



Effects of Clinical Pathway Implementation in Management of Pediatric Inpatients with Pneumonia: A Cross-Sectional Study in Indonesia

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ABSTRACT

Pneumonia is the leading cause of morbidity and mortality in children worldwide. Antibiotics are the mainstay treatment for bacterial pneumonia so their use should be clearly mentioned in the pneumonia clinical pathway (CP). This study aimed to evaluate the effectiveness of pneumonia CP in pediatrics. A cross-sectional observational study was conducted in a private hospital in Indonesia. The inclusion criteria were pediatric patients admitted with pneumonia in the period of January-December 2017 (pre-CP period) and January-December 2018 (post-CP) and receiving antibiotics. The effectiveness of CP was evaluated according to four parameters: length of stay, clinical outcomes, quality (Gyssens antibiogram) and quantity of antibiotics. A total of 121 eligible patients' medical records were analyzed (60 before and 61 after CP implementation). Second and third generation cephalosporins (42.1%) predominated the use of antibiotics pre-CP period, whilst aminoglycosides (59.6%) constituted more than half of antibiotic use in post-CP group. More than half of the patients stayed in the hospital not more than 3 days pre-CP period vs 31.1% post-CP period. Nearly all patients had good clinical outcomes during hospitalization between both periods. The proportion of quality of antibiotics was less than 5% either before or after CP implementation. The quantity of antibiotics post-CP (408.42 defined daily dose/DDD per 100 patient days) was almost two times of pre-CP period (222.42 DDD per 100 patient days). In conclusion, implementation of CP could not achieve the targeted goals to reduce the length of hospitalization and improve the antibiotic use. No discernible difference was observed in clinical outcomes before and after CP implementation.



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INTRODUCTION

Pneumonia has been well-defined as the leading cause of morbidity and mortality in children across the globe, particularly those younger than five years. The World Health Organization (WHO) Child Health Reference Group uncovered the fact that the median global incidence of pneumonia was around 150 million cases per year among young children with 10-20 million hospitalization. Further, the report highlighted another finding that more than 95% of the pneumonia cases occurred in developing countries (WHO, 2019). Besides, according to the United Nations Children's Fund (UNICEF), pneumonia is

responsible for more than 800,000 deaths of young children annually (United Nations Children's Fund, 2020). In the context of Indonesia, in 2017, the Ministry of Health documented more than 500,000 pneumonia cases in children and 2,000 fatalities in this vulnerable population (Center for Data and Information, 2017).

Pneumonia is also attributable to significant treatment costs imposing economic burden for the health system in many countries, in particular, those with limited financial resources. WHO estimated the costs of pneumonia treatment, including diagnostic procedures and antibiotics, was approximately 109 US\$ million each year (WHO, 2019).

Management of pneumonia requires comprehensive and evidence-based treatment to improve clinical outcome and control the treatment costs. The treatment should be under the clinical pathway specified for each disease. Clinical Pathways (CPs) are pivotal components of continuous healthcare quality improvement initiatives (Lawal et al., 2016). CPs are documents constructed to organize and standardize healthcare process. Thus, initiation, development and implementation of CPs are essential to facilitate the optimization of patient outcomes and patient safety and contain the costs concurrently (Vanhaecht et al., 2012).

It has evident that *Streptococcus pneumoniae* is the most typical pathogen of pneumonia in children (Cilloniz et al., 2016). Thus, antibiotics are the mainstay treatment for pneumonia management signifying the pivotal role of rational antibiotic use in this infectious disease. The use of antibiotics should be well-determined and mentioned in the CP for pneumonia. Rational use of antibiotics significantly predicts the improvement of patients' outcomes. Nonetheless, antibiotics used irrationally may lead to some adverse ramifications, including treatment failure, microbial resistance and increased treatment costs (Waseem, 2020). The effectiveness of CP implementation to decrease hospitalization, hospital readmission rates and healthcare costs have been documented in some countries (Rotter et al., 2010). However, CP is regarded as a relatively new issue among Indonesian hospitals with an inadequate evaluation of its implementation.

To some extent, CP has been merely considered as the supporting document for hospital accreditation. As a consequence, little study has been conducted in Indonesia to justify the value of CP. This study aimed to evaluate the effectiveness of CP implementation in the management of pediatric inpatients with pneumonia in Indonesia.

