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Original Article

AWaRe ANTIBIOTIC SURVEILLANCE MANAGEMENT AND TREATMENT DOCUMENTATION IN INPATIENT MEDICATION THERAPY MONITORING

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ABSTRACT

Background. Medication therapy monitoring can support antibiotic surveillance if records distinguish treatment decisions from pharmacy transactions.

Research Purpose. To describe the Access, Watch and Reserve profile of documented inpatient antibiotics, assess the traceability of treatment decisions, and determine how including antibiotics identified only in billing changed the profile.

Research Method. A retrospective descriptive audit screened inpatient forms from an Indonesian district hospital. We classified each charted systemic antibiotic outside tuberculosis regimens once per admission, assessed documentation from initiation to discharge, and repeated the classification with additional agents found only in billing records.

Findings. Fifteen episodes were screened. Nine met the criteria and contributed fourteen distinct combinations of episode and antibiotic. Watch antibiotics predominated, with ceftriaxone most frequent. All absent or conflicting start dates concerned Watch agents. Only one explicit stop date was found and it conflicted with the narrative. No documented review could be traced through to implementation. Adding antibiotics identified only in billing increased the Watch share.

Conclusion. The audit identifies third generation cephalosporins as a local priority for stewardship review. Linking treatment decisions to orders and administration records would help verify implementation and clarify discrepancies at discharge.

Keywords: Antibiotic Stewardship, Antibiotic Use, AWaRe, Medication Therapy Monitoring, Surveillance.

BACKGROUND

Bacterial antimicrobial resistance was estimated to cause 1.14 million deaths in 2021, and international surveillance shows substantial variation in antibiotic use [1, 2]. The World Health Organization (WHO) Access, Watch and Reserve (AWaRe) classification can help hospitals select regimens for review. Assessing whether an antibiotic was appropriate still requires the indication and clinical context [3, 4].

Indonesian studies have identified variation in prescribing and barriers to collecting and analysing stewardship data [5, 6]. Qibtiyah and colleagues assessed consumption and prescribing quality separately [7]. Natadidjaja and colleagues examined initial empirical intravenous therapy across ten hospitals [8]. These studies help explain which drugs are

used and how they are selected. They leave open whether a later decision to continue, change or stop an antibiotic can be traced to its implementation.

Surveys in Viet Nam and the Dutch–Belgian border area found that elements of the initial regimen were more often documented than the full treatment plan or stop and review dates [9, 10]. Pharmacy supply and medication administration records can also disagree [11]. A charge can help locate a missing record, but it cannot verify that a dose was given.

This study aimed to describe the Access, Watch and Reserve profile of documented inpatient antibiotics, assess the traceability of treatment decisions, and determine how including antibiotics identified only in billing changed the profile. The audit contributes a comparison of two source rules within the same episodes. Linking AWaRe classification, decision documentation and unmatched charges for each episode and agent shows which records need verification before use in local surveillance.

RESEARCH METHOD

Design and Setting

This retrospective descriptive audit examined inpatient medication therapy monitoring (MTM) forms from September 2026 at RSUD Bakti Pajajaran, a public general hospital in Bogor Regency, West Java, Indonesia. The forms bear the former name, RSUD Cibinong [12]. This study has passed ethical clearance from Ethic Research Commision Universitas Pembangunan Nasional "Veteran" Jakarta number 209/VII/2026/KEP date of 28 July 2026. The selected dataset comprised 15 available forms, some with itemised billing, and a transaction workbook linked to three existing neurology episodes. It was neither a random nor a consecutive sample of admissions.

Episode Selection and Source Linkage

One episode was the admission represented by one MTM form. Eligibility required a systemic antibacterial outside a tuberculosis regimen with a timing mark in the current admission chart. We excluded agents used solely for tuberculosis, topical antibacterials, antifungals, earlier admission drugs and theoretical examples. Billing alone did not confer eligibility.

An existing index linked the three workbook sheets to forms using available identifiers and the admission period. We standardised generic names, matched billing entries by episode and agent, and checked dates and locations where available. We rechecked discrepancies against the source and retained unresolved or missing entries. Table 1 summarises how each source was used. Episode codes replaced direct identifiers.

