guided by the SANRA framework, emphasizing transparency, conceptual relevance, and methodological rigor. From an initial 132 records identified through database searching, titles and abstracts were screened for relevance to COPD, Peak Flow Meter (PFM), length of stay (LOS), and inpatient cost. A total of 54 full-text articles were reviewed, and 28 studies ultimately met all inclusion criteria. This process prioritized the relevance, quality, and contribution of each source to the conceptual framework rather than quantitative aggregation. Studies were included based on their ability to inform theoretical understanding, clinical implications, and managerial insights within the Indonesian healthcare context.

Synthesis of Findings

A total of 28 eligible studies were narratively analyzed to identify conceptual and empirical linkages between Peak Flow Meter (PFM) assessment, length of stay (LOS), and inpatient costs. The synthesis was organized thematically into four interrelated domains: (1) the role of PFM in the initial assessment of COPD exacerbation, (2) the association between LOS and both clinical and financial outcomes, (3) the economic implications of LOS within the INA-CBGs reimbursement context, and (4) the relevance of these findings to Indonesian health policy and hospital management. In accordance with the SANRA framework, this synthesis emphasizes conceptual coherence and interpretive depth rather than quantitative aggregation. Among the 28 included studies, a subset of core empirical evidence directly supporting the PFM, LOS, inpatient cost pathway is summarized in Table 1, while the remaining sources, including clinical guidelines, systematic reviews, and innovation-oriented studies, were integrated into the Discussion to enrich theoretical and contextual interpretation. Through this approach, the review highlights both the clinical significance and managerial utility of PFM assessment, positioning it as a practical and policy-relevant instrument within Indonesia's evolving hospital financing system.

Methodological Quality Assurance

To ensure methodological transparency and scholarly rigor, this review was developed in accordance with the Scale for the Assessment of Narrative Review Articles (SANRA). The framework encompasses six core quality dimensions: justification of the topic's importance, clarity of objectives, adequacy of literature search, critical evaluation of sources, logical structuring of argumentation, and accuracy in presentation and interpretation of evidence. In applying these principles, the article articulates a clear research objective, integrates evidence from multiple databases and national policy sources, and synthesizes findings through interpretive rather than descriptive analysis. The narrative structure maintains coherence between clinical, managerial, and policy perspectives while ensuring that interpretations remain balanced, objective, and aligned with Indonesia's evolving hospital financing reforms. The following section presents a structured discussion of these findings, beginning with the role of PFM as an initial assessment tool in COPD management. The following section presents the main findings derived from this synthesis, beginning with the role of PFM as an initial assessment tool in COPD management.

Results

Peak Flow Meter (PFM) as an Initial Assessment in COPD

Building upon the thematic synthesis presents in the previous section, this part explores how Peak Flow Meter (PFM) serves as an objective early assessment tool in COPD management. Peak Flow Meter (PFM) assessment provides Peak Expiratory Flow (PEF) values that reflect the degree of airway obstruction. As a simple and inexpensive tool, PFM is particularly relevant in resource-limited healthcare settings. Clinical evidence demonstrates that low PEF values on admission predict the likelihood of hospitalization among patients with acute exacerbation of COPD (AECOPD). Cen et al. reported that patients presenting with PEF values below 100 L/min had a significantly higher probability of requiring inpatient care (Cen et al., 2019). In addition, daily variability in PEF has been associated with greater disease instability and a higher risk of readmission (So et al., 2016). Lower baseline PEF values have also been shown to correlate with longer hospital stays, averaging two to three additional days compared with patients who have higher initial readings (Cen & Weng, 2022).

From a managerial standpoint, PFM assessment helps reduce diagnostic uncertainty, minimize delays in treatment initiation, and decrease inter-physician variability. Audit data from European hospitals demonstrated that the standardized use of objective parameters, including PEF, was associated with shorter and more consistent care pathways (Ruparel et al., 2016). Guideline documents further reinforce this role. The Indonesian PNPK COPD 2019 formally recognizes PEF as an alternative to spirometry during acute exacerbations (Perhimpunan Dokter Paru Indonesia, 2019), while the GOLD 2023 report highlights its utility as a practical bedside tool when spirometry is not feasible (Agustí et al., 2023). Collectively, this evidence supports PFM as an essential component of early assessment in AECOPD, bridging subjective clinical judgment with objective severity evaluation and contributing to more timely and precise therapeutic decision-making.