MATERIALS AND METHODS

An observational study with the cross-sectional design was conducted in a private hospital in West Java, Indonesia. The study hospital initiated the implementation of CP for pediatric pneumonia inpatients in January 2018. The CP development involved the participation of multi-disciplinary healthcare professional in the hospitals to draft and finalize the evidence-based CP. Before CP implementation, the paediatricians used varying medical references for supporting their clinical decisions, including the selection of antibiotics. Since the CP implementation, the paediatricians were required to follow pre-specified CP for treating children admitted with pneumonia. The two-page pneumonia CP was developed and made available in the pediatric ward in late 2017. The pneumonia CP was an algorithm designed to provide the staff in pediatric ward with information on the management of pediatric inpatients with pneumonia including the information on the diagnostic examination, the choice of antibiotic therapy regimen and other supportive treatment.

The inclusion criteria for the study samples were pediatric patients admitted with pneumonia in the period of January-December 2017 (pre-implementation of CP) and January-December 2018 (post-implementation) and receiving antibiotics during hospitalization. Patients were excluded if they received antibiotics before hospital admission, had other infectious disease requiring antibiotics, and their medical records were incomplete/unavailable. For sample size estimation, Krejcie and Morgan (1970) was used, and the randomized sampling technique was applied to select the patients. The study was approved by the study hospital and the Institutional Ethics Committee.

Data was collected retrospectively by retrieving patients' medical records. The information retrieved from the medical records were patients' demographic characteristics (age, gender), clinical features (nutritional status, presenting symptoms), length of stay, treatment during hospitalization (symptomatic medicines, antibiotics) and clinical outcomes. There were two clinical outcomes, namely good and poor outcomes. Patients had good clinical outcome if they demonstrated recovery features and were able to continue treatment at home after hospital discharge. Conversely, patients with deteriorating clinical features requiring intensive care and /or referral to other hospital were defined as those with the poor clinical outcome. The effectiveness of CP were evaluated according to

four parameters: length of stay, clinical outcomes, quality and quantity of antibiotics. Gyssens method was used to evaluate the quality of antibiotic use (Gyssens *et al.*, 1992). Guidelines for Pediatric Pneumonia from Indonesian Pediatrician Association (2009) and the study hospital pneumonia CP were used to as the standard for evaluating the quality of antibiotic use before and after CP implementation, respectively. Meanwhile, the Anatomical Therapeutic Chemical classification system and the Defined Daily Dose (ATC-DDD) method was applied to calculate the number of antibiotics (WHO Collaborating Centre for Drug Statistics Methodology, 2018).

Data were analyzed using IBM SPSS Statistics for Windows (version 22.0). Univariate descriptive statistics were applied to describe the demographic characteristics, clinical features, treatment, length of stay, clinical outcomes, the proportion of quality antibiotic and quantity of antibiotic. Comparison of CP effectiveness indicators (length of stay, clinical outcomes and quality of antibiotics) before and after the implementation of CP for pediatric pneumonia were tested using the Chi-Square test. Mann-Whitney test was used to compare the number of antibiotics used between the two periods. Statistical significance was established at $p < 0.05$ for the test.

RESULTS AND DISCUSSION

During the study period, a total of 121 eligible patients' medical records were retrieved and reviewed (60 before and 61 after CP implementation). Both groups were comparable to demographic and clinical characteristics (Table 1). As depicted in Table 1, more than 70% of the patients aged less than five years which were in line with the prevalence data reported in other pediatric studies (Donà *et al.*, 2018; Bradley *et al.*, 2011). From the gender perspective, no significant difference was observed as the proportion of males and females were similar in both groups. Among the study patients, the majority had normal nutritional status leaving less than 40% being under/overnutrition. Fever, respiratory and gastrointestinal-related symptoms were documented as the most frequent presenting problems during patient admission to the hospital.