Table 1. Source Rules For Extracting And Interpreting Antibiotic Data

Source	Data Extracted	Interpretation
MTM treatment chart	Agent, dose, frequency, route, start and stop fields, and timing marks.	Timing marks were not verified against administration records.
MTM notes and discharge list	Indication, culture result, recommendations, decisions and discharge regimen.	Recommendations, decisions and implementation were coded separately.
Itemised billing and workbook	Active ingredient, transaction date and location, and unmatched agents.	A charge is a transaction, not confirmation of a dose.
History and theory	Drugs for previous admissions or listed as guideline examples.	Excluded from the current admission counts.

Units and Traceability Measures

Each active ingredient contributed one episode–agent pair per admission regardless of strength, number of entries or repeat courses. We classified agents using the 2025 WHO AWaRe list [3] and recorded route as oral or parenteral. Repeated overlap required timing marks on at least two shared dates. A single shared date could not establish combination therapy or a switch.

We organised documentation measures around initiation, review and transition using Start Smart Then Focus as an interpretive framework [13]. We coded start dates as explicit and consistent, explicit but conflicting, or absent. A conflict meant that start fields disagreed with one another or with timing marks. The first marked day did not replace a missing start date. A stop date required an explicit entry in the designated field. Conflicts with billing were assessed separately.

A traceable review required a dated decision for the agent, a rationale and a chart entry consistent with implementation. Blank cells or charges did not confirm implementation. A traceable switch required a linked decision and chart evidence that parenteral treatment stopped and oral treatment started. A discharge list recorded a plan without confirming supply or use. Culture documentation required a specimen and a result.

Descriptive Analysis

We used counts, percentages, and the median and range of agents per episode. Charted pairs were the denominator for the antibiotic profile and chart fields. Selection, culture and switching used episode denominators. The sensitivity analysis added unmatched non-tuberculosis agents from billing within the same eligible episodes. We retained one pair per agent per episode and express the difference in Watch share in percentage points.

We did not impute missing information or perform hypothesis tests. Incomplete data on indication, severity and response prevented assessment of appropriateness. Missing administration and length of stay data precluded calculation of days of therapy, defined daily doses and rates per patient-days [14]. There was no independent second extraction or validation against electronic orders and medication administration records.

FINDINGS

Episode selection and antibiotic profile

We screened 15 episodes: 12 adults and three children. Nine episodes had an eligible charted antibiotic, comprising six adults and all three children (Figure 1). Six adult episodes lacked a charted non-tuberculosis systemic antibiotic meeting the timing criterion. One of the six listed cefixime only for an earlier admission.

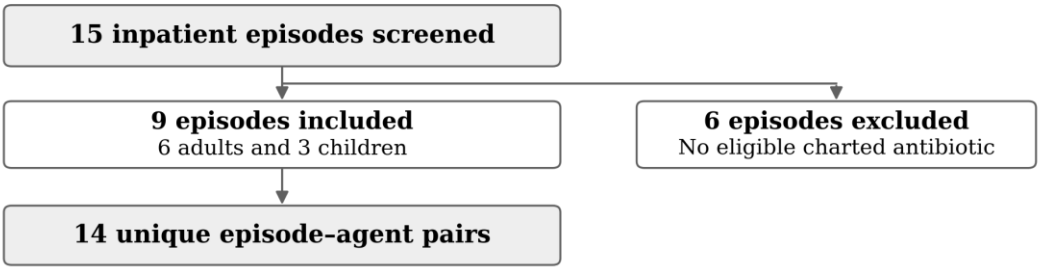


Figure 1. Selection of Episodes and Derivation of The Primary Analysis Denominator

The nine included episodes contributed 14 pairs across seven agents (Table 2). Ten pairs were parenteral (71.4%) and four oral (28.6%). The median was two agents per episode (range, one to two). Five episodes had two agents; four had repeated timing overlap. In the other episode, ceftriaxone and cefixime shared only the date on which the discharge regimen was recorded.

Table 2. Documented Antibiotics by Unique Episode–Agent Pair

Agent	WHO AWaRe	Recorded route	n	%
Ceftriaxone	Watch	Parenteral	6	42.9
Cefotaxime	Watch	Parenteral	2	14.3
Cefixime	Watch	Oral	2	14.3
Procaine benzylpenicillin	Access	Parenteral	1	7.1
Gentamicin	Access	Parenteral	1	7.1
Clindamycin	Access	Oral	1	7.1
Metronidazole	Access	Oral	1	7.1
Total	—	—	14	100.0

Denominator: 14 pairs. Percentages describe charted pairs and may not sum to the total because of rounding.