Length of Stay (LOS) in COPD Patients

Length of stay (LOS) is a critical indicator of both clinical outcomes and hospital efficiency. Empirical evidence consistently demonstrates that prolonged LOS worsens patient prognosis. A cohort study in China reported that patients hospitalized for more than 10 days had nearly double the risk of in-hospital complications compared with those discharged within one week (Satibi et al., 2019). In a large multicenter analysis, each additional hospital day increased the relative risk of all-cause rehospitalization by approximately 6% among COPD patients (Ruparel et al., 2016). From an economic perspective, LOS exerts a direct and substantial influence on inpatient costs. In Indonesia, retrospective analyses revealed that each day beyond the standard LOS added approximately IDR 650,000 to direct hospital expenditures, while INA-CBGs reimbursement remained unchanged (Satibi et al., 2019; Suryanegara et al., 2023). A study conducted in a large public hospital further demonstrated that LOS exceeding eight days resulted in real costs 28% higher than the INA-CBGs tariffs (Silitonga et al., 2024). Comparable evidence from other Asian settings confirms that patients with LOS exceeding 12 days incurred hospitalization costs nearly 1.8 times greater than those discharged earlier (Yu et al., 2023). Beyond disease severity, patient comorbidities also influence LOS and inpatient costs, as patients with multiple chronic conditions generally require longer hospitalization and more intensive resource utilization. Although these factors are non-modifiable, optimizing early clinical assessment through objective tools such as PFM remains essential to mitigate avoidable extensions of hospital stay.

Interventions targeting the early phase of hospitalization have proven effective in shortening LOS and improving recovery trajectories. Early pulmonary rehabilitation during inpatient care has been shown to reduce LOS and enhance functional recovery (Lu et al., 2023), while structured discharge bundles effectively lower adverse post-discharge events and downstream healthcare utilization (Yan et al., 2023). High-level evidence reinforces these findings: a recent Cochrane review demonstrated that COPD clinical pathways reduce LOS by an average of 1–2 days and decrease costs by up to 15% (Rotter

et al., 2025). Consistent with this, Kim et al. (2025) reported that implementation of an inpatient COPD care pathway not only shortened LOS but also improved adherence to evidence-based therapy and increased referrals to pulmonary rehabilitation. Taken together, these findings underscore the central role of LOS as a mediating variable linking disease severity with both clinical outcomes and financial sustainability. Effective LOS management therefore represents a critical strategy to enhance patient safety while maintaining hospital viability under prospective payment systems.

Inpatient Costs in COPD Patients

Inpatient costs for COPD patients are shaped by multiple components, including medications, diagnostic testing, accommodation, and healthcare personnel. Under the INA-CBGs reimbursement system, the financial gap between actual hospital expenditures and standardized package tariffs becomes particularly evident when LOS exceeds the expected duration (Utami & Fanny, 2021; Yan et al., 2023). Across studies, LOS consistently emerges as the strongest determinant of hospitalization costs. Evidence from multiple contexts supports this conclusion. Dilixiati et al. (2024) demonstrated that prolonged LOS, together with severe airflow obstruction, were the most significant predictors of high hospitalization costs in acute exacerbations. Similarly, Yu et al. (2023) reported that patients with LOS exceeding 12 days generated costs nearly 1.8 times higher than those discharged earlier. Li et al. (2018) further showed that each additional hospital day increased direct expenditures by approximately 9%, regardless of treatment modality. In parallel, Weiss et al. (2023) confirmed that while intensive interventions such as mechanical ventilation markedly elevated expenditures, hospitalization duration remained the dominant factor explaining total cost variation. Beyond LOS, these studies also indicate that greater comorbidity burden is associated with longer hospitalizations and higher inpatient costs, reinforcing the importance of early, objective assessment to mitigate avoidable extensions of care (Dilixiati et al., 2024; Li et al., 2018; Weiss et al., 2023; Yu et al., 2023).