Concerning the types of antibiotics used before and after CP implementation, no similar trend could be observed (Table 2). As detailed in Table 2, second and third-generation cephalosporins (42.1%) predominated the use of antibiotics pre-CP period. They were followed by penicillins (15.4%), a macrolide (12.44%), aminoglycosides (11.3%) and

carbapenem (8.86%), respectively. The different trend of antibiotic use was seen in the post-CP group, where aminoglycosides constituted more than half of antibiotic use, followed by macrolide with 16.2%. Meanwhile, ceftriaxone as the CP recommended antibiotic was administered to a negligible number of patients accounting 1.2% of antibiotic use for this indication. Besides, as seen in Table 2, there was a significant increase in the use of gentamycin and azithromycin along with the concomitant decrease in the use of cephalosporins and narrow-spectrum beta-lactams (ampicillin, amoxicillin) in the post-CP period. Also, it is important to note that the use of carbapenem (i.e. meropenem) remained relatively steady pre-and post-CP period. Carbapenem should be reserved as a life-saving antibiotic for severe or resistant bacterial infections, so the use of meropenem in this sense may trigger the emergence of carbapenem-resistant bacteria and its serious complication. Further, it was uncovered in our study that injectable antibiotics predominated the route of administration either before or after CP implementation. However, the proportion of oral antibiotics was slightly higher preceding CP period (28.9%) as opposed to after CP came into effect (24.4%). CP has been used to facilitate quality and cost-efficiency in health services. The effectiveness of CP implementation can be evaluated using varying indicators, for example, length of stay, clinical outcomes. In the context of infectious disease, the judicious use of antibiotics can be included as the indicators of successful CP implementation. The effectiveness of CP implementation in the present study was assessed using four parameters: length of stay, clinical outcomes, quality and quantity of antibiotics (Table 3)

As depicted in Table 3, there were no significant differences between the two periods concerning pre-defined parameters of CP effectiveness. With the length of stay, more than half of the patients stayed in the hospital not more than three days pre-CP period, yet the reverse was seen after CP implementation in which nearly 70% of patients were hospitalized for 4-7 days. No discernible trend was observed in clinical outcomes between pre-and post-CP groups as nearly all study patients had good clinical outcomes during hospitalization. It is important to note that CP implementation was yet able to improve the quality of antibiotic prescribing with less than 5% of patients receiving rational antibiotics before and after CP periods. Intriguingly, CP implementation, however, increased the antibiotic consumption as the number of antibiotics administered post-CP was almost two times of pre-CP period ($p = 0.408$).

Table 1: Patients' Demographic and Clinical Characteristics Before and After Implementation of Pneumonia Clinical Pathway (CP)

Variables	Before CP Implementation (N=60) No. (%)	After CP Implementation (N=61) No. (%)	p-value
Age (years)			
<1	22 (36.7)	25 (41.0)	0.758
1-5	27 (45.0)	24 (39.3)	
6-10	8 (13.3)	11 (18.0)	
>10	3 (5.0)	1 (1.6)	
Gender			
Male	31 (51.7)	36 (59.0)	0.416
Female	29 (48.3)	25 (41.0)	
Nutritional status			
Undernutrition	13 (21.7)	7 (11.5)	0.319
Normal	38 (63.3)	44 (72.1)	
Overnutrition	9 (15.0)	10 (16.4)	
Presenting symptoms			
Fever	49 (81.7)	49 (81.7)	0.972
Cough	51 (85.0)	46 (75.4)	0.273
Shortness of Breath	26 (43.3)	46 (75.4)	0.006
Runny Nose	31 (51.7)	23 (37.7)	0.172
Diarrhoea	12 (20.0)	7 (11.5)	0.301
Nausea/Vomiting	31 (51.7)	28 (46.7)	0.259
Others	15 (25.0)	8 (13.3)	0.590

When comparing our findings with other international and national studies investigating the effectiveness of CP implementation, the results were mixed considerably. Implementation of CP for pediatric pneumonia in Italian setting (inpatient and outpatient) uncovered that CP implementation significantly decreased the prescription of broad-spectrum antibiotics (e.g. macrolides, second and third-generation cephalosporins) and duration of treatment ([Donà et al., 2018](#)). The proportion of patients receiving broad-spectrum antibiotics halved and duration of antibiotic treatment reduced by two days post-CP period. However, no significant difference was documented in the length of hospital stay and treatment failure between pre-and post-CP groups ([Donà et al., 2018](#)). A multi-site study in China involving adult and pediatric patients admitted with pneumonia found compliance rate with the recommended antibiotics was far higher in the CP group (80.1%) compared to its non-CP counterpart (52.5%) ([Zhu et al., 2018](#)). A multicenter study in the United States of America (USA) conducted to assess the effectiveness of CP for managing pediatric asthma patients found that CP compliance had a

direct impact on the length of stay reduction ([Kaiser et al., 2018](#)). Another American study undertaken by Bryan et al. found that concordance to CP for respiratory infections in a children's hospital was associated with shorter length of stay and lower hospitalization costs. The use of CP may decrease the length of hospitalization by approximately one day and decreased the hospitalization costs by approximately US\$82 per patient ([Bryan et al., 2017](#)).