Ten pairs (71.4%) were Watch, all third generation cephalosporins, and four (28.6%) were Access. No Reserve agent was documented. Ceftriaxone was the most frequent agent (6/14 pairs), accounting for six of the ten Watch pairs. Each included episode had at least one Watch agent. Table 3 shows how the charted regimens were linked to gaps in the documented decisions.

Table 3. Charted Regimens and Documentation Gaps by Episode

Code	Clinical Context	Regimen in Treatment Chart	Item Requiring Verification
K02	Adult; stroke with swallowing difficulty	Ceftriaxone 2 g × 1 (P); cefixime 200 mg × 2 (O)	Cefixime appeared in the discharge plan without a linked switch decision or indication.
K04	Adult; heart failure and recorded infection	Ceftriaxone 2 g × 1 (P); clindamycin 300 mg × 3 (O)	The ceftriaxone stop field conflicted with the narrative. Clindamycin frequency differed between the discharge day note and the plan.
K06	Adult; cardiac illness and pneumonia	Cefixime 200 mg × 2 (O)	The chart listed a start date but no review or stop date.
K08	Adult; wound with suspected infection	Ceftriaxone 2 g × 1 (P); metronidazole 500 mg × 3 (O)	The ceftriaxone start field was blank. Later blank cells could not verify a stop.
K11	Adult; respiratory illness and tuberculosis	Ceftriaxone 2 g × 1 (P)	The ceftriaxone indication was unclear. Ofloxacin was documented for tuberculosis.
K12	Adult; pneumonia with tuberculosis in the differential	Ceftriaxone 2 g × 1 (P)	Ceftriaxone was billed before its charted start. Cefixime was found only in billing.
K13	Infant; pneumonia with congenital heart disease	Cefotaxime 300 mg × 2 (P); gentamicin 50 mg × 1 (P)	Cefotaxime had conflicting start dates. No response or implementation was linked to a proposed gentamicin stop.
K14	Infant; congenital infection	Procaine benzylpenicillin 185,000 IU × 1 (P); cefotaxime 150 mg × 2 (P)	A treatment day annotation and subsequent charge could not establish continuity or a specific injection route.
K15	Child; pneumonia and other acute illness	Ceftriaxone 650 mg × 2 (P)	The chart gave two start dates. Levofloxacin and cefixime appeared only in billing.

P, parenteral; O, oral; IU, international units. The number after × is the charted daily frequency.

Traceability of treatment decisions

All pairs had a recorded dose and frequency, but only eight had an explicit start date that was internally consistent (57.1%). Two start dates conflicted (14.3%) and four were absent (28.6%). All six start date gaps occurred in Watch pairs (6/10 Watch versus 0/4 Access). Table 4 reports these documentation measures by group.

Table 4. Documentation by AWaRe Group in The Primary Analysis

Documentation Indicator	Access (n = 4)	Watch (n = 10)	All pairs (n = 14)
Dose and frequency recorded	4	10	14
Start date explicit and internally consistent	4	4	8
Start date explicit but conflicting	0	2	2
Start date absent	0	4	4
Explicit stop date recorded	0	1	1
Decision linked to chart evidence of implementation	0	0	0

The three start date categories are mutually exclusive. The only explicit stop date conflicted with the clinical narrative.

Ceftriaxone in K04 was the only pair with an explicit stop date (1/14). No pair had all the elements needed to trace a review decision through to implementation. Cefixime in K02 and clindamycin in K04 were recorded in discharge plans, but no switch could be verified in the eight episodes with a charted parenteral agent. One episode (K14) recorded a negative blood culture. The record did not establish the timing of sampling in relation to the first antibiotic dose, and no susceptibility result was linked to a regimen change.

Reconciliation of treatment charts and billing

Among the same nine episodes, three had four additional pairs found only in billing: cefixime in three episodes and levofloxacin in one. The count increased from 14 to 18 pairs and from seven to eight agents. The Watch share rose from 71.4% (10/14) to 77.8% (14/18), a difference of 6.3 percentage points calculated before rounding (Figure 2). Access remained at four pairs.