The same trend is consistently observed in Indonesia. Suryanegara et al. (2023) found that public hospitals experienced systematic financial deficits when LOS exceeded eight days, with real costs surpassing INA-CBGs tariffs by 25–30%. Similarly, Silitonga et al. (2024) documented substantial discrepancies between real costs and reimbursement among COPD patients with prolonged hospitalizations. Global evidence highlights contrasting cost structures between high-income and low- and middle-income countries (LMICs). In high-income settings, cost burdens are largely driven by advanced medical technologies and intensive therapies, whereas in LMICs, extended LOS and diagnostic delays remain the principal cost drivers. Within the Indonesian context, controlling LOS therefore becomes a critical managerial priority, as constrained INA-CBGs tariffs limit hospitals' ability to absorb additional expenditures associated with prolonged inpatient care (Tabyshova et al., 2021).

Conceptual Framework

Integrating the preceding thematic findings, this section synthesizes the clinical, managerial, and economic dimensions into a unified conceptual framework. The interrelationship between Peak Flow Meter (PFM) assessment, length of stay (LOS), and inpatient costs can be conceptualized as a causal pathway. PFM provides an objective and quantifiable measure of airway obstruction at the time of hospital admission. Lower Peak Expiratory Flow (PEF) values have been shown to predict exacerbation severity and hospitalization needs (Cen et al., 2019; So et al., 2016). LOS functions as the pivotal mediator within this framework. Patients with prolonged stays exceeding 10–12 days face nearly double the risk of complications and incur hospitalization costs approximately 1.8 times higher than those discharged earlier (Li et al., 2018). Extended LOS also increases the likelihood of nosocomial infections and in-hospital mortality, effectively linking initial disease severity with both clinical outcomes and resource utilization. In addition to disease severity, the presence of multiple comorbid conditions, often measured using the Charlson Comorbidity Index (CCI), has been associated with

longer hospitalizations and higher inpatient costs. Although comorbidity is a non-modifiable factor, understanding its influence reinforces the importance of early, objective assessment through tools such as PFM to minimize avoidable extensions of care (Dilixiati et al., 2024; Li et al., 2018; Weiss et al., 2023; Yu et al., 2023).

From an economic standpoint, LOS serves as a direct driver of inpatient expenditures under the INA-CBGs reimbursement mechanism. Indonesian studies confirm that when LOS exceeds eight days, real costs surpass reimbursement tariffs by 25–30% (Lu et al., 2023; Yu et al., 2023). Local data from RSU Hidayah Boyolali mirror this national pattern, indicating an average LOS of 6.29 days and claim deficits in more than 95% of COPD admissions during 2024–2025. Accordingly, the conceptual relationship among these variables can be represented as $\text{PFM} \rightarrow \text{LOS} \rightarrow \text{Inpatient Costs}$. By providing objective severity stratification at admission, PFM facilitates timely interventions that contribute indirectly to faster stabilization, shorter hospitalization, and improved financial efficiency. Recent advancements, including the use of intelligent clinical decision-support systems, further emphasize that integrating simple objective measures such as PFM into clinical pathways enhances triage accuracy, reduces practice variability, and strengthens hospital efficiency frameworks (Rachmawaty et al., 2025; López-Canay et al., 2025; Mujaković et al., 2023; Waeijen-Smit et al., 2024). Of the 28 studies included in this review, a subset of 14 directly examined the interrelationship between PFM, LOS, and inpatient costs. These studies are summarized in Table 1, while the remaining literature contributes to the broader contextual discussion presented in Section 4.

Table 1. Representative studies directly examining links between PFM, LOS, and inpatient costs in COPD. Drawn from the 28 included studies; additional sources are discussed in Section 4 for broader context