The evidence regarding CP effectiveness was also sourced from some national studies ([Siswanto and Chalidyanto, 2020](#); [Adiwisastira et al., 2019](#); [Fadilah and Budi, 2017](#)). A study conducted in a private hospital in Surabaya uncovered no correlation between CP compliance and length of stay of pediatric patients with gastrointestinal infections ([Siswanto and Chalidyanto, 2020](#)). A study evaluating the effectiveness of CHF in the management of dengue hemorrhagic fever in pediatric patients in Yogyakarta found that CP can significantly reduce the duration of hospital stay. Consistent with our study, that study revealed that CP was yet able to improve patient outcomes in this acute viral infection ([Fadilah and Budi, 2017](#)). Clini-

Table 2: Types and Quantity of Antibiotics Administered Before and After Clinical Pathway (CP) Implementation

Types of Antibiotics	Pre-CP Period (Total Defined Daily Dose/DDD per 100 patient days = 222.41)		Pre-CP Period (Total Defined Daily Dose/DDD per 100 patient days = 408.42)	
	DDD per 100 patient days	Drug Utilization (%)	DDD per 100 patient days	Drug Utilization (%)
Cephalosporins				
Cefixime p.o	30.90	13.9	3.42	0.9
Cefotaxime i.v	18.80	8.5	18.05	4.4
Ceftriaxone i.v	35.70	16.1	4.9	1.2
Cefoperazone. v	8,30	3,7	-	-
Ceftazidime i.v	4.20	1.9	-	-
Penicillins				
Ampicillin i.v	14.33	6.4	12.7	3.1
Amoxicillin p.o	-	-	2.28	0.6
Amoxicillin plus clavulanic acid p.o	5.83	2.6	0.86	0.21
Ampicillin-sulbactam i.v	14.02	6.3	-	-
Meropenem i.v	19.70	8.9	26.56	6.5
Aminoglycosides				
Gentamicin i.v	19.08	8.6	235.2	57.6
Amikacin i.v	6.0	2.7	8.2	2.0
Azithromycin p.o	27.66	12.4	66.25	16.2
Chloramphenicol i.v	17.40	7.8	3.40	0.9
Metronidazole i.v	0.50	0.2	-	-
Nitrofurantoin p.o	-	-	26.6	6.5

i.v = intravenous administration, p.o = peroral administration

Table 3: Four Parameters of Clinical Pathway (CP) Effectiveness Before and After CP Implementation

Parameters	Pre-CP Period (N=60)	Post-CP Period (N=61)	P-value
Length of stay, No. (%)			
1-3 days	31 (51.7)	19 (31.1)	0.065
4-7 days	29 (48.3)	42 (68.9)	
Quality of antibiotics, No. (%)			
Quantity of antibiotics (in Defined Daily Dose per 100 patient days)	222,42	408.42	0.408
Clinical Outcomes, No. (%)			
Good outcome	59 (98.3)	60 (98.4)	1.000
Poor/deteriorating outcome	1 (1.7)	1 (1.6)	

cal outcomes are likely determined by multitude factors, for example, patient severity, nature of the disease (acute or chronic) and other factors. Another national study was conducted in West Java, in which the study assessed the effectiveness of CP for the management of gastroenteritis in pediatric inpatients. The study above revealed that CP was significantly effective to increase the rational use of antibiotics, decrease the number of antibiotics prescribed and decrease the length of hospital stay without compromising the targeted clinical outcomes ([Adi-wisastra et al., 2019](#)).

It is interesting to note that implementation of CP in the current study could not achieve the targeted goals to reduce the resource use (i.e. length of stay) and improve the antibiotic use (quality and quantity indicators). To some extent, low compliance to CP after its implementation may be attributed to the suboptimal findings. Regarding the types of antibiotics used, the majority of antibiotics prescribed were not in line with that of CP, where only 21.7% and 19.7% of antibiotics used pre-and post-CP, respectively, conformed with CP. Low level of compliance among prescribers in selecting antibiotics in this study might be due to the differences of antibiotic selection between those written in CP and the external guidelines such as that set by Indonesian Association of Pediatricians (IDAI) ([Indonesian Pediatrician Association, 2009](#)).