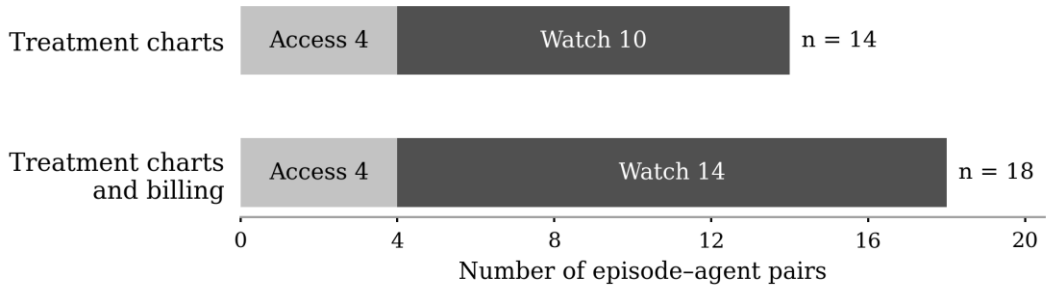


Figure 2. AWaRe Composition Under the Two Source Rules

Table 5 shows the main timing and transaction discrepancies. Matched pairs were counted once; unmatched charges entered only the sensitivity analysis.

Table 5. Examples of Reconciliation and Their Analytical Treatment

Code	Records Compared	Analytical Decision
K02	Both agents matched the chart. One cefixime line total differed from quantity multiplied by unit price.	Counted each charted agent once. Charge amounts were not used to measure use.

Code	Records Compared	Analytical Decision
K12	Ceftriaxone was billed a day before the chart start. Cefixime was billed on discharge day.	Retained the recorded chart start. Cefixime entered only the sensitivity analysis.
K13	Cefixime syrup was billed on discharge day without a corresponding clinical regimen.	Counted cefixime only in the sensitivity analysis. A switch was unverified.
K14	Procaine benzylpenicillin had a day ten annotation, followed by a charge the next day. One chart column was out of sequence.	Did not infer duration from timing marks or vial charges.
K15	Levofloxacin and cefixime were billing-only. The header discharge date preceded admission.	Included both agents only in the sensitivity analysis. The header did not support a length of stay estimate.

DISCUSSIONS

AWaRe and The Choice of Surveillance Priorities

Watch agents predominated and accounted for all missing or conflicting start dates. Ceftriaxone was the most frequent charted agent. It also led surgical ward consumption in Qibtiyah and colleagues' study, at 41.67 defined daily doses per 100 bed-days, while an Indonesian emergency department study ranked cefixime first [7, 15]. Both studies highlight third generation cephalosporins. Our episode–agent measure gives each drug equal weight per admission, so it cannot rank the volume of use or be compared directly with prescription counts.

Vu and colleagues reported a Watch share of 69.7% in five Vietnamese referral hospitals [9], close to our 71.4%. Their survey counted prescriptions on a single day at each site, with a different case mix. Hospital characteristics influence antibiotic profiles [16]. A Southeast Asian survey of neonates and infants recorded Reserve agents [17]; finding none here does not establish lower resistance. Ceftriaxone is a local review priority because it appeared frequently. Indication, severity and susceptibility information are needed to assess individual choices [3, 4].

Natadidjaja and colleagues assessed initial empirical intravenous choices [8]. This audit complements that work by asking whether a later decision could be linked to its implementation. The distinction matters when an MTM form identifies a concern but the pharmacist needs an order or administration record to verify what the team did.

Why The Source Changes The Watch Share

The Watch share rose by 6.3 percentage points when four unmatched charges were added. Because all four were Watch and the episodes were unchanged, the rise reflects the source rule, without establishing additional exposure. Walker and colleagues also found discrepancies between pharmacy supply and electronic administration [11]. Although supply and billing represent different events, both studies show why the source of each entry must remain identifiable.

Sakai and colleagues validated automated data for administration and indication against a point prevalence survey [18]. In a prospective audit here, the order history,

electronic medication administration record (eMAR) and discharge prescription could distinguish an administered dose from discharge supply or an unexplained charge. A missing start date instead calls for a check of the order and first documented dose.

From Documented Regimen to Verified Review

Vu and colleagues reported that 90.1% of prescriptions recorded an indication, while 5.3% recorded a stop or review date [9]. In nine Dutch and Belgian hospitals, 95.0% recorded dose and interval and 71.0% recorded a stop or review date [10]. Dose and frequency were likewise easier to find in our forms. Our measures are stricter: we counted an explicit stop date separately from a dated review with a rationale and evidence of implementation. In K04, the chart recorded a stop date, but the narrative described an earlier instruction. The date field alone could not show when the instruction took effect.