No	Authors (Year)	Study Design & Setting	Key Findings	Relevance to Conceptual Pathway
1	Cen et al. (2019)	Prospective observational, China	Low PEF (<100 L/min) predicts need for hospitalization.	$\text{PFM} \rightarrow \text{Severity} \rightarrow \text{LOS}$
2	Cen & Weng (2022)	Comparative study	PEF correlates with LOS and readmission risk.	$\text{PFM} \rightarrow \text{LOS}$
3	Ruparel et al. (2016)	European multicenter audit	LOS variation affects rehospitalization & costs.	$\text{LOS} \rightarrow \text{Cost}$
4	So et al. (2016)	Cohort study	Daily PEF variability indicates instability and longer LOS.	$\text{PFM} \rightarrow \text{LOS}$
5	Satibi et al. (2019)	Cost analysis	Excess LOS $\rightarrow$ real cost > INA-CBGs.	$\text{LOS} \rightarrow \text{Cost}$
6	Suryanegara et al. (2023)	Retrospective multi-hospital Indonesia	$\text{LOS} > 8 \text{ days} \rightarrow \text{deficit } 25\text{--}30\%$.	$\text{LOS} \rightarrow \text{Cost}$
7	Silitonga et al. (2024)	Cross-sectional Indonesia	Long LOS $\rightarrow$ significant tariff gap.	$\text{LOS} \rightarrow \text{Cost}$
8	Yu et al. (2023)	Observational China	$\text{LOS} > 12 \text{ days} \rightarrow 1.8\times \text{ higher costs}$.	$\text{LOS} \rightarrow \text{Cost}$
9	Lu et al. (2023)	Systematic review	Early rehab $\rightarrow \downarrow \text{LOS} \rightarrow \downarrow \text{Cost}$.	LOS mediates intervention effect
10	Rotter et al. (2025)	Cochrane review	Clinical pathway $\rightarrow \downarrow \text{LOS}$ by 1–2 days & $\downarrow \text{costs } 15\%$.	$\text{Pathway} \rightarrow \text{LOS} \rightarrow \text{Cost}$
11	Kim et al. (2025)	Quasi-experimental	Pathway $\downarrow \text{LOS}$, $\uparrow \text{rehab referrals}$.	$\text{Pathway} \rightarrow \text{LOS}$
12	Dilixiati et al. (2024)	Nomogram model	LOS & severity predict high cost.	$\text{LOS} \rightarrow \text{Cost}$
13	Yu et al. (2023)	Cross-sectional China	$\text{LOS} \uparrow \rightarrow \text{cost} \uparrow (1.8\times)$.	$\text{LOS} \rightarrow \text{Cost}$
14	Li et al. (2018)	Retrospective analysis	Each extra LOS day $\uparrow \text{cost}$ by 9%.	$\text{LOS} \rightarrow \text{Cost}$

To further illustrate the synthesized relationships among clinical, managerial, and economic dimensions, Figure 1 presents the conceptual framework derived from the reviewed evidence. The model visualizes how early objective assessment using Peak Flow Meter (PFM) indirectly influences inpatient costs through the mediating effect of length of stay (LOS), while acknowledging the contextual influence of non-modifiable factors such as comorbidity burden. This framework serves as a theoretical foundation for the subsequent discussion, where its implications for clinical practice, policy, and hospital management are examined in depth.

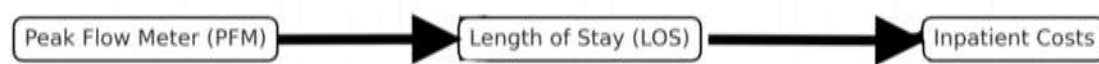


Figure. 1. Conceptual framework depicting the indirect effect of Peak Flow Meter (PFM) assessment on inpatient costs through the mediating variable of length of stay (LOS) among patients with COPD

Discussion

The discussion elaborates on the conceptual framework presented in Figure 2 by interpreting the interrelationships between Peak Flow Meter (PFM) assessment, length of stay (LOS), and inpatient costs. The synthesis highlights how objective clinical assessment through PFM can influence hospital efficiency both directly and indirectly, linking patient-level outcomes with managerial and policy considerations. Each subsection discusses these dimensions in turn, beginning with clinical implications for LOS reduction, followed by policy alignment within Indonesia's healthcare financing reforms, and concluding with managerial strategies for pathway implementation.

Clinical Implications of PFM on LOS

Peak Flow Meter (PFM) assessment holds strategic value in the management of patients hospitalized with acute exacerbations of COPD (AECOPD). Peak Expiratory Flow (PEF) values provide objective information on airway obstruction, complementing clinical evaluation and enabling a more accurate appraisal of disease severity at admission. By strengthening the foundation of decision-making, PFM serves as an early supportive tool in acute care (Cen et al., 2019; Cen & Weng, 2022; Evison et al., 2023; Miravittles et al., 2023). The availability of objective parameters reduces clinical uncertainty, guides therapeutic choices, and accelerates initiation of definitive therapy (Cen & Weng, 2022; Ruparel et al., 2016). Optimized management at admission promotes earlier stabilization, fewer complications, and reduced need for additional interventions, all of which contribute to shorter hospitalization (Agustí et al., 2023). In addition to disease severity, the presence of comorbid conditions can also extend hospitalization due to higher clinical complexity and resource requirements. Since these factors are non-modifiable, early objective assessment using tools such as PFM remains essential to minimize preventable delays and variability in care (Satibi et al., 2019; Suryanegara et al., 2023). Conversely, delayed or inaccurate therapeutic decisions are linked to higher risks of nosocomial complications, repeated exacerbations, and prolonged LOS (Satibi et al., 2019; Suryanegara et al., 2023). Meta-analyses further confirm that extended LOS during AECOPD is associated with increased in-hospital mortality, higher rates of rehospitalization, and poorer recovery trajectories (Li et al., 2018). Evidence also indicates that incorporating early inpatient pulmonary rehabilitation shortens LOS while improving patient outcomes (Pereira et al., 2023).