IDAI in its guideline-recommended amoxicillin with the alternatives including amoxicillin-clavulanic acid, cefaclor and macrolides for children less than five years, and macrolides as empirical antibiotics of choice for children > 5 years. Besides, the guideline mentioned injectable ampicillin, chloramphenicol, amoxicillin-clavulanic acid and, second and third-generation cephalosporins as the recommended antibiotic for children who cannot tolerate oral antibiotics ([Indonesian Pediatrician Association, 2009](#)). By contrast, CP in the study hospital only mentioned third-generation cephalosporins (i.e. ceftriaxone) as the first-line treatment, and the CP did not mention alternative antibiotics, including oral regimens.

The clinicians likely preferred to comply with the recommendations from external references instead of hospital guideline. CP in the study hospital should be reviewed further as injectable ceftriaxone was assigned as the recommended antibiotic. If this treatment was less effective, there was a high likelihood to change to a more potent broader spectrum antibiotic such as carbapenem. Besides, inadequate dissemination on CP-related information and training sessions on CP use was likely to be the contribu-

tors of CP non-compliance.

A comprehensive review highlighted its paramount findings that successful CP implementation was predicted by some determinants including the novelty of evidence supporting CP, effective dissemination approaches, adequate support from the organization, continuous collaboration and communication among healthcare professionals, availability of regular audit and monitoring of CP implementation ([Asmirajanti et al., 2018](#)).

An Australian study uncovered that CP was successful in improving adherence to pneumonia treatment in hospital if CP implementation was supplemented by monthly feedback from an organization ([Almatar et al., 2016](#)). Unfortunately, up to now, there is no national pneumonia CP in Indonesia despite the presence of guidelines for treating pneumonia published Indonesian Pulmonologist Association. The absence of national CP for treating pneumonia, particularly, may lead to high variation in antibiotic use. Lack of reward and punishment approach to evaluate the CP compliance among healthcare professionals may contribute to a low level of CP compliance.

CP utilization to change antibiotic prescribing behaviour have demonstrated a positive impact in a range of settings in many countries ([Jenkins et al., 2013](#); [Weiss et al., 2011](#); [Dellit et al., 2008](#)). Besides, the effective use of CP to decrease unnecessary use of broad-spectrum antibiotics for treating patients with pneumonia has been documented in a primary care setting in the USA highlighting the positive results of CP were not exclusive for hospital setting ([Jenkins et al., 2013](#)). Some barriers of poor adherence to CP might include poor support from organization (e.g. hospital management), inadequate dissemination of CP leading to lack of awareness, lack of participation from clinicians during CP development creating the presence of conflicting guidelines in the same institution ([Schouten et al., 2007](#)).

Some strategies should be conducted to ensure the utmost benefits of CP implementation. It has been evident that successful implementation of CP required some strategies including updating the content of existing CPs regularly to ensure the patients could receive the best evidence-based care, dissemination of the CPs to healthcare professionals, so the frontline clinicians are well-informed as to the existence of the CPs as the guidance for their clinical practice followed by tailored educational sessions to improve CP awareness among the clinicians, engaging senior doctors during the CP development, provision of regular audit and feedback to clinicians during CP implementation ([Almatar et al.,](#)

2016; Lawal *et al.*, 2016).

Some limitations of this study should be acknowledged. The study was conducted using a retrospective approach in which the researcher relied on documentation of patients' data on medical records that may be subject to reporting bias. Modest sample size pre- and post-CP periods, and the use of a single-centre setting may limit the generalizability of the study.

CONCLUSION

Our findings showed that the implementation of CP could not achieve the targeted goals to reduce the length of hospitalization and improve the antibiotic use (quality and quantity indicators). No discernible difference was observed in clinical outcomes before and after CP implementation. Low compliance with CP among healthcare professionals may be attributed to the suboptimal findings. However, the study highlighted the significant findings that CP development and implementation were merely the initial phases of the long-term process to ensure its use as a useful tool for improving healthcare quality. The initial phases should be followed by continuous monitoring and evaluation of its content and implementation.

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Conflict of Interest

The authors declare that they have no conflict of interest for this study.

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