The ARK-Hospital trial and a pharmacist-led time-out pilot evaluated structured review; DETOURS used a safety screen before discussing de-escalation for suspected sepsis [19–21]. The Start Smart Then Focus toolkit recommends reassessment at 48 to 72 hours [13]. A local review could record the clinical evidence, rationale and decision, then match the decision to the order and administration record. This would distinguish a recommendation from an implemented action.

Adult pneumonia guidance and a duration meta-analysis support considering disease severity and clinical stability when deciding how long to treat [22–24]. SCOUT-CAP evaluated shorter therapy in children improving on outpatient treatment [25]. These studies inform what to assess during review, but the incomplete indications and response data in our audit prevented judging the appropriate duration.

Diagnostic Evidence and Follow Up For Safety

K14 had a negative blood culture, but sampling time was unverified. A Jakarta survey used specimens taken before antibiotics, while Bright STAR targeted unnecessary paediatric cultures [26, 27]. An audit should record the indication and timing of collection. The procaine benzylpenicillin annotation and charge did not establish the route or continuity of treatment for the recorded congenital infection [28].

K13 listed gentamicin with furosemide and proposed checking renal function and considering stopping gentamicin. Furosemide labelling identifies increased ototoxic potential with aminoglycosides [29]. The form did not link a monitoring result or order change to the recommendation. It did not establish harm.

Route Transition and Discharge Reconciliation

Cefixime appeared on the K02 discharge plan without a verified switch, and swallowing difficulty made oral suitability relevant. Three other episodes contained oral antibiotics in billing alone. Adult switch criteria consider clinical improvement, oral suitability and the infection being treated [30, 31]. A Veterans Affairs study measured early switching within a defined window [32]. Our forms do not establish switch frequency or eligibility.

Route conversion and spectrum narrowing are separate decisions. The discharge plan should link the oral dose and remaining duration to the inpatient course. A stewardship trial improved prescribing for selected diagnoses without reducing overall discharge antibiotic use, and pharmacist-led reconciliation reduced unintentional discrepancies after discharge [33, 34]. This supports measuring discharge plan quality alongside antibiotic volume.

A Prospective Stewardship Audit

Table 6 proposes measures for a ceftriaxone pilot. The first administered dose would anchor the review window, and pharmacy could check the team's decisions against orders and administration.

Table 6. Proposed Measures for A Prospective Stewardship Audit

Focus	Numerator / Denominator	Verification Source
Initial regimen	Complete start plan* / all new eligible regimens.	Order and MTM form.
Timely review	Dated decision with rationale within the review window / all regimens eligible for review.	First dose and review note.
Implementation	Actions verified / all documented review decisions.	Order history and eMAR.
Billing linkage	Unmatched pairs resolved / all unmatched pairs reviewed.	Billing, eMAR and discharge records.
Discharge plan	Plans with duration and instructions / all discharge regimens.	Prescription and counselling record.

*A complete start plan records indication, dose, route, start time and planned review. No proposed measure was estimated in this audit.

INSPIRE reduced empiric extended-spectrum treatment for pneumonia with risk-based prompts, while COMPASS did not significantly reduce its primary antibiotic use outcome [35, 36]. A local evaluation should measure use of the prompts and verified implementation. Exposure and patient outcomes require validated data and separate denominators.

Strengths and Limitations

A fixed set of episodes allowed direct comparison of the two source rules. The sample was small, nonrandom and from one hospital. The forms may omit decisions recorded elsewhere, billing coverage varied, and repeat courses of an agent were counted once. The findings therefore cannot estimate hospital prevalence, treatment appropriateness, resistance or outcomes.

Future studies should sample consecutive admissions over a longer period across more wards or hospitals. Two independent extractors should apply a shared codebook, report percentage agreement and Cohen's kappa, and resolve differences by consensus or a third reviewer. Electronic orders, eMAR and discharge prescriptions should be used to validate the implementation indicators and verify unmatched billing entries.

CONCLUSION

Third generation cephalosporins, particularly ceftriaxone, were the main priority for local review. Antibiotics identified only in billing increased the apparent Watch share, and treatment decisions were rarely traceable through to implementation. A prospective audit should link each regimen to its indication, review decision, orders, administration and discharge plan.

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Conflict of Interest. The authors declare no conflicts of interest.

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