Guideline reviews underscore this perspective. The Asia Pacific COPD guideline comparison explicitly highlights the role of objective bedside measures when spirometry is not feasible, thereby reinforcing the value of PFM for severity stratification and timely treatment (Cheng & Lin, 2021). Large-scale audits have similarly shown that standardized use of early objective assessment tools, including PFM, reduces variability in management and is directly correlated with lower complication rates and shorter LOS (Meidiawaty, 2024). Taken together, these findings underscore that PFM does not directly shorten hospitalization but indirectly influences LOS by improving the precision of early clinical decision-making. Within this causal chain, LOS becomes the pivotal mediator translating the value of PFM into both improved clinical outcomes and enhanced cost efficiency.

Policy Implications and National Context

These findings carry important implications for health policy in Indonesia. The bundled payment system under INA-CBGs demands efficiency in resource utilization, while variation in LOS for COPD cases remains a major contributor to hospital claim deficits (Satibi et al., 2019; Utami & Fanny, 2021; Yu et al., 2023). National regulations, including the 2019 COPD Clinical Practice Guidelines (PNPK PPOK), emphasize the necessity of objective early assessment to standardize exacerbation management. PFM can be positioned as a supporting instrument to strengthen the implementation of these regulations. The relevance of PFM is further heightened in resource-limited hospitals, such as RSU Hidayah Boyolali, a private type D hospital in Central Java. Local data indicate that the average LOS for COPD inpatients reached 6.29 days, with claim deficits occurring in more than 95% of cases between 2024 and 2025. This underscores that patient management efficiency is not only a national issue but also an urgent challenge for smaller healthcare facilities.

Evidence from Indonesia shows that the implementation of integrated clinical pathways improved patient satisfaction while reducing hospital costs (Rachmawaty et al., 2025). At the global level, standardized discharge bundles or transition-of-care protocols have been proven more cost-effective than conventional management, while also improving continuity of care (Yan et al., 2023). Converging national and international evidence shows that integrating objective bedside assessment into standardized care pathways and prospective payment systems (INA-CBGs/KRIS), alongside data-driven decision-support for LOS prediction, improves tariff–cost alignment, accelerates patient flow, and enhances hospital financial sustainability (Meidiawaty, 2024; Pinheira et al., 2025). In this context, accounting for patient complexity and comorbidity burden through early objective assessment becomes crucial, as these non-modifiable factors often drive cost variation within bundled payment models (Meidiawaty, 2024; Pinheira et al., 2025). Thus, policies that encourage objective assessment at admission and pathway integration in smaller hospitals align with national efforts to improve quality of care and sustain hospital finances.

Furthermore, the health system transformation agenda in Indonesia for 2021–2025, which includes the implementation of the Standardized Inpatient Class (KRIS) policy and the digitalization of INA-CBGs claims emphasizes the need for standardized and measurable care. A simple instrument such as PFM can be embedded within this policy framework as a practical tool to ensure that early patient assessment is objective and consistent across all levels of hospitals. This aligns with global recommendations for adopting scalable technologies that strengthen health system resilience and equity, particularly in post-pandemic recovery strategies (Salvi et al., 2024). In addition, the integration of PFM into national policy frameworks carries broader implications for equity and financial sustainability. By enabling objective assessment in smaller and resource-limited hospitals, PFM reduces disparities in the quality of care between tertiary and peripheral facilities. Moreover, as Indonesia moves toward value-based healthcare and potential bundled payments covering post-discharge services, early assessment tools such as PFM may serve as risk-stratification indicators that inform financing models. Recent work on value-based healthcare in Asia highlights the importance of embedding objective triage parameters

into reimbursement systems to avoid underfunding high-severity cases while promoting efficiency (Lüthi-Corridori et al., 2023). This vision positions PFM not only as a clinical support tool but also as a policy-relevant instrument that bridges equitable access with sustainable financing.

Managerial Implications and Pathway Implementation

From a managerial perspective, incorporating Peak Flow Meter (PFM) assessment into routine admission procedures offers a dual advantage. On one hand, PFM provides objective numerical data that enable physicians to establish accurate therapy earlier, stabilizing patients more quickly and reducing unnecessary interventions. On the other hand, its structured use supports the implementation of evidence-based clinical pathways, which are designed to standardize care processes, minimize variation, and optimize resource utilization (Kim et al., 2025; Kuwornu et al., 2023; Miravittles et al., 2023; Rotter et al., 2025). Evidence consistently shows that clinical pathways are among the most effective managerial strategies to improve both efficiency and quality. Comparative studies across COPD care programs demonstrate that pathway implementation reduces length of stay (LOS) by an average of one to two days and can lower hospital costs by up to 15% (Weiss et al., 2023). Similarly, Kim et al. (2025) demonstrated that an inpatient COPD care pathway shortened hospitalization duration while simultaneously improving referral rates to pulmonary rehabilitation. A 2025 Indonesian study further showed that pathway-based nursing models significantly enhanced patient satisfaction while reducing overall costs and improving continuity of care, while related analyses identified predictors of prolonged LOS that can guide early intervention (Rachmawaty et al., 2025).

Regional cohort data also highlight substantial variation in hospital management and outcomes among COPD cases, underscoring the need for standardized, objective tools at admission, particularly for patients with higher clinical complexity or multiple comorbidities where variability in early management often amplifies LOS differences even under uniform protocols (Rhee et al., 2024). By anchoring the pathway with objective parameters such as PFM, hospitals can ensure that early assessment directly shapes standardized decision-making, reducing uncertainty and accelerating patient flow. The financial implications are equally significant. Since LOS remains the strongest determinant of inpatient costs, pathways that consistently reduce LOS contribute directly to financial sustainability under the INA-CBGs payment model. Indonesian evidence further indicates that prolonged stays beyond eight days result in cost overruns of 25–30% relative to reimbursement (Rachmawaty et al., 2025). Complementary analyses from large tertiary hospitals in China and Southeast Asia demonstrate similar efficiency gains when early objective assessment is integrated into standardized COPD pathways, resulting in measurable financial savings through faster stabilization, reduced diagnostic delays, and improved bed turnover efficiency (Lu et al., 2023; Yu et al., 2023). Thus, implementing a COPD pathway that begins with PFM assessment offers a pragmatic strategy to align clinical practice with financial realities.

For smaller hospitals, which face limited resources and frequent deficits in COPD claims, pathway integration can be a critical management innovation. Embedding PFM into clinical workflows not only strengthens early triage but also provides a low-cost, scalable mechanism to reduce LOS variability. Furthermore, building managerial strategies around PFM-based pathways also contributes to health system resilience. Lessons from the COVID-19 pandemic show that standardized, objective, and scalable interventions enable hospitals to maintain continuity of care under pressure, even when resources are constrained (Saulnier et al., 2023). International implementation experiences confirm that reproducible, low-complexity tools integrated into care pathways achieve higher adherence rates in resource-limited hospitals compared to advanced technologies, highlighting the global relevance of scalable approaches for sustained efficiency and resilience (Ahmed, 2025). This dual impact of improving patient outcomes and easing financial pressures underscores the managerial value of positioning PFM as the entry point to standardized COPD care.

Limitation and Future Research Agenda

This review identifies several knowledge gaps that warrant further empirical investigation. To date, evidence on the direct impact of PFM use on LOS and inpatient costs in Indonesian hospitals remains limited. Most available studies are observational cohorts conducted outside Indonesia (Agustí et al., 2023). A systematic scoping review of COPD guidelines in LMICs further highlighted that current recommendations often lack emphasis on low-cost bedside tools, creating a gap between guideline directives and the realities of resource-limited hospitals (Tabyshova et al., 2021). Therefore, prospective quasi-experimental research is needed to validate the conceptual framework linking PFM, LOS, and inpatient costs within the Indonesian health system.

Future investigations should include evaluations of PFM as part of standardized emergency-department assessments, analyses of its influence on LOS and hospital expenditures, and feasibility testing of integrating PFM into clinical pathways. Recent clinical evaluations in diverse settings (Mujaković et al., 2023; Weiss et al., 2023) along with innovative inpatient management models that combine early pulmonary rehabilitation and intelligent decision-support technologies, demonstrate promising strategies for improving both patient outcomes and hospital efficiency (Lu et al., 2023; Pereira et al., 2023). Furthermore, because comorbidity burden strongly affects both LOS and cost, future studies should control for indices such as the Charlson Comorbidity Index (CCI) to differentiate modifiable from non-modifiable cost drivers within the framework of objective assessment tools like PFM.

Analytical studies could employ pathway analysis or mediation modeling to quantitatively assess the causal mechanism proposed in this review, particularly the mediating role of LOS between PFM use and inpatient costs. Comparative evaluations of PFM against other bedside instruments (e.g., portable spirometry or pulse oximetry) would also help clarify its relative clinical and economic advantages. Multi-center research across type D and type C hospitals in Indonesia would enhance representativeness and provide robust evidence for scalable implementation strategies. In contrast, much of the existing literature in high-income countries remains focused on expensive therapeutic innovations such as biologics for severe asthma and COPD, which may have limited relevance in low- and middle-income contexts (Adhikari et al., 2025). This contrast reinforces the importance of prioritizing simple, affordable, and evidence-based tools like PFM in future Indonesian research agendas.

Beyond clinical applications, further research has strategic implications for national health-financing reform. The INA-CBGs payment system and the ongoing implementation of the Standardized Inpatient Class (KRIS) emphasize the need for objective, measurable, and efficient care processes. By empirically demonstrating the role of PFM in reducing LOS and costs, future studies could provide policymakers with actionable evidence to refine reimbursement structures, strengthen KRIS implementation, and align hospital-financing models with value-based healthcare principles. Positioning research on PFM within this policy framework underscores not only its clinical relevance but also its strategic role in advancing efficiency and sustainability. By generating empirical evidence that PFM-based early assessment reduces LOS and consequently lowers inpatient costs, such studies could guide policymakers in refining INA-CBGs reimbursement standards and enhancing national healthcare equity. In this way, PFM emerges not merely as a bedside diagnostic tool but as a policy-relevant instrument linking objective clinical assessment with financial sustainability under Indonesia's prospective payment system.

Conclusion

This review confirms that Peak Flow Meter (PFM) assessment is a simple yet strategically valuable instrument in the management of hospitalized patients with acute exacerbations of COPD (AECOPD). By providing objective and reproducible data at admission, PFM enhances the precision of clinical decision-making, facilitates earlier initiation of definitive therapy, accelerates clinical stabilization, shortens the length of stay (LOS), and ultimately reduces inpatient costs. The conceptual chain identified in this review demonstrates that PFM functions as the objective entry point, LOS serves as the pivotal mediating variable linking disease severity with both clinical outcomes and resource utilization, and inpatient costs emerge as the final outcome most strongly determined by hospitalization duration. This triad forms a coherent framework that is clinically relevant, managerially actionable, and financially meaningful.

The practical implications are particularly critical in the Indonesian context. Under the INA-CBGs prospective payment system, hospital sustainability is directly tied to operational efficiency, making LOS management a key determinant of financial viability. Local data from RSU Hidayah Boyolali demonstrate that efficiency challenges are not confined to tertiary hospitals but are equally pressing in smaller type D facilities with limited resources. Integrating PFM into admission protocols provides a low-cost, scalable strategy that aligns with Indonesia's broader health-system reform agenda, including the implementation of the Standardized Inpatient Class (KRIS) and the transition toward value-based healthcare financing. Moreover, PFM is uniquely positioned as both a clinical and policy-relevant instrument. Its routine use may help reduce disparities in care quality between tertiary and peripheral hospitals while simultaneously informing policymakers in refining reimbursement models and strengthening national efficiency standards.

In conclusion, incorporating PFM into the initial assessment of COPD patients should be regarded as a strategic, evidence-based initiative to enhance quality of care while safeguarding hospital financial sustainability. Beyond its immediate clinical and managerial benefits, this review emphasizes the need for future empirical research, particularly quasi-experimental and pathway-based analyses, to validate the proposed conceptual framework and generate robust evidence that supports clinical practice, optimizes hospital management, and informs Indonesia's ongoing healthcare reform.